Western
Pacific
Regional
Fishery
Management
Council

March 8, 2002

Mr. Rod McInnis
Acting Regional Administrator
National Marine Fisheries Service
501 W Ocean Blvd
Long Beach, California 90802-4213

Dear Rod:

Pursuant to section 303(h)(1) and 304(a)(1) of the Magnuson Stevens Fishery Conservation and Management Act, the Western Pacific Regional Fishery Management Council (Council) requests that the National Marine Fisheries Service (NMFS) transmit the Final Fishery Management Plan (FMP) for Coral Reef Ecosystems of the Western Pacific, including the Final Environmental Impact Statement and Essential Fish Habitat document to the Secretary of Commerce for Secretarial Review. This landmark plan is the nation's first ecosystem-based FMP and is the culmination of over five years of diligent work by many colleagues within the Council and NMFS families and the public at large. Key in the development of this FMP has been the extensive and in-depth reviews it has received which have shaped the contents of the final document.

The FMP includes specific objectives to promote sustainable fisheries while providing for substantial protection of coral reef ecosystem resources and habitat throughout the Council's jurisdiction. The FMP establishes a network of marine protected areas throughout the region's coral reef habitats. Twelve percent of U.S. coral reef habitat have been designated no-take areas. The plan also establishes permit and reporting requirements for monitoring the harvest of coral reef resources, and contains measures to minimize impacts on coral reef habitat including, a prohibition on the use of destructive and non-selective fishing gears, and a prohibition on the harvest of coral and live rock, except for limited amounts under a special permit for seed stock by aquaculture operations and collection by indigenous people for traditional and ceremonial purposes. More importantly, the plan incorporates an adaptive management approach using a framework process for rapid regulatory modifications in the event of major changes within coral reef ecosystems or coral reef fisheries.

The Council understands the NMFS has the complete package and the appropriate copies of the plan and the accompanying documents which the Council transmitted in November 2001. Therefore, the Council requests NMFS to complete the plan review in a timely manner to protect the coral reefs and associated marine resources in the Western Pacific Region.

Sincerely,

Kitty M. Simonds
Executive Director

FINAL
FISHERY MANAGEMENT PLAN
FOR
CORAL REEF ECOSYSTEMS OF THE WESTERN PACIFIC REGION

Volume I

Including:

Amendment 7	Bottomfish and Seamount Groundfish Fisheries
Amendment 11	Crustaceans Fisheries
Amendment 5	Precious Corals Fisheries
Amendment 10	Pelagics Fisheries

Western Pacific Regional Fishery Management Council

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PREFACE

The Fishery Management Plan (FMP) for Coral Reef Ecosystems of the Western Pacific Region is the "first ever ecosystem-based plan for fisheries developed in the U.S." (NOAA 2001-R103, 1/30/01).

The central feature of the FMP is adaptive management, which recognizes the uncertainty, changing conditions and resilience associated with coral reef ecosystems. The emphasis is not on controlling short-term harvest so much as maintaining coral reef ecosystems and their capacity for natural resource regeneration for the long-term.

The many preparers of the FMP were often sharply divided on how to best achieve this objective. Their differences may be explained by "conceptual pluralism" (Norgaard 1994). Following Colchester (1994), Long and Long (1992), Blaikie and Jeanrenaud (1996), and Berkes (1999), resource management needs to recognize pluralistic thinking:

1. There exist different actors (i.e., stakeholders) who relate in different ways to resources (coral reef and other);
2. The actors define knowledge, ecological relations and resources in different ways and at different levels of geographic scales;
3. They bring to bear on these definitions their culture and their experience; and,
4. They will use different definitions in pursuit of their own interests or political agendas.

The most fundamental difference is between the Western perspective-that even low levels of human activity are an intrusion on the ecosystem-and the Pacific Island indigenous vision-that proper use of natural resources is essential to their sustainability, and that people who have no personal relationship with the resources lose respect for them.

The Magnuson-Stevens Fishery Conservation and Management Act, Endangered Species Act, and other pertinent U.S. laws, as the products of Western culture, represent but one cultural perspective on natural resource management. Pacific Island management systems represent another. These systems have allowed Pacific Islanders to survive for several millennia by coexisting with coral reef resources, and are best viewed as adaptive responses that have evolved over time, not as mere traditions (Berkes 1999). As a pluralistic society, the United States should provide room for both Western and non-Western knowledge of and perspectives on coral reef resource conservation.

Rooted in diverse views and cultures, different stakeholders may never be able to reach consensus. This FMP provides a resource management system open to alternative ways of thinking and a methodological framework in which different cultures, stakeholders and knowledge systems can find common ground in the area of coral reef management.

EXECUTIVE SUMMARY

The Fishery Management Plan (FMP) for Coral Reef Ecosystems of the Western Pacific Region was developed by the Western Pacific Regional Fishery Management Council (WPRFMC, or Council) using an ecosystem-based approach. A recent report to Congress by the Ecosystem Principals Advisory Board recommends that FMPs be developed as "Fisheries Ecosystem Plans" covering the ecosystems under a Council's jurisdiction. This FMP represents the first such fishery ecosystem plan developed in the United States.

About 70% of the world's coral reefs and 94% of the coral reefs under U.S. jurisdiction are located in the Pacific Ocean. Coral reefs cover an estimated 15,852 km^2 of the shallow ocean bottom around U.S. Pacific Island areas served by the Council, which includes the State of Hawaii, the Territories of American Samoa and Guam, the Commonwealth of the Northern Mariana Islands, and the Pacific remote island areas (PRIAs) of Johnston Atoll, Kingman Reef, Palmyra and Midway Atolls, and Jarvis, Howland, Baker and Wake Islands. Some 90% of coral reefs in the region's exclusive economic zone (EEZ, or the 200-mile limit) are found in remote areas, away from fishing communities.

Coral reefs are very diverse ecosystems that provide many benefits to mankind. They build atolls, protect island shores from coastal erosion and wave damage, support fisheries of cultural and economic value, provide a natural medicine cabinet for traditional healing and biomedical research, and serve as museums of the world's tropical marine biodiversity.

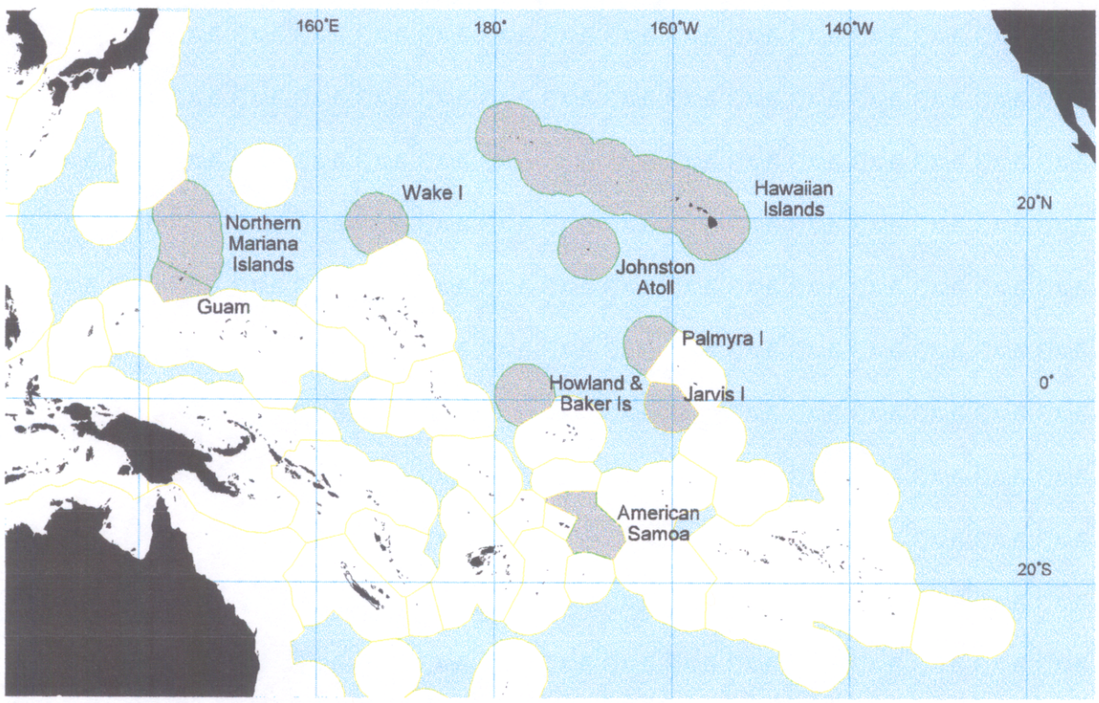

Figure E1: Western Pacific Region. EEZ areas under WPRFMC jurisdiction in grey.

The Pacific Islands were settled long ago, and these indigenous people represent an important part of U.S. Pacific island populations today. Their cultures historically depended on coral reefs to meet varied social-subsistence, economic, and spiritual needs. These needs and values continue to shape and support these distinct cultures today. Resident and tourism-related recreation—important parts of contemporary island economies—also depend on healthy nearshore coral reef resources.

This FMP uses a precautionary approach; in so doing it addresses potential problems before they can occur and establishes a management regime that can quickly adapt to changes. Local regulations control most of the impacts of resource exploitation on nearshore coral reefs in settled areas. This FMP complements these efforts by implementing measures to conserve coral reef ecosystems in the Western Pacific Region's EEZ. Although these areas have as yet been minimally exploited, there is potential for fisheries to expand into them. Possible sources of this expansion include existing nearshore fisheries for coral reef species, new fisheries for the live fish markets in Southeast Asia, expanded fisheries for coral and "live rock" for the U.S. aquarium trade, and developing fisheries for pharmaceutical uses. In addition, the holistic vision intrinsic in this plan allows impacts—stemming from natural environmental changes, other FMP managed fisheries, and non-fishing anthropogenic impacts, such as dredging—to be better understood.

FMP Goal and Objectives

The overall goal of the Coral Reef Ecosystems FMP (CRE-FMP) is to establish a management regime for the entire Western Pacific Region that will maintain sustainable coral reef fisheries while preventing any adverse impacts to stocks, habitat, protected species, or the ecosystem. Based on this goal, and consistent with an ecosystem-based management approach, the Council formulated eight objectives. The objectives promote sustainable use of coral reef resources, especially by fishing communities and indigenous fishermen in the region, an adaptive management approach based on fishery-dependent and fishery-independent research, marine protected areas and habitat conservation, cooperative and coordinated management by the various agencies concerned with the conservation of coral reef resources, and education to foster public support for management. These objectives are:

1. To foster sustainable use of multi-species resources in an ecologically and culturally sensitive manner, through the use of the precautionary approach and ecosystem-based resource management.
2. To provide a flexible and responsive management system for coral reef resources that can rapidly adapt to changes in resource abundance, new scientific information, and changes in fishing patterns among user groups or by area.
3. To establish integrated resource data collection and permitting systems, establish a research and monitoring program to collect fishery and other ecological information, and to collect scientific data necessary to make informed management decisions about coral reef ecosystems in the EEZ.

4. To minimize adverse human impacts on coral reef resources by establishing new—and improving existing—marine protected areas, managing fishing pressure, controlling wasteful harvest practices, reducing other anthropogenic stressors directly affecting coral reef resources, and allowing the recovery of naturally-balanced reef systems. This objective includes the conservation and protection of essential fish habitats.

5. To improve public and government awareness and understanding of coral reef ecosystems and their vulnerability and resource potential in order to reduce adverse human impacts and foster support for management.

6. To collaborate with other agencies and organizations concerned with the conservation of coral reefs, in order to share in decision-making and to obtain and share data and resources needed to effectively monitor this vast and complex ecosystem.

7. To encourage and promote improved surveillance and enforcement to support the plan's management measures.

8. Provide for sustainable participation by fishing communities in coral reef fisheries and, to the extent practicable, minimize the adverse economic impacts on such communities.

Management Measures

In order to achieve its goal, the FMP implements the following management measures.

Marine Protected Areas (MPAs)

EEZ coral reefs in unpopulated areas—the Pacific remote island areas, the Northwestern Hawaiian Islands, and Rose Atoll in American Samoa—are designated MPAs. The outer boundary for these MPAs is the 50-fm isobath. A zone-based management approach is applied to MPA design and designation, distinguishing no-take and low-use areas. Fishing is prohibited in no-take MPAs, including that by existing FMP fisheries. No-take MPAs are delineated by the 10-fm isobath, except for certain ecologically sensitive areas where the boundary is extended to the 50-fm isobath. These areas are French Frigate Shoals, Laysan Island, the northern half of Midway Atoll, Jarvis Island, Howland Island, Baker Island, Kingman Reef and Rose Atoll. All other areas within the 50-fm isobath would by default become low-use MPAs, where fishing is tightly controlled by a special permit requirement and other conditions for fishing. Although not an MPA in the sense of having these restrictions, Guam's Southern Banks is designated as a no-anchoring zone.

All extractive activities would be prohibited in no-take MPAs, except for small harvests related to scientific research and related resource management. Existing FMPs are amended to prohibit take of their respective management unit species (MUS) in addition to this FMP's MUS from no-take MPAs. In low-use MPAs existing fishing activities, and recreational fisheries by residents on certain remote islands, would be allowed under special permits. New fisheries and fishing by indigenous people could be allowed under special permits. Existing FMP fisheries in low-use MPAs would follow the permit and reporting requirements already established in their respective FMPs.

All fishing vessels transiting MPAs, including those regulated under the Council's already-implemented FMPs, would be required to carry insurance in order to pay for the costs of vessel removal and habitat damage mitigation in the event of a grounding. The Council felt that prohibiting large non-fishing vessels, and in particular cruise ships, from entering MPAs would be beneficial. However, the Council does not have the authority to regulate these vessels. Several longer-term, cooperative efforts are proposed to manage the potential impacts of these vessels.

Using the framework process, vessel anchoring areas may be designated in MPAs at a future date. The only immediate restriction in this FMP applies to large fishing vessels (those longer than 50 ft) at Guam's Southern Banks, which would be prohibited from anchoring.

Permits and Monitoring

Locally administered monitoring systems (such as creel surveys) will provide information from populated areas. If needed, a general permit could be developed and implemented for EEZ reef fisheries, using a so-called framework process to modify FMP management measures. For unpopulated areas, where coral reefs would be designated as marine protected areas, special permits would regulate fishing and other types of fishing-related resource use, except in no-take MPAs where fishing would not be allowed. Special permits would also be required for new fisheries on coral reef taxa previously unreported in catch reports. Under this permit regime, the harvesting of live rock and coral would be specifically prohibited. However, the Council identified four exemptions to this permit regime. Permit holders in other FMP-managed fisheries would not have to obtain an additional permit for incidental catch of coral reef taxa, because they are already required to report all incidental catch. Indigenous people, aquaculture operations, and scientific management activities would be exempted from the prohibition on the harvest of live hard coral and wild live rock. These three activities would require permits: a special permit for the first two and a scientific permit, established under existing regulations and issued by the NMFS Regional Administrator, for the third. In addition, the allowable take would be limited.

Fishing Gears and Methods

Three conditions on gear use, in order to minimize habitat and resource impacts, are incorporated into this FMP. The Council also developed a list of allowable gear types, which includes the following: (1) hand harvest; (2) spear; (3) slurp gun; (4) hand/dip net; (5) hoop net for Kona crab; (6) throw net; (7) barrier net for aquarium fish; (8) surround/purse seine net for targeted schooling fish (e.g., *akule*, baitfish, *weke*) with a minimum of bycatch; (9) hook-and-line (powered and unpowered handlines, rod and reel, and trolling); (10) traps (with conditions); and (11) remote operating vehicles/submersibles. The following gears are specifically prohibited for coral reef management unit species: gillnets, trawls, dredges, tanglenets, longlines, explosives, and poisons. Finally, scuba-assisted spearfishing is prohibited at night in the Pacific remote island areas and the Northwestern Hawaiian Islands.

Other Management Measures

ADAPTIVE MANAGEMENT: A framework process, providing an administratively simplified procedure for FMP modification, is an important component of the FMP.

NON-REGULATORY MEASURES: A set of measures, consistent with FMP objectives, will be implemented by the Council outside of the regulatory regime. This includes the process and criteria for essential fish habitat consultations, formal plan team coordination to identify and address ecosystem impacts from existing FMP fisheries, facilitating consistent state and territorial level management, and research and education efforts.

Consideration for the NWHI Coral Reef Ecosystem Reserve

On 4 December 2000 President Clinton issued Executive Order (EO) 13178 which established the NWHI Coral Reef Ecosystem Reserve (NWHI Reserve). That Order was later amended by Executive Order 13196 issued 18 January 2001. The NWHI Reserve extends from the seaward boundaries of the Hawaiian Islands National Wildlife Refuge and the State of Hawaii to 50 nmi around all NWHI. The NWHI Reserve is intended to be a temporary management regime until completion of the process to designate certain coral reef areas around the NWHI as a National Marine Sanctuary. Conservation and management measures contained in the NWHI EOs include:

1. A cap on commercial and recreational fishing throughout the NWHI Reserve at the "previous year's" (from 4 December 2000) level of effort and take. (The bottomfish level would be based on an individual's average over the previous 5 years).
2. Establishment of 15 Reserve Preservation Areas in which almost all activities are prohibited seaward to 100 fm around most islands. (Bottomfishing and recreational trolling would be allowed in waters deeper than 25 or 50 fm around some islands.)
3. Prohibition on anchoring on live or dead coral, where the bottom can be seen.
4. Prohibition on anchoring where buoys are available or outside a yet-to-be-determined designated area.
5. General prohibition on the removal of living/non-living resources (with exceptions).
6. Prohibition on the taking or touching of living or dead coral.
7. General prohibition on discharging or depositing any material, except cooling water or engine exhaust (with few exceptions).
8. Additional restrictions on non-fishing activities.
9. Native Hawaiian uses to be allowed in yet-to-be-identified sub-areas. These activities would be restricted to subsistence, cultural, and religious purposes and would be allowed in both the Reserve and Reserve Preservation Area.

The NWHI EOs also established the NWHI Reserve Council, whose membership includes Native Hawaiian representatives, representatives from non-Federal scientific communities, representatives from non-governmental organizations, commercial and recreational fishing industry representatives, an ocean-related tourism industry representative, a non-Federal marine conservation representative, a citizen at large representative and one representative from the State of Hawaii. The membership also includes one representative each from the

Department of the Interior, the Departments of State and Defense, the United States Coast Guard, the National Marine Fisheries Service, the Hawaiian Islands Humpback Whale National Marine Sanctuary, the National Science Foundation, the Marine Mammal Commission and the Western Pacific Regional Fishery Management Council. The function of the NWHI Reserve Council is to provide the Secretary of Commerce with advice and recommendations on the Reserve Operations Plan and designation and management of any sanctuary. However, the Council is not tasked with preparing or developing any plans or documents.

Currently, it is unknown how the NWHI EOs will ultimately affect existing fisheries operating within the boundaries of the NWHI Reserve. However, because these executive orders will prohibit almost all extractive activities to 50 nautical miles around most islands, the NWHI Reserve will provide an ideal location for conducting scientific research, as it could provide unique opportunities for:

- Establishing a baseline for assessing the health of coral reef ecosystems;
- Determining the impacts of oceanic regime shifts on reproduction, recruitment and productivity of the coral reef ecosystem and associated marine resources;
- Assessing the effects of oceanic regime shifts on representative coral reef habitats (i.e., effects on the coral reef ecosystem at Kure vs. effects on the coral reef ecosystems at Nihoa);
- Determining the degree of habitat impacts attributed to storms and hurricanes;
- Determining the primary factors influencing the survival of the Hawaiian monk seal;
- Determining ecological relationships between reef fish with the surrounding environment and population dynamics during different life stages; and,
- Assessing and monitoring ecosystem dynamics in an environment relatively free of anthropogenic impacts.

The NWHI Reserve may also provide an impetus to generate funds and direct resources toward cleaning marine debris, avoiding vessel groundings, and cleaning-up toxic sites such as at Tern Island, French Frigate Shoals. Additionally, the NWHI Reserve could also provide expanded opportunities for scientific research and education activities, and closer coordination among stakeholders in determining research priorities. Administratively, the establishment of the NWHI Reserve would alleviate some of the burdens to fishery management agencies tasked with developing fishery management plans and issuing permits for NWHI fisheries.

Scientific data collected on marine organisms in the NWHI in the absence of fishing or other human activities would be relatively academic. The information would reflect an ecosystem where changes in species abundance and productivity would be largely related to prevailing oceanographic and environmental conditions. Because at least portions of this unique coral reef ecosystem, with low species diversity and high endemism, are surviving at or near the limit of suitable environmental conditions, the applicability of this information as a baseline in comparison with unexploited coral reefs in the Western Pacific Region is open to debate.

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CHAPTER 1

INTRODUCTION TO THE PLAN

1.1 Prologue

Long before Western contact and association with the U.S., what are now the U.S. Pacific Islands were settled by seafaring peoples whose continued survival depended on fishing wisely. This is the basis for indigenous islanders' cultural and spiritual relationship with marine resources, especially coral reef resources. It is not surprising, therefore, that the indigenous cultures of the U.S. Pacific Islands abound in proverbs, myths, and legends about coral reef resources. A few of these follow.

Hawaiian

Translated from the Hawaiian chant of creation, *Kumulipo* (Beckwith 1951):

> The night gave birth
> Born was *Kumulipo* in the night, male
> Born was *Po`ele* in the night, female
> Born was the coral polyp, born was the coral, came forth
> .....(over 2,000 more lines of the creation chant follow)

Hawaiians of old used products of the coral reef for nearly every purpose. Some organisms were collected to extract medicine. Some organisms had a darker purpose. *Limu make*, a soft coral *(Palythoa toxica)*, contained a deadly poison. Scientists from the Hawaii Institute of Marine Biology traveled to Kanewai, Hana, island of Maui in December 1961 to collect specimens for research. They were warned by native residents of the area that *limu make* was *kapu* (forbidden). That same day, a fire of undetermined origin occurred at their Coconut Island marine laboratory, completely destroying the main building (Titcomb 1978).

Samoan

The *tulavae* is a portion of the fish net made by one person. All of the *tulavae* made by a section of the village are joined into a *fata*. The totality of the *fata* forms the complete net. A person who has supplied a *tulavae* for the *fata* is entitled to take part in the fishing and to share in the catch.

Ua `ou seuseu ma le fata. "I am fishing because I have helped to make a *fata*."

The saying means: I have the right to take part in the discussion.

Chamorro

Long ago, Guam was inhabited by a race of superhuman people (known as the taotaomona) who were capable of magic. One day, fishermen noticed that Hagatna Bay and Pago Bay were growing. They saw that a giant parrotfish was nibbling at the shoreline and eating away the island. "If this keeps up, our island will be cut into two pieces," they said. Their search could not find the fish, however.

Every day, maidens would gather at Hagatna Springs to wash their beautiful long hair and rinse it with the juice of lemons. The maidens noticed that the discarded lemon peels they had thrown into Hagatna Bay later appeared in Pago Bay. Thinking that the giant fish was tunneling between bays, they were determined to trap it. The maidens cut off their long hair and wove it into a magic net. They sang into the tunnel to lure the fish into Hagatna Bay where it became tangled in the net made from their hair. This is how their island was saved from destruction.

Pacific Remote Island Areas

In Marshallese tradition, Eneen-Kio (Wake Island) was associated with a large bird whose bones were used to fashion tattooing chisels. Legend recounts that when a chief required a tattoo the only suitable chisels were made from human bones or the bones of this large bird, most likely the albatross. The albatross nested on Eneen-Kio but only flew over the other Marshall Islands. When a human sacrifice was selected, he could be spared if he was able to procure the proper bird bones for the tattooing chisel. This required a voyage to Eneen-Kio. Archeological surveys of other Pacific remote island areas provide little evidence of human habitation or use prior to Western contact.

1.2 History of Coral Reef Resource Use and Management

The seafaring people who settled Samoa, Hawaii, and the Mariana Islands depended on marine fisheries–and especially coral reef resources–for protein in their diet. Through much trial and error, the indigenous peoples devised social and cultural controls to foster, in modern terminology, "sustainable" use of these resources several thousand years before Western forms of marine resource management were introduced. After European contact, Westernization eroded island cultures and subsistence economies; but islanders have perpetuated some ancestral fishing techniques, sophisticated knowledge of marine resources, and a code of fishing conduct.

Fisheries for coral reef resources in the U.S. Pacific Islands are multi-species and multi-gear. Harvesting methods include hand gathering, hook-and-line, spear, and various types of nets and traps. The existing fisheries target several hundred different species of inshore fishes, invertebrates, and in Hawaii, seaweeds, with most of the harvest from reef areas near the main populated islands. Many of the fisheries that currently harvest coral reef resources in the U.S. Pacific Islands can be traced back to fishing methods that were practiced by indigenous populations hundreds to thousands of years ago. Population growth, cash

economies, Western laws designating the oceans as a commons, breakdown of traditional knowledge, and the introduction of modern, manufactured gear have magnified the impact of these fisheries in modern times. They are managed under island government laws and regulations. (These governments are the Territories of American Samoa and Guam, the State of Hawaii, and the Commonwealth of the Northern Mariana Islands.) More recently, established fisheries that target coral reef resources for the marine ornamental products market are also controlled, to varying degrees, by island governments.

Fishing controls vary among the different island governments, but they include commercial fishing licenses, gear restrictions, bag limits, seasonal closures, and minimum size restrictions for possession and sale of fish. In addition to specific limitations on fishing effort and catch, some island governments have closed particular reefs indefinitely to most types of fishing, and have zoned other areas to separate competing uses. Destructive fishing methods, such as explosives and poisons, are prohibited by the island governments.

A few fisheries reef-related resources are harvested farther offshore in the U.S. Exclusive Economic Zone (EEZ) surrounding U.S. Pacific Islands. These commercial and semi-commercial activities require boats. Bottomfish are taken by hook-and-line on deep slopes in the EEZ around American Samoa, Guam, Hawaii, and CNMI. Spiny and slipper lobster are trapped in some areas of the Northwest Hawaiian Islands (NWHI).

These and other fisheries in the EEZ around the U.S. Pacific Islands are managed by the Western Pacific Regional Fishery Management Council (hereafter, the Council). The Council is composed of government officials and members of the public who reflect various interests. Its primary function is to prepare, evaluate, and revise FMPs, which must balance long-term conservation of fish stocks and fish habitats with optimal use of these resources. These plans must be approved by the Secretary of Commerce before implementation.

1.3 Purpose and Need for Action

Coral reefs are relatively robust and have survived millions of years of natural disturbance. Despite such long-term resiliency, however, reefs undergo episodes of high natural stress. Human uses of, and impacts on, reefs have never been higher, and there is growing concern that human stressors could add to cumulative natural impacts on reefs in the Western Pacific Region. A Fishery Management Plan (FMP) for Coral Reef Ecosystems of the Western Pacific region is needed:

- To establish a management regime for the protection and sustainable use of coral reef ecosystems and their associated marine resources.

- To anticipate and avoid potential damage to essential and non-renewable coral reef habitat.

- To address the secondary effects of all reef-related fisheries on non-target coral reef resources, thereby encouraging ecosystem-scale management.

- To ensure that newly emerging coral reef fisheries are managed using precautionary principals and the best available information.

- To manage new underwater harvesting technologies that are extending the depth and time limits at which coral reef resources can be harvested.

- To encourage coherent and coordinated coral reef management, monitoring, and enforcement across jurisdictional boundaries.

- To facilitate consensual management that considers all types of stakeholders, and adaptive management that considers new data and unforeseen impacts.

- To allow sustained use of the coral reef resources, which are important for the continuity of indigenous cultures in the U.S. Pacific Islands.

Stony corals are among the principal reef-framework-building organisms in the U.S. Pacific Islands. In 1998, global coral bleaching and die-off was unprecedented in geographic extent, depth, and severity. Several studies have related bleaching to the combination of increased ultraviolet radiation and ocean warming, phenomena that may be exacerbated by human activities. Projected long-term climatic changes are likely to expose stony corals to an increasingly hostile environment and could possibly lead to mass extinctions.

The degradation and destruction of essential habitats for many coral reef species' reproduction and recruitment is of foremost concern. To date, non-fishing activities—such as coastal and harbor development, watershed land use practices and runoff, industrial discharges, and military use—have caused much of the damage to coral reef habitats in the U.S. Pacific Islands, but fishing and non-fishing vessels also have the potential to degrade habitat through vessel grounding, anchoring, introduction of invasive exotic marine species, and substrate scouring and ghost fishing by derelict gear and other marine debris. Removing live rock and using destructive fishing techniques, such as explosives and poisons, can also directly affect coral reef habitats. Because many resources that contribute to coral reef habitat are essentially non-renewable, when gauged by our life span, preventing damage, rather than mitigating its effects, is a far more effective strategy.

1.3.1 Ecosystem Effects of Established Fisheries

Fisheries for coral reef resources are well established around the inhabited U.S. Pacific Islands. Currently, most coral reef fishing occurs on nearshore reefs, which are regulated by U.S. Pacific Island governments, while the Council, through its FMPs, manages fisheries in the federal EEZ. Fishermen use a wide variety of gear and some of these gear types, or the ways in which they are used, can cause habitat degradation. For example, a new method of

reef fishing with gill nets was recently introduced to Hawaii. When retrieved by hydraulically-powered reels from depths of 10 to 100 m, the nets snag and damage the bottom. Lobster tangle nets used in nearshore areas around the main Hawaiian Islands have the same impact. The State of Hawaii has taken action to control destructive gill-netting in state waters around the main Hawaiian Islands, but no equivalent regulations apply in federal EEZ waters surrounding other U.S. Pacific Islands.

Although the Council has already developed and implemented four FMPs—to manage pelagic, bottomfish, lobster, and precious coral fisheries in federal waters—they do not comprehensively address fisheries targeting coral reef resources. In addition, they have been crafted around conventional fishery management objectives: to prevent overfishing; minimize bycatch; and produce optimum yield of target resources. There are, however, no procedures or requirements for monitoring or managing ecosystem effects of reef-related fishing activities. As a result, their management regimes may overlook the potential for secondary effects on non-targeted resources resulting from effects on habitat and other interactions. Such effects, if severe enough, can bring about undesirable structural or functional changes to complex coral reef ecosystems. Fortunately, hook-and-line, longline, lobster traps, and hand harvest—the predominant gear types used in Council-managed fisheries—are not known to cause significant adverse impacts to coral reef habitat (URS Corp., in prep). Several other measures also limit the ecosystem effects of these fisheries. First, these FMPs prohibit fishing with potentially destructive fishing gear such as bottom trawls, bottom-set nets, explosives, and poisons. Second, the Precious Corals FMP prohibits using non-selective gear to harvest precious corals in the MHI. A regulatory adjustment to this FMP—developed by the Council and awaiting secretarial approval—will extend this prohibition to the entire Western Pacific Region EEZ.

There are two ways that the four implemented Council FMPs, along with this FMP, can more effectively address ecosystem effects. First, recently implemented essential fish habitat (EFH) provisions are designed to prevent, mitigate, or minimize any adverse habitat effects, when it can be documented that these impacts result from fishing. (See Chapter 6 in this volume and Volume III for a discussion of EFH.) These effects can include physical, chemical, or biological alterations of the substrate and loss of, or injury to, benthic organisms and prey species, their habitats, and other components of the ecosystem. Second, this Coral Reef Ecosystem FMP (CRE-FMP) outlines a formal process to coordinate the plan teams established under each of the Council's FMPs. This process will allow plan team members to identify and control the secondary effects that may result from fisheries managed by the Council's four implemented FMPs. Similarly, this CRE-FMP also describes a mechanism to enhance coordination and cooperation with State, territorial, and other agencies managing coral reef resources in the Western Pacific Region.

1.3.2 Ecosystem Effects of Developing Fisheries

Coral reefs represent one of the Earth's most genetically and biologically diverse and undocumented environments (Birkeland 1997a). Because a coral reef ecosystem is composed of many species with a long co-evolutionary history, removing certain species may result in undesirable changes in ecosystem structure or function, such as a predominance of less valuable generalist species. Most species of reef organisms have small body size, restricted dispersal, and small geographic ranges. They often have low population densities and low turnover rates that limit the potential harvest of any single species.

Bioprospecting for emerging biomedical and natural products industries, and the expanding trade in marine ornamental products, coupled with new harvest technologies, could result in the harvest of organisms whose characteristics—particular life cycle, place in the food web, or their abundance and distribution—are poorly understood or completely unknown. Like the tropical rainforest, their terrestrial equivalent, coral reefs harbor hundreds of thousands of mostly cryptic and unnamed species.

Bioprospecting

The search for promising new medicines provides strong incentives to explore coral reef ecosystems for potentially useful resources. This activity is known as "bioprospecting." This search for novel natural products for medicine, industry, and agriculture has become an established field over the past quarter-century. About half of the potential pharmaceuticals being explored are from the ocean, many from coral reef ecosystems.

The companies involved in the business are often billion-dollar corporations. Due to the high profiles of bioprospectors and some initial harmful bioprospecting, advocate groups have been active in impeding wholesale harvest and protecting the rights of local indigenous groups throughout the world. In addition, the Convention on Biological Diversity, drafted at the Rio Earth Summit, recommends strong measures to protect against harmful bioprospecting. These companies now write detailed contracts with local and indigenous groups, strictly regulate harvest, negotiate up-front cash and royalties for successful products, train local people in the field, and offer means for environmental protection.

Pharmaceutical companies are only interested in collecting enough material from the wild to screen for active ingredients that could be useful for biomedical applications. Virtually any coral reef resource could become a target for bioprospecting, including species presently unknown to science and for which there is no understanding of sustainable yield. Million-dollar grants have been given for medical bioprospecting in coral reef ecosystems in the Pacific basin, although not yet in the U.S. Pacific Islands. Coral reef resources that have already attracted research interest include bryozoans, sponges, tunicates, coral, and seaweeds. The most interesting chemicals are usually species-specific; these species may be rare or patchily distributed, and the natural production of the active chemical may vary in time and space (Birkeland 1997a).

Initial screening of the organisms, generally algae, sponges, and lower invertebrates, requires less than 1 kg of sample material. If a potentially useful bioproduct is discovered, the laboratory will make every attempt to synthesize the product in the lab without collection of additional samples. The reason for this is two-fold. Most important, this research requires multiple replications under strict protocols to verify the nature and intensity of bioactivity, and natural variation between samples of the same species can confound these protocols. Therefore, laboratory-grown samples or synthesized products are necessary for large-scale development and production. Second, field sampling is expensive and samples often arrive at the laboratory in poor condition for screening.

Several organizations are bioprospecting on reefs near several U.S. Pacific Islands. The U.S. National Cancer Institute has contracted the Coral Reef Research Foundation, a non-profit organization based in the Republic of Belau, to collect and identify coral reef and other marine organisms for anti-cancer and anti-AIDS screening tests (CRRF 2000). In addition, the University of Guam Marine Laboratory is seeking new examples of the chemical deterrents that coral reef organisms possess to deter predators. They are collaborating with researchers at the University of Hawaii, who are also examining the properties of these chemical deterrents. Some of these substances could have biomedical uses: they might kill cancer cells; halt inflammatory responses; or deter microbes and viruses. Other substances may be effective insecticides for use in agriculture.

Since its founding in 1999, the Marine Biotechnology Engineering Center in the Department of Oceanography at the University of Hawaii has been actively screening organisms from the marine environment. This multi-disciplinary group connects researchers from many University departments with industry sponsors. In addition, the Governor of Hawaii has made biotechnology industry development a priority for State economic development; and the most prestigious biotechnology conference in the world is scheduled to take place in Hawaii in 2004. Bioprospecting in the EEZ around U.S. Pacific Islands can be socially beneficial, with minimal adverse effects, if it is carefully monitored and managed. The take of potentially-harvested coral reef resources can be maintained at safe levels while new resource information is gathered to estimate biological reference points, assess sustainable yields, and learn how to improve management of new fisheries.

Marine Ornamentals Collection

With dramatic improvements in husbandry techniques and distribution abilities, the private sector marine aquarium trade has expanded considerably in the past decade. This trade, encompassing both public and private aquaria and including pet shop retailing, imports hundreds of species of reef-dwelling fish, corals, and other invertebrates.

Coral reef organisms for the marine aquarium trade are predominantly collected in the Indo-Pacific region. This trade involves numerous species of reef fish (especially angelfish, butterflyfish, and damselfish), and a widening spectrum of invertebrates, including corals, anemones, crustaceans, molluscs, polychaetes, echinoderms, and sponges. Endemic coral

reef resources could become locally extinct if heavily collected in their limited range of distribution. In order to address some of their impacts, the aquarium trade is developing education and conservation projects meant to improve fish survivability. These projects include captive breeding of fishes, propagation of corals, and education about advanced husbandry techniques. The goal of these efforts is to significantly decrease the number of species harvested from the wild. So far, few marine ornamental products are collected from reef areas in the EEZ around U.S. Pacific Islands. Nevertheless, the rapidly expanding reef ornamentals industry could soon begin harvesting coral reef resources in some areas of the U.S. Pacific Islands' EEZs.

Live Rock Harvest

Harvesting coral reef habitat itself, in the form of "live rock," is rapidly increasing in the marine ornamentals trade. These rocks consist of stony corals, soft corals, and other attractive reef substrates. Their removal is harmful because many extracted coral species grow so slowly that, in human terms at least, they can be considered non-renewable resources. In addition to a direct loss of valuable habitat, the harvest of live rock substratum unavoidably includes an incidental harvest of commensal and infaunal organisms, which are removed with the rock.

The harvest and possession of live rock and certain coral species are prohibited, with limited exceptions, by island governments in the U.S. Pacific Islands. Collection of live rock and hard coral in the EEZ is completely unregulated, however. Both Hawaii and Guam have recently faced cases in which live rock or coral was being exported, but prosecution was impeded by claims that the collection took place outside territorial waters in the EEZ. This demonstrates that management and enforcement is currently inadequate and cannot effectively control this threat in the EEZ around the U.S. Pacific Islands.

Improvements in Underwater Harvesting Technology

Long established reef-related fisheries in the U.S. Pacific Islands employ conventional types of gear, subject to regulation by the island governments and through FMPs. Advances in scuba technology (e.g., mixed gas, rebreather) and manned and unmanned submersibles are providing greater access to deep-water coral reef resources. As this technology becomes more affordable, fishing pressure will increase on high-value species that are already heavily exploited at shallower depths. Unless new harvesting technologies are monitored and controlled, they could harm the reproductive capacity of species that have slow population turnover or those with few reproductive-size adults because of heavy fishing in shallow habitats.

Recently, the demand for small, immature black coral colonies has increased because of the growing popularity of household marine aquaria. To date, black coral in Hawaii has been hand harvested by a small group of divers using conventional compressed air scuba gear. Divers using this gear can safely descend to a maximum depth of less than 75 m. However, it is likely that in the near future black coral divers will start using mixed-gas diving methods or

re-breathers that enable divers to increase both their safe diving depth and their bottom time. Already, some harvesters are experimenting with towed underwater camera systems and other devices that may increase the output from old harvest areas and lead to the discovery of new beds (URS Corp. in prep).

Manned submersibles and remotely-operated vehicles are still very expensive, but during the past two decades innovations in submersible technology in the petroleum and defense industries have significantly reduced their capital and operating costs (URS Corp. in prep).

1.3.3 Need for Comprehensive Ecosystem-Based Management, Monitoring, and Enforcement

Reefs extend across jurisdictional boundaries, and mechanisms for coordinated management among different government agencies are largely *ad hoc*. Reefs in nearshore areas are under the jurisdiction of the island governments. Coral reef resources in the EEZ are managed by the Departments of Commerce and Interior. Fisheries throughout the U.S. EEZ—including coral reef fisheries—are managed under the authority of the Magnuson Fishery and Conservation Act of 1997, as amended (MSFCMA). This legislation delegates much of the responsibility to regional councils. The reef-related bottomfish and lobster fisheries conducted in the EEZ around the NWHI have been actively managed by the Council for more than a decade.

The management objectives of the various agencies are not consistent. Even when effective regulations are in place enforcement is difficult, labor intensive, and often inadequate. Fragmented jurisdiction and management authority complicate prosecution of violators. Coral reefs represent an extreme in biological diversity, habitat complexity, and competing demands for resource use. Only holistic management is likely to be effective.

1.3.4 Need for Consensual and Adaptive Management

A wide range of consumptive and non-consumptive activities, commercial and non-commercial uses, and resident and non-resident populations compete for coral reef resources. Residents of the U.S. Pacific Islands include significant numbers of indigenous people whose cultures are dependent on fishing and seafood. Increased tourism-related ocean recreation in Hawaii, CNMI, and Guam means more island visitors who place a premium on non-consumptive uses of nearshore coral reef resources (Pooley 1993b).

There is almost universal agreement about the need for sustainable resource use, but users are divided by fundamentally different views on marine resources: how to study them, analyze them, and manage them. It is difficult, therefore, to define management objectives and "preferred" ecosystem outcomes that are clearly desirable and recognizable by all interests.

The council system, created by the MSFCMA, is more decentralized than other forms of living resource management by U.S. government agencies (e.g., national parks, forests and

wildlife refuges, endangered species). Under the council process management policies for EEZ fisheries evolve during the preparation and amendment of FMPs. Participants in plan development are diverse—they include regulators, scientists, and resource users. The process is also very open: public participation—through advisory panels and at meetings—is early, systematic, and meaningful. The process encourages participation by stakeholders representing different views and cultures, facilitating dialogue even in an adversarial environment. Decision-making relies heavily on consensual agreement. Typically, the technical data available for management decisions are uncertain and incomplete. The Council, therefore, follows an adaptive management strategy that allows for improvement of FMPs as new information becomes available. An adaptive management process is well suited to coral reef fisheries management because of the diverse stakeholders and poor biological and ecological understanding of the resource base.

1.3.5 Consideration Given to Indigenous People in Plan Development

The indigenous people of the U.S. Pacific Islands have centuries-old connections to coral reefs that pre-date European contact and Western concepts of coral reef management. Beginning when the islands were first settled, indigenous cultures evolved a physical, economic, and spiritual life defined by dependence on marine fisheries for food security. Indigenous cultures believe that the ocean and land environments are inextricably connected. Because of this holistic perspective, Pacific Islanders see themselves as an integral part of the ecosystem. And because of their intimacy with local inshore marine environments, indigenous communities developed a far more detailed understanding of coral reefs than that of modern-day resource users and managers. This fostered the development of relatively sophisticated social controls over fishing, in order to ensure sustainable harvests. For example, islanders recognized that fishing should not disrupt crucial life history bottlenecks like spawning aggregations, and they often imposed corresponding restrictions on fishing times and places. Because of the precision of these controls, traditional conservation measures can be likened to a "rifle" as opposed to a "shotgun."

In developing this FMP, the Council has been ever appreciative of these accomplishments. As important, when preparing FMPs the Council is required to take into account the various traditional fishing practices of indigenous island residents. For example, marine protected areas, one of the management measures outlined in this FMP, could be construed as a limited access system. In this case the MSFCMA dictates that the Council must take into account "historical fishing practices in, and dependence on the fishery" and "the cultural and social framework relevant to the fishery" (§303 (b)(6)).

Apart from considerations of historical participation and cultural dependence on coral reef fisheries, the Council is concerned that communities consisting of descendants of indigenous Pacific Islanders have not sufficiently benefitted from the region's fisheries. The MSFCMA provides for the establishment of a community development program for Western Pacific fisheries. This provision is intended to increase opportunities for indigenous communities to participate in and benefit from fisheries in the Council's jurisdiction.

It is also important to note that in numerous statutes the U.S. Congress has specially considered aboriginal Hawaiians because they are socio-economically disadvantaged and there is a federal trust obligation stemming from Section 5 of the Admissions Act. In addition, the way that the U.S. gained control of Hawaii should be taken into account. As a result, in 1993 Congress passed the Apology Bill, which states that "...the indigenous Hawaiian people never directly relinquished their claims to their inherent sovereignty as a people or over their national lands to the United States, either through their monarchy or through a plebiscite or referendum." In the absence of any treaty or voluntary relinquishment, the lingering sovereignty claim by Hawaiians may dictate caution in establishing regulations that restrict the right of Hawaiians to harvest coral reef marine resources, particularly in areas held by the State of Hawaii as part of the Ceded Lands Trust for the benefit of Native Hawaiians. Many of the submerged lands surrounding the NWHI are part of the Ceded Lands Trust.

1.4 Management Plan Objectives

The MSFCMA mandates fishery management measures that achieve optimum yield from fisheries resources of the U.S., while preventing overfishing. However, in 1999 the Ecosystems Principles Advisory Panel (EPAP) submitted a report to Congress arguing for management that—while not abandoning optimum yield and overfishing principles—takes an ecosystem-based approach (EPAP 1999). Heeding the basic principles, goals, and policies for ecosystem-based management outlined by EPAP, the Council plans to develop "Fisheries Ecosystem Plans" for each major ecosystem under its jurisdiction. This Coral Reef Ecosystem FMP represents the first of these plans. While outlining several new and important coral-reef-specific management measures, it also serves as a framework for incorporating ecosystem approaches into the regulatory structure created by the already-implemented Bottomfish, Crustaceans, Precious Corals, and Pelagics FMPs.

The overall goal of this management program is to establish a management regime for the entire Western Pacific Region that will maintain sustainable coral reef fisheries while preventing any adverse impacts to stocks, habitat, protected species, or the ecosystem. To further this goal the Council established eight objectives for the CRE-FMP. The objectives promote: (1) sustainable use of coral reef resources, especially by fishing communities and indigenous fishermen in the region; (2) an adaptive management approach based on fishery-dependent and fishery-independent research; (3) marine protected areas and habitat conservation; (4) cooperative and coordinated management by the various agencies concerned with the conservation of coral reef resources; and (5) education to foster public support for management.

Objective 1: To foster sustainable use of multi-species resources in an ecologically and culturally sensitive manner, through the use of the precautionary approach and ecosystem-based resource management.

Objective 2: To provide a flexible and responsive management system for coral reef resources that can rapidly adapt to changes in resource abundance, new scientific information, and changes in fishing patterns among user groups or by area.

Objective 3: To establish integrated resource data collection and permitting systems, establish a research and monitoring program to collect fishery and other ecological information, and to collect scientific data necessary to make informed management decisions about coral reef ecosystems in the EEZ.

Objective 4: To minimize adverse human impacts on coral reef resources by establishing new—and improving existing—marine protected areas, managing fishing pressure, controlling wasteful harvest practices, reducing other anthropogenic stressors directly affecting coral reef resources, and allowing the recovery of naturally-balanced reef systems. This objective includes the conservation and protection of essential fish habitats.

Objective 5: To improve public and government awareness and understanding of coral reef ecosystems and their vulnerability and resource potential in order to reduce adverse human impacts and foster support for management.

Objective 6: To collaborate with other agencies and organizations concerned with the conservation of coral reefs, in order to share in decision-making and to obtain and share data and resources needed to effectively monitor this vast and complex ecosystem.

Objective 7: To encourage and promote improved surveillance and enforcement to support the plan's management measures.

Objective 8: Provide for sustainable participation by fishing communities in coral reef fisheries and, to the extent practicable, minimize the adverse economic impacts on such communities.

1.5 Management Plan Approach

Coral reefs are complex, multi-resource marine ecosystems comprising thousands of species, few of which are targeted by existing fisheries. They represent an extreme in biological diversity, ecological complexity and competing demands for resource use. Therefore, only holistic management is likely to be effective. However, the basics, much less the intricacies, of coral reef ecosystems are poorly understood. Furthermore, it is doubtful that there will ever be enough data available to calculate total removals, including incidental mortality, and show how they relate to standing biomass, production, optimum yields, natural mortality, and trophic structure. Ecosystem-based management of coral reefs, therefore, is a long-term goal

that can only be achieved as new information allows for improved understanding and decision-making. EPAP (1999) made recommendations to guide the further development of ecosystem management for fisheries, built around the following policies:

- Change the burden of proof.
- Apply the precautionary approach.
- Purchase "insurance" against unforseen, adverse ecosystem impacts.
- Learn from management experience.
- Make local incentives compatible with global goals.
- Promote participation, fairness, and equity in policy and management.

To the extent possible, the CRE-FMP attempts to incorporate these concepts. According to EPAP, a fishery ecosystem plan should incorporate eight actions (EPAP 1999, pp. 27-32). The way in which this FMP incorporates each of these action items is outlined below.

1. *Delineate the geographic extent of the ecosystem(s) that occur(s) within Council authority, including characterization of the biological, chemical, and physical dynamics of those ecosystems.*

   The geographic extent and ecological characterization of coral reef ecosystems around the U.S. Pacific Islands are described in Chapter 2 of this FMP. High biological and environmental variability is a natural characteristic of these ecosystems, with or without fishing. Irregular pulses of new recruits cause cycles in the abundance and harvest potential of individual reef species. Environmental variability is both spatial—related to differences in the quality of habitat—and temporal—related to monthly moon phase, and seasonal and longer-term environmental changes. Coral reef resources are also affected by large-scale climatic shifts. Natural disturbance cycles in areas exposed to large storm waves can dramatically alter coral cover and resulting habitat quality.

2. *Develop a conceptual model of the food web.*

   The ECOPATH model, as applied to coral reef ecosystems, is described in Section 2.4 of this FMP. ECOPATH is a simple mathematical model that estimates mean annual biomass, production, and food consumption for major components (species groups) of an ecosystem. Application of ECOPATH to French Frigate Shoals found that the coral reef ecosystem is controlled mainly by predation from the top down and primary production is controlled mainly by nutrients, photosynthetic rate limits, and habitat space.

3. *Describe the habitat needs of different life history stages for all plants and animals that represent the "significant food web."*

In addition to Chapter 2, Chapter 6 and Volume III of this FMP, which describe and discuss essential fish habitat, detail the habitat needs of different life history stages for all species managed under this FMP, based on available scientific information.

4. *Calculate total removals—including incidental mortality—and show how they relate to standing biomass, production, optimum yield, natural mortality and trophic structure.*

Because available biological and fishery data are poor for all species and areas covered by the CRE-FMP, it is not possible to address this action item.

5. *Assess how uncertainty is characterized and what kind of buffers against uncertainty are included in conservation and management actions.*

The FMP acknowledges that there is uncertainty regarding the impacts of fishing and other human activities on coral reef ecosystems. As a buffer against uncertainty, the FMP establishes marine protected areas as insurance against this risk, and reporting requirements to monitor changes in the fisheries, as described in Chapter 5.

6. *Describe available long-term monitoring data and how they are used.*

Section 3.3 includes an overview of available long-term monitoring data while Chapter 7 describes research needs. Fishery monitoring and fishery-independent research activities will generate information that may be used for future adjustments to the CRE-FMP under a framework procedure that allows for timely action.

7. *Develop indices of ecosystem health as targets for management.*

What constitutes a "healthy" reef in the U.S. Pacific Islands is difficult to define, but should be considered within a specific geographic and temporal context, considering the quality of natural habitat, environmental variability, natural disturbance cycles, and also the history of human impacts. Measuring changes and differentiating natural rhythms from fisheries' effects, even in specific localities, present major challenges because of the highly dynamic ecosystem. Because of these factors, no indices of ecosystem health have yet been established under this FMP beyond the MSY, OY and overfishing reference points, as discussed in Chapter 4.

8. *Assess the ecological, human, and institutional elements of the ecosystem which most significantly affect fisheries, and are outside Council/Department of Commerce authority. Included should be a strategy to address those influences in order to achieve both FMP and FEP objectives.*

Much of the previous damage to coral reefs around U.S. Pacific Islands has occurred as a result of non-fishing activities such as coastal and harbor development, watershed land use practices and runoff, industrial discharges, non-fishing vessel operation, and military and tourist use. The most severe impacts have occurred on nearshore reefs under island government jurisdiction. Few reefs in the EEZ are close enough to inhabited land areas to be significantly affected by tourism, coastal development, upland runoff, beach erosion, and other terrestrial impacts. Some impacts occur at a scale too large to be mitigated by unilateral management actions for the Western Pacific Region. These include: overpopulation, ocean warming and increased ultraviolet radiation, introduction of invasive exotic marine species, and accumulation of marine debris.

Reefs extend across jurisdictional boundaries, and mechanisms for coordinated management among different government agencies are largely *ad hoc*. Inter-regional and international management will be necessary to find solutions to this problem. Reef areas in near-shore areas are under the jurisdiction of the island governments. Other reefs are in areas managed by various federal agencies (e.g., national parks, marine sanctuaries, national wildlife refuges). The management objectives of the various agencies are not consistent. Even when effective regulations are in place, enforcement is difficult, labor intensive and often inadequate. Fragmented jurisdiction and management authority complicate prosecution of violators.

To address these problems, several steps could be taken. The Council could negotiate a memorandum of understanding with states to increase the extent of marine protected areas. Reliance on island government permit and reporting for the EEZ adjacent to populated islands, as described in this FMP could be enhanced. Through an amendment to the MSFCMA, the Council's and NMFS's authority could be expanded to address non-fishing vessel impacts on habitat. Finally, the essential fish habitat consultation process, mandated by the 1996 Sustainable Fisheries Act amendment to the MSFCMA, could be actively pursued and enhanced. These possible measures are described in more detail in Chapters 5 and 6 of the FMP.

1.6 Management Unit

1.6.1 Management Area

The Coral Reef Ecosystems Management Area (CRE management area, or management area) includes the EEZ surrounding Hawaii, Guam, Samoa, CNMI and Pacific Remote Island Areas.[1] (The Pacific Remote Island Areas, hereafter PRIAs, consist of Palmyra Atoll,

[1] Generally, EEZ waters are outside of territorial waters, which extend from the shore to 3 miles, and within 200 miles from shore. However, jurisdictional issues in the CNMI are complicated because the federal government claims jurisdiction to the shoreline while the CNMI claims jurisdicition over the whole EEZ. For purposes of the CRE-FMP, waters from shore to 3 miles offshore are the management responsibility of CNMI. Management of inshore waters around CNMI remains with the regional authorities because (1) cooperation between the

Kingman Reef, and Howland and Baker Islands in the central south Pacific; Midway Island at the northwest end of the Hawaiian archipelago; Johnston Atoll southwest of the main Hawaiian Islands; and Wake Island in the Marshall Islands Archipelago.) The management area for this FMP includes at least 11,382 km^2 of reef area, summarized in Table 1.1. Approximately 80% of the coral reef area that would be managed under the CRE-FMP is in the NWHI. The nature and extent of coral reefs in EEZ waters around each Western Pacific Region jurisdiction[2] are briefly described below.

During the development of the Bottomfish, Crustacean and Precious Corals FMPs, the EEZs surrounding the CNMI and the PRIA were not initially included under the management regime. This omission was due to the fact that these fisheries were not active in the EEZ when the FMPs were being developed. Since that time, bottomfisheries in the CNMI and the PRIA have developed. While data has been collected through voluntary compliance, these areas have yet to be included in the management areas of the bottomfish FMP. An amendment to include these areas in existing FMPs is near completion with submission to NMFS expected at same time as submission of this FMP. The amendment will include the CNMI and PRIA under the crustacean and bottomfish FMPs and the CNMI under the Precious Corals FMP.

American Samoa

American Samoa is composed of seven islands in the eastern part of the Samoan Archipelago (14° S, 168-173° W). The islands are small, ranging in size from the densely populated high island of Tutuila (145 km^2) to the remote and uninhabited Rose Atoll (4 km^2). Mean air and sea surface temperatures (27.0° C and 28.3° C, respectively) vary little seasonally, although average air temperatures rose sharply, by 2° C, in the 1990s. The high islands receive heavy annual rainfall (300-500 cm on Tutuila) (Craig *et al.* in press).

As shown in Table 1.1, coral reefs are limited in area and only 8.4% of them are located within the EEZ, mostly on offshore banks (Green 1997). The main islands are volcanic mountains that descend steeply below sea level. They are fringed by narrow reef flats (50-500 m wide) that drop steeply to a depth of 3-6 m and descend gradually to 40 m. From this depth, the ocean bottom drops rapidly, reaching depths of 1,000 m within 1-3 km from shore (Craig *et al.* in press). Almost 300 coral species occur in American Samoa (Green 1997). The reefs also support a diverse assemblage of nearly 900 fish species. Dominant families are damselfish, surgeonfish, wrasse, and parrotfish. Spawning for some, and perhaps most, species occurs year-round, although peak spawning may be seasonal (Craig *et al.* in press).

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regional government and the Council relies on recognition of local management authority of the state waters, (2) the CNMI-based small vessel fishermen are best managed by local hands-on interaction and knowledge of the issues, and (3) this regime retains consistency with the other areas under Council jurisdiction.

[2]Recognizing that the region comprises several different political entities—a state, a commonwealth, two territories, and unincorporated federal territory—hereafter, as shorthand, these constituent parts (excluding federal territory) will be generically referred to as states.

Table 1.1: Coral reef area (in km² <100m deep) in nearshore waters (0-3 nmi from shore) and offshore waters (3-200 nmi from shore) in each location in the Western Pacific Region (Hunter 1995).

Location	0-3 mni	3-200 nmi	Total Coral Reef Area
American Samoa	271	25	296
Guam	69	110	179
Hawaii			
Main Hawaiian Islands	1,655	880	2,535
Northwestern Hawaiian Islands	2,227	9,104	11,331
CNMI	45	534	579
PRIAs	620	89	709
Midway*	203	20	223
TOTAL	5,090	10,762	15,852

*Midway is a PRIA located in the Hawaiian Archipelago.

Little is known about the biological assemblages on offshore banks in the EEZ around American Samoa. Species composition on the offshore reefs may be similar to that on the outer reef slopes, although species diversity may be less because of the absence of estuarine, reef flat and shallow lagoon habitats (Green 1997).

Guam

Situated at 13° N latitude and 144° E longitude, Guam is the southernmost and largest island (550 km²) in the Mariana Islands Archipelago. Guam's climate is warm and humid year round. Annual rainfall ranges from approximately 200 cm along the coast to 220 cm at higher elevations. The rainy season is generally from July through November. Sea surface temperatures range from a monthly mean of 27-28° C in February to 30° C in August. Guam regularly experiences typhoons, with winds greater than 65 knots. Typhoons are possible throughout the year, but their likelihood is greatest from July through December.

Guam is largely a raised limestone island on a volcanic base. Approximately half of the shoreline is bordered by well-developed coral reefs with reef flats as wide as 600 m. A broad barrier reef encloses Cocos Lagoon at the southwest tip of the island. A raised barrier reef, a greatly disturbed barrier reef, and a coral bank enclose the deep lagoon of Apra Harbor. The 110 km² of coral reefs on offshore banks in the EEZ account for about 60% of the total reef area in Guam (Green 1997).

Over 250 stony coral species have been recorded in the southern Mariana Islands (Birkeland 1997c). Guam's reefs also support a diverse assemblage of about 800 fish species. The fish families most important to coral reef fisheries—based on the number of fished species they

contain—are the wrasses, groupers, surgeonfish, jacks, squirrelfish, snappers, parrotfish, emperors, and goatfish (Green 1997).

Little is known about the biological assemblages on offshore banks in the EEZ around Guam. The tops of these banks are relatively deep (20-40 m) (Green 1997). Myers (1997) has suggested species composition on these banks may be similar to that on the outer reef slope around the island of Guam, although the relative abundance of species would probably be different because of the isolation of the banks from continuous reef tracts and from heavy fishing pressure.

Hawaii

The Hawaiian Islands are the exposed parts of an elongated submarine ridge that extends for a length of nearly 2,400 km, between 19°-28° N latitude and longitudes 155°-178° W. Based on geologic age, the Hawaiian chain is divisible into three sections: eight major volcanic islands, most of which are inhabited, make up the southeastern part; several small islets and pinnacles constitute the middle section; finally, low atolls, sand islets, and shoals compose the most northwesterly part of the chain. The islands have a combined land area of over 16,600 km^2.

The northernmost atolls of Midway and Kure are exposed to cool temperatures during the winter months, but the rest of the chain is subtropical. The climate is determined by prevailing northeast trade winds.

With 89% of the total, Hawaii's coral reefs constitute the vast majority of coral reef area in the U.S. Pacific Islands. By the same token, this 10,004 km^2 of coral reefs is by far the largest area in the Council Region, and 90%, or 9,124 $km^2$of these reefs, is in the NWHI. Almost all sizeable coral reef area (880 km^2) in the EEZ surrounding the main Hawaiian Islands (MHI) is located on Penguin Bank between the islands of Molokai and Oahu.

The islets and atolls between Nihoa Island and Kure Atoll (excluding Midway Atoll), are known as the Northwestern Hawaiian Islands. Except for Kure, these islands are national wildlife refuges, providing habitat for several protected species, including the green sea turtle and the Hawaiian monk seal.

The main Hawaiian Islands represent the young part of the Hawaiian Archipelago; consequently, they have less well-developed fringing reefs, which have not subsided as far below sea level as those in the NWHI (Green 1997). The coral reefs of the MHI were mapped extensively in the 1970s and 1980s, and have since been surveyed only intermittently. Grigg (1997) summarized the condition of MHI reefs in 1996-97, based on a statewide survey of knowledgeable individuals and agencies. He reports, based on that survey, that 90% of the reefs in Hawaii are healthy. The best reef development and highest live coral cover in the MHI are found in areas sheltered, or partially sheltered from, open ocean swell.

Coral reef resources in Hawaii are characterized by relatively low biological diversity, but a high degree of endemism. Hawaii's isolation has produced a large proportion of endemic coral reef species. It is estimated that 20-30% of the fish, 18% of the algae, and 20% of the molluscs are endemic to Hawaii. Hawaii's coral reefs are also unique because some species that are relatively uncommon in other areas of the Pacific are quite abundant in Hawaii (Fielding and Robinson 1987). Only 47 species of reef-building corals have been recorded. Coral species richness tends to be higher in the NWHI, where the genus *Acropora*, not found in the MHI, is present. Many reefs in the NWHI are comprised of calcareous algae (Green 1997). Black corals are found off promontories at depths of 30-100 m in both state and federal waters around the MHI (URS Corp. in prep).

A total of 557 marine reef fish species have been identified from the Hawaiian Islands, and about 24% of these are considered endemic. Reef and coastal pelagic fish families with species valued for food include surgeonfish, goatfish, parrotfish, jacks, bigeye scad, mackerel scad, and soldier fish. Coral reefs in Hawaii also provide habitat for over 1,000 mollusks, 1,350 other macroinvertebrates, and 400 seaweeds.

In general, fish species diversity appears to be lower in the NWHI than in the MHI. Although the inshore fish assemblages of the two regions are similar, fish size, density, and biomass are higher in the NWHI. Fish communities in the NWHI are dominated by apex predators, such as sharks and jacks, while communities in the MHI are not. Some fish species are common in parts of the NWHI that are rare elsewhere in the archipelago (Green 1997).

Perhaps the most important factor in the population dynamics of many coral reef species in the NWHI, and the ecosystem as a whole, are cyclical oceanographic events, which affect productivity over large areas and may account for large fluctuations in population abundance. In a comprehensive study of recent climatic and oceanographic events and their effect on productivity in the NWHI, Polovina *et al.* (1994) found that declines of 30-50% in a number of species from various trophic levels, from the early 1980s to present, could be explained by a shift in oceanographic conditions. Before this, oceanographic conditions lasting from the late 1970s until the early 1980s moved nutrient-rich deep ocean water into the euphotic zone, resulting in higher survival of reef fish, crustaceans, monk seals, and sea birds. The researchers caution that "resource managers need to be aware that target levels of productivity (in the NWHI), for protected species, or sustainable yield for fishery resources, may vary with interdecadal climate events."

The new NWHI Coral Reef Ecosystem Reserve is a related management issue. Executive Orders (EO) 13178 (December 4, 2000) and 13196 (January 18, 2001), issued by President Clinton, established the Reserve which spans the 1,200 mile length of the NWHI by a 100 mile corridor. Conservation measures listed in these EOs include:

- A cap on commercial and recreational fishing at the "previous year's" (from December 4, 2000) level of effort and take. (The bottomfish level would be based on an individual's average over the previous five years.)

- Establishing Reserve Preservation Areas that prohibit almost all activities to 100 fm around most islands. (But bottomfishing and recreational trolling would be allowed in waters deeper than 25 or 50 fm around some islands.)
- Prohibiting anchoring on live or dead coral, where the bottom can be seen.
- Prohibiting anchoring where buoys are available or outside a yet-to-be-determined designated area.
- Prohibiting removal of living/non-living resources.
- Prohibiting taking or touching of living or dead coral.
- Prohibiting discharging or depositing any material, except cooling water or engine exhaust.
- Additional restrictions on non-fishing activities.
- Certain Native Hawaiian uses are allowed in yet-to-be-identified sub-areas. Activities allowed in both the Reserve and Preservation Area would be restricted to subsistence, cultural, and religious purposes.

The Reserve is intended to serve as a temporary management regime until completion of the process to designate the NWHI as a National Marine Sanctuary. On January 19, 2001, the NOAA/NOS Office of National Marine Sanctuaries announced its intent to initiate the Sanctuary designation process for the Reserve pursuant to sections 303 and 304 of the National Marine Sanctuaries Act (16 U.S.C.1433, 1434). During this process, NOAA will prepare an environmental impact statement and management plan, which will examine the management, boundary, and regulatory alternatives associated with sanctuary designation. As required, NOAA must also initiate public scoping meetings to solicit information and comments on the range and significance of issues related to sanctuary designation and management.

In designating the sanctuary, the EOs direct the Secretary of Commerce to supplement or complement the existing Reserve, and in consultation with the Governor of the State of Hawaii, determine whether State submerged lands and waters should be included as part of the Sanctuary. The effect of the reserve on the CRE-FMP, and existing FMPs, cannot be fully assessed until an ongoing review of the EOs by the new Administration is completed. Still ambiguous conservation measures also need to be clarified before the relation between measures in this FMP and Reserve regulations can be resolved.

Commonwealth of the Northern Mariana Islands

The Commonwealth of the Northern Mariana Islands is a subset of the Mariana Archipelago. It encompasses 14 islands (15-21° N latitude, 144-146° E longitude) oriented along a north-south axis stretching over a distance of 740 km. The islands can be divided into two sections based on age and geology. Saipan, Tinian, Rota, Aguijan, and Farallon de Medinilla, in the southern part of the chain, are old, raised limestone islands. In contrast, the northern islands—Anatahan, Sarigan, Guguan, Alamagan, Pagan, Agrihan, Asuncion, Maug, and Uracas—are geologically young volcanic islands with steep seaward slopes.

The CNMI's 579 km^2 of coral reefs represent the second largest reef area in the U.S. Pacific Islands. The 534 km^2 of reefs in the 3-200 nm offshore zone (see footnote 1) account for the majority of this area. The largest single tract is off Farallon de Medinilla (311 km^2). Saipan's best developed reefs occur in the 0-3 nm nearshore zone. These include fringing reefs, inshore and offshore patch reefs, and a well-developed barrier reef-lagoon system along most of the western leeward coast. In the northern islands in general, reef development is poor to non-existent. In addition, there are numerous shoals along the island chain (Green 1997). A chain of small, shallow banks topped with coral reefs lie in a parallel arc 240 to 320 km to the west of the Mariana Islands (Myers 1997).

The number of stony coral and reef fish in the southern part of the CNMI is similar to that of Guam. Diversity drops markedly off the northern volcanic islands, where only 159 species of stony coral and only about 360 species of reef fish have been recorded (Birkeland 1997c). Dominant fish families are the same as in Guam.

Pacific Remote Island Areas

Howland, Jarvis, and Baker are arid coral islands located close to the equator in the southern Line Island group. Kingman Reef is a coral reef shoal in the central Pacific in the northern Line Islands. Palmyra Atoll is a wet atoll located. It is composed of three sub-lagoons and over 50 separate islets that have been modified by construction activity. Johnston Atoll is an open atoll in the north Central Pacific. Until the 1940s, there were only two islands, but by 1964 massive dredge-and-fill operations significantly expanded the original area of Johnston Island. Wake Island is an isolated island north of the Marshall Islands, and consists of three islets and a reef enclosing a sheltered lagoon.

The total reef area around remote U.S. Pacific Islands (not including Midway) is 709 km^2, of which 89 km^2 is offshore (3-200 nmi). The remote U.S. Pacific Island possessions range in location from less than 1° S latitude to 20° N latitude and from 162° W to 167° E longitude. The climate regimes range from arid to wet and equatorial to sub-tropical. Marine resources are similarly varied. Several of these islands are of extreme scientific interest because of their age, with origins in the Mesozoic era, and the majority are designated or proposed as national wildlife refuges. The biological diversity of coral reef ecosystems in these areas varies considerably from island to island. Fish densities and biomass are higher than around the populated islands in the region. Rare species occur in some areas. For example, giant clams are prolific throughout the lagoon at Wake Atoll (Green 1997).

Johnston Atoll has a unique mix of coral reef species not duplicated elsewhere in the Pacific. Invertebrates from both the Western and Central Pacific are present, suggesting that the atoll serves as a bridge connecting distributions of Polynesian and Micronesian invertebrate fauna. The coral fauna has a strong affinity with that of Hawaii, but the appearance of the reef is quite different. This is due to the dominance of *Acropora*, not found in the main Hawaiian Islands, and the lack of the common Hawaiian species *Porites compressa*. Endangered

Hawaiian monk seals occasionally visit the atoll, but are not known to pup there. NMFS has released bachelor male monk seals there to reduce harassment of females in the NWHI. The extremely rare Cuvier's beaked whale is regularly seen offshore and may actually calve in the lagoon (Green 1997).

1.6.2 Management Unit Taxa

As already noted, many different organisms inhabit the coral reef ecosystem. Numerous species are caught in different reef-related fisheries. The biology and population dynamics of many coral reef organisms are poorly understood and it is possible that they may be targeted by commercial fishermen in the future. In developing an FMP, councils must identify management unit species (MUS), which are those species that come under the purview of the management plan. For all the reasons just outlined, this is difficult for coral reef species. The approach taken here is to rely on taxonomically more general designations and to divide these taxa into two groups:

1. Currently Harvested Coral Reef Taxa (CHCRT). Because these organisms are commercially harvested, fishery information for them is available, allowing more effective management. The species in this group have been reported on commercial fishery catch report records for federal EEZ waters but are not MUS under any of the Council's already-implemented FMPs. Membership in this group is based on two criteria: (1) More than 1,000 lbs. annual harvest for all members of a taxon, based on commercial fishery catch reports. These taxa are families or subfamilies. (2) Within these taxa particular genera or species are identified, based on their appearance on catch reports. CHCRT are listed in Table 1.2, grouped by family or subfamily. Table 1.2 also lists Aquarium taxa (discussed below.)

2. Potentially Harvested Coral Reef Taxa (PHCRT). These are coral reef organisms that are not known to be currently caught, or for which very little fishery information is available. However, emerging coral reef fisheries—such as the rapidly expanding marine ornamental products trade and the emerging industries for pharmaceutical and natural products—may target them at some future date. Several family/subfamily taxa in the CHCRT list are also PHCRT. As noted in Table 1.3, which lists PHCRT, all genera or species in these taxa that are not listed as CHCRT are by default PHCRT.

Because fishing for coral reef resources is light to non-existent in the EEZ, the CHCRT list was developed as a functional means to facilitate data collection and monitoring of coral reef ecosystem species that are currently being harvested, both directly and incidentally in commercial fisheries in state/territorial and federal waters. It will also help fishery managers to develop harvest strategies and proxies so that they can begin managing the coral reef ecosystem as a whole. The Currently Harvested Coral Reef Taxa also includes a subgroup of species that aquarium fish collectors presently harvest. With the exception of the nearshore waters of West Hawaii (Big Island), the commercial collection of Aquarium Taxa is minimal

throughout the management area. However, the taxa listed in this category represent individual species that have been harvested in the EEZ and will likely continue to be harvested in the EEZ. For this reason they are listed separately at the end of Table 1.2. Their inclusion in the CHCRT list will allow continuing data collection by existing local management programs. As a result, the impacts on resources and habitats by aquarium fish collectors in the EEZ can be better assessed. As discussed in Section 5.3.1, local fishery management agencies will oversee permitting and reporting requirements for harvest of these species.

Subdividing the MUS and limiting the number of species on the CHCRT list makes it easier to establish baseline reference points. These reference points will be used to assess changes in species composition and abundance and will help to manage both currently harvested coral-reef-associated species and those likely to be targeted, should a coral reef fishery in the EEZ develop in the future. This subdivision also encourages cooperation of fishermen by reducing unreasonable permitting requirements, which also reduces unnecessary administrative and regulatory burdens.

The Potentially Harvested Coral Reef Taxa list consists of literally thousands of taxa for which little to no catch or effort data exist. For a great majority of these species scientific knowledge about their life histories, habitat requirements, and other biological information is completely lacking. Therefore, to begin data collection for management purposes, special permits will be required to target the PHCRT listed in Table 1.3 and for any species that is not explicitly listed on the CHCRT list. (Permitting is detailed in Section 5.3.)

The ecosystem concept considers the organisms themselves, grouped by taxa, their interactions, and their relationship to habitats. Taken together, these are the characteristics that structure the ecological relationships. Cooperation by fishermen, coupled with continued data collection and analyses, are all necessary in order to further our understanding of the intricacies of these relationships. Ecosystem-based management of coral reef resources will continually improve as a result. Management Unit Species designation is an important initial step in this effort

In 1999, the bottomfish plan team noted that a large number of species were currently being harvested in Guam, American Samoa and the CNMI using bottomfish gear and techniques. There regularity in catch has been documented since the onset of the WPacFIN creel surveys. They recommended that the Council include these species under the bottomfish FMP to allow for future management measures as needed. The list of species is found in Table 1.4 and will be part of the Bottomfish MUS upon approval of an amendment to be submitted to the NMFS at the same time as this FMP.

Table 1.2: Currently Harvested Coral Reef Taxa.

Acanthuridae (Surgeonfishes)	Orange-spot surgeonfish (*Acanthurus olivaceus*) Yellowfin surgeonfish (*Acanthurus xanthopterus*) Convict tang (*Acanthurus triostegus*) Eye-striped surgeonfish (*Acanthurus dussumieri*) Blue-lined surgeon (*Acanthurus nigroris*) Whitebar surgeonfish (*Acanthurus leucopareius*) Blue-banded surgeonfish (*Acanthurus lineatus*) Blackstreak surgeonfish (*Acanthurus nigricauda*) Whitecheek surgeonfish (*Acanthurus nigricans*) White-spotted surgeonfish (*Acanthurus guttatus*) Ringtail surgeonfish (*Acanthurus blochii*) Brown surgeonfish (*Acanthurus nigrofuscus*) Elongate surgeonfish (*Acanthurus mata*) Mimic surgeonfish (*Acanthurus pyroferus*) Yellow-eyed surgeonfish (*Ctenochaetus strigousus*) Striped bristletooth (*Ctenochaetus striatus*) Twospot bristletooth (*Ctenochaetus binotatus*)
	Bluespine unicornfish (*Naso unicornus*) Orangespine unicornfish (*Naso lituratus*) Humpnose unicornfish (*Naso tuberosus*) Black tongue unicornfish (*Naso hexacanthus*) Bignose unicornfish (*Naso vlamingii*) Whitemargin unicornfish (*Naso annulatus*) Spotted unicornfish (*Naso brevirostris*) Humpback unicornfish (*Naso brachycentron*) Barred unincornfish (*Naso thynnoides*) Gray unicornfish (*Naso caesius*)
Balistidae (Triggerfishes)	Titan triggerfish (*Balistoides viridescens*) Clown triggerfish *(B. conspicillum*) Orangstriped trigger*fish* (*Balistapus undulatus*) Pinktail triggerfish (*Melichthys vidua*) Black triggerfish (*M. niger)* Blue Triggerfish (*Pseudobalistesfucus*) Picassofish (*Rhinecanthus aculeatus*) Wedged Picassofish (*B. rectangulus*) Bridled triggerfish (*Sufflamen fraenatus*)
Carangidae (Jacks)	Bigeye scad (*Selar crumenophthalmus*) Mackerel scad (*Decapterus macarellus*)
Carcharhinidae (Sharks)	Grey reef shark (*Carcharhinus amblyrhynchos*) Silvertip shark (Carcharhinus albimarginatus) Galapagos shark (*Carcharhinus galapagenis*) Blacktip reef shark (*Carcharhinus melanopterus*) Whitetip reef shark (*Triaenodon obesus*)

Holocentridae (Soldierfish/Squirrelfish)	Bigscale soldierfish (*Myripristis berndti*) Bronze soldierfish (*Myripristis adusta*) Blotcheye soldierfish (*Myripristis murdjan*) Bricksoldierfish (*Myripristis amaena*) Scarlet soldierfish (*Myripristis pralinia*) Violet soldierfish (*Myripristis violacea*) Whitetip soldierfish (*Myripristis vittata*) Yellowfin soldierfish (*Myripristis chryseres*) Pearly soldierfish (*Myripristis kuntee*) (*Myripristis hexagona*) Tailspot squirrelfish (*Sargocentron caudimaculatum*) Blackspot squirrelfish (*Sargocentron melanospilos*) File-lined squirrelfish (*Sargocentron microstoma*) Pink squirrelfish (*Sargocentron tieroides*) Crown squirrelfish (*Sargocentron diadema*) Peppered squirrelfish (*Sargocentron punctatissimum*) Blue-lined squirrelfish (*Sargocentron tiere*) Ala'ihi (*Sargocentron xantherythrum*) (*Sargocentron furcatum*) (*Sargocentron spiniferum*) Spotfin squirrelfish(*Neoniphon spp.*)
Kuhliidae (Flag-tails)	Hawaiian flag-tail (*Kuhlia sandvicensis*) Barred flag-tail (*Kuhlia mugil*)
Kyphosidae (Rudderfish)	Rudderfish (*Kyphosus biggibus*) (*Kyphosus cinerascens*) (*Kyphosus vaigienses*)
Labridae (Wrasses)	Saddleback hogfish (*Bodianus bilunulatus*) Napoleon wrasse (*Cheilinus undulatus*) Triple-tail wrasse (*Cheilinus trilobatus*) Floral wrasse (*Cheilinus chlorourus*) Harlequin tuskfish (*Cheilinus fasciatus*) Ring-tailed wrasse (*Oxycheilinus unifasciatus*) Bandcheek wrasse (*Oxycheilinus diagrammus*) Arenatus wrasse (*Oxycheilinus arenatus*) Razor wrasse (*Xyricthys pavo*) Whitepatch wrasse (*Xyrichtes aneitensis*) Cigar wrass (*Cheilio inermis*) Blackeye thicklip (*Hemigymnus melapterus*) Barred thicklip (*Hemigymnus fasciatus*) Threespot wrasse (*Halichoeres trimaculatus*) Checkerboard wrasse (*Halichoeres hortulanus*) Weedy surge wrasse (*Halichoeres margaritacous*) (*Halichoeres zeylonicus*) Surge wrasse (*Thalassoma purpureum*) Redribbon wrasse (*Thalassoma quinquevittatum*) Sunset wrasse (*Thalassoma lutescens*) Longface wrasse (*Hologynmosus doliatus*) Rockmover wrasse (*Novaculichthys taeniourus*)

Mullidae (Goatfishes)	Yellow goatfish (*Mulloidichthys spp.*) (*Mulloidichthys Pfleugeri*) (*Mulloidichthys vanicolensis*) (*Mulloidichthys flaviolineatus*) Banded goatfish (*Parupeneus spp.*) (*Parupeneus barberinus*) (*Parupeneus bifasciatus*) (*Parupeneus heptacanthus*) (*Parupeneus ciliatus*) (*Parupeneus ciliatus*) (*Parupeneus cyclostomas*) (*Parupeneus pleurostigma*) (*Parupeneus indicus*) (*Parupeneus multifaciatus*) Bantail goatfish (*Upeneus arge)*
Mugilidae (Mullets)	Stripped mullet (*Mulgil cephalus)* Engel's mullet (*Moolgarda engeli*) False mullet (*Neomyxus leuciscus*) Fringelip mullet (*Crenimugil crenilabis*)
Muraenidae (Moray eels)	Yellowmargin moray (*Gymnothorax flavimarginatus*) Giant moray (*Gymnothorax javanicus*) Undulated moray (*Gymnothorax undulatus*)
Ocotpodidae	Octopus (*Octupus cyanea; O. ornatus*)
Polynemidae	Threadfin (*Polydactylus sexfilis*) -Moi
Pricanthidae (Bigeye)	Glasseye (*Heteropriacanthus cruentatus*) Bigeye (*Priacanthus hamrur*)
Scaridae (Parrotfishes)	Humphead parrotfish (*Bulbometapon muracatum*) Parrotfishes (*Scarus spp.*) Pacific longnose parrotfish (*Hipposcarus longiceps*) Stareye parrotfish (*Catolomus carolinus*)
Scombirdae	Dogtooth tuna (*Gymnosarda unicolor*)*
Siganidae (Rabbitfish)	Forktail rabbitfish (*Siganus aregentus*) Golden rabbitfish (*Siganus guttatus*) Gold-spot rabbitfish (*Siganus punctatissimus*) Randall's rabbitfish (*Siganus randalli*) Scribbled rabbitfish (*Siganus spinus*) Vermiculate rabbitfish (*Signaus vermiculatus*)
Sphyraenidae (Barracuda)	Heller's barracuda (*Sphyraena helleri*) Great Barracuda (*Sphyraena barracuda)*
Turbinidae (turban shells/green snails)	Green snails (*Turbo spp.*)

*Moved from Pelagic MUS list as part of this FMP.

Aquarium Taxa/Species	**Acanthuridae** Yellow tang (*Zebrasoma flavescens*) Yellow-eyed surgeon fish (*Ctenochaetus strigosus*) Achilles tang (*Acanthurus achilles*) **Muraenidae** Dragon eel (*Enchelycore pardalis*) **Zanclidae** Morrish idol (*Zanclus cornutus*) **Pomacanthidae** Angelfish (*Centropyge shepardi* and *C. flavissimus*) **Cirrhitidae** Flame hawkfish (*Neocirrhitus armatus*) **Chaetodontidae** Butterflyfish (*Chaetodon auriga, C. lunula, C. melannotus* and *C. ephippium*) **Pomacentridae** Damselfish (*Chromis viridis, Dascyllus aruanus* and *D. trimaculatus*) **Sabellidae** Featherduster worm (*Sabellidae*)

Table 1.3: Potentially Harvested Coral Reef Taxa (PHCRT). Several taxa in the CHCRT list appear below. As noted in the table, all species in these taxa that are not listed as CHCRT are by default PHCRT.

Other Labridae spp. (wrasses) *(Those species not listed on CHCRT list)*	Ephippidae (batfish)
Other Carcharhinidae, Sphyrnidae *(Those species not listed on CHCRT list)*	Monodactylidae (mono)
Dasyatididae, Myliobatidae, Mobulidae (rays)	Haemulidae (sweetlips)
Other Serranidae spp. (groupers) *(Those species not managed under the Bottomfish FMP or listed in table 1.4)*	Echineididae (remoras)
Carangidae (jacks/trevallies) *(Those species not listed on CHCRT list or managed under the Bottomfish FMP or listed in table 1.4)*	Malacanthidae (tilefish)
	Acanthoclinidae (spiny basslets)
Other Holocentridae spp. (soldierfish/squirrelfish) *(Those species not listed on CHCRT list)*	Pseudochromidae (dottybacks)

Other Mullidae spp. (goatfish) *(Those species not listed on CHCRT list)*	Plesiopidae (prettyfins)
Other Acanthuridae spp. (surgeonfish/unicornfish) *(Those species not listed on CHCRT list)*	Tetrarogidae (waspfish)
Other Lethrinidae spp. (emperors) *(Those species not managed under the Bottomfish FMP or listed in table 1.4)*	Caracanthidae (coral crouchers)
Chlopsidae, Congridae, Moringuidae, Ophichthidae (eels) Other Muraenidae (morays eels) *(Those species not listed on CHCRT list)*	Grammistidae (soapfish)
Apogonidae (cardinalfish)	*Aulostomus chinensis* (trumpetfish)
Other Zanclidae spp. (moorish idols)	*Fistularia commersoni* (coronetfish)
Other Chaetodontidae spp. (butterflyfish)	Anomalopidae (flashlightfish)
Other Pomacanthidae spp. (angelfish)	Clupeidae (herrings)
Other Pomacentridae spp. (damselfish)	Engraulidae (anchovies)
Scorpaenidae (scorpionfish)	Gobiidae (gobies)
Blenniidae (blennies)	Lutjanidae *(Those species not managed under the Bottomfish FMP or listed in table 1.4)*
Other Sphyraenidae spp. (barracudas)	Other Ballistidae/Monocanthidae spp. *(Those species not listed on CHCRT list)*
Pinguipedidae (sandperches)	Other Siganidae spp. *(Those species not listed on CHCRT list)*
Gymnosarda unicolor	Other Kyphosidae spp.
Bothidae/Soleidae/Pleurnectidae (flounder/sole)	Caesionidae
Ostraciidae (trunkfish)	Cirrhitidae
Tetradontidae/Diodontidae (puffer/porcupinefish)	Antennariidae (frogfishes)
	Syngnathidae (pipefishes/seahorses)
Stony corals	Echinoderms (e.g., sea cucumbers, sea urchins)

Heliopora (blue)	Mollusca
Tubipora (organpipe)	Sea Snails (gastropods)
Azooxanthellates (non-reefbuilders)	Trochus spp.
Fungiidae (mushroom corals)	Opistobranchs (sea slugs)
Sm/Lg Polyped Corals (endemic spp.)	*Pinctada margaritifera* (black lipped pearl oyster)
Millepora (firecorals)	Tridacnidae
Soft corals and Gorgonians	Other Bivalves
Anemones (non-epifaunal)	Cephalopods
Zooanthids	Crustaceans (Lobsters, Shrimps/Mantis, True Crabs and hermit crabs) (*Those species not managed under the Crustacean FMP*)
Sponges (non-epifaunal)	Stylasteridae (lace corals)
Hydrozoans	Solanderidae (hydroid fans)
Bryozoans	Annelids
	Algae
Tunicates (solitary/colonial)	Live rock
All other coral reef ecosystem marine plants, invertebrates and fishes not listed under existing FMPs.	

Table 1.4 Proposed Bottomfish Species for Bottomfish Management Unit Species List

Carangidae	
Carangoides orthogrammus	yellow-spotted trevally
Carangoides caeruleopinnatus	coastal trevally
Caranx melampygus	bluefin trevally
Caranx papuensis	brassy trevally
Caranx sexfasciatus	bigeye trevally
Caranx lugubris	black jack
Seriola rivoliana	almaco jack/amberjack

Lethrinidae	
Gnathodentex aurolineatus	yellowspot emperor, striped large eye bream
Gymnocranius microdon	blue-spotted large-eye bream
Gymnocranius rivulatus	blue-line, large-eye bream
Lethrinus atkinsoni	Pacific yellowtail emperor
Lethrinus erythacanthus	orange-spotted emperor
Lethrinus harak	thumbprint emperor, blackspot emperor
Lethrinus kalliopterus	orange-spotted emperor
Lethrinus obsoletus	orange-striped emperor
Lethrinus olivaceus	longnose emperor
Lethrinus xanthochilus	yellowlip emperor
Monotaxis grandoculus	humphose bigeye bream, bigeye emperor
Lutjanidae	
Aphareus furca	blue smalltooth jobfish
Lutjanus bohar	twinspot snapper, red snapper
Lutjanus fulvus	flametail snapper
Lutjanus gibbus	humpback snapper
Lutjanus monostigmus	onespot snapper
Lutjanus rufolineatus	rufous snapper
Lutjanus sanguineus	blood snapper
Paracaesio kusakarii	kusakar snapper
Paracaesio stonei	stone's snapper
Paracaesio xanthurus	deepwater bream
Pristipomoides argyrogrammicus	blue gindai
Pristipomoides multidens	multidens snapper
Serranidae	
Cephalopholis argus	peacock grouper
Cephalopholis igarashiensis	yellow-banded grouper
Cephalopholis sonnerati	tomato grouper
Cephalopholis urodeta	flagtail grouper
Epinephelus hexagonatus	hexagon grouper
Epinephelus howlandi	blacksaddle grouper
Epinephelus lanceolatus	giant grouper
Epinephelus macrospilos	snubnose grouper
Epinephelus maculatus	highfin grouper
Epinephelus merra	honeycomb grouper
Epinephelus microdon	smalltooth grouper
Epinephelus morrhua	striped grouper
Epinephelus octofasciatus	eightbar grouper
Epinephelus polyphekadion	camouflaged grouper
Epinephelus timorensis	yellowspotted grouper
Plectropomus laevis	giant coral grouper
Saloptia powelli	pink grouper
Variola albimarginata	white-margined lyretail grouper
Scorpaenidae	
Pontinus macrocephala	hogo

1.7 Definitions and Acronyms Applicable to the Coral Reef Ecosystem FMP

1.7.1 Definitions

Adaptive Management: A program that adjusts regulations based on changing conditions of the fisheries and stocks.

Bycatch: Any species caught in a fishery, but which are not sold or kept for personal use, and includes economic discards and regulatory discards.

Barrier Net: A small-mesh net used to capture coral reef or coastal pelagic fishes.

Bioprospecting: The search for commercially valuable biochemical and genetic resources in plants, animals and microorganisms for use in food production, the development of new drugs and other biotechnology applications.

Bottomfish Fishery Management Plan: Council's FMP for bottomfish and seamount groundfish of the Western Pacific Region.

Charter Fishing: Fishing from a vessel carrying a passenger for hire (as defined in section 2101(21a) of Title 46, United States Code) who is engaged in recreational fishing.

Commercial Fishing: Fishing in which the fish harvested, either in whole or in part, are intended to enter commerce or enter commerce through sale, barter or trade. For the purposes of this Fishery Management Plan, commercial fishing includes the commercial extraction of biocompounds.

Consensual Management: Decision making process where stakeholders meet and reach consensus on management options to implement.

Coral Reef: All benthic substrata from 0 to 50 fathoms deep.

Coral Reef Ecosystem (CRE): Those species, interactions, processes, habitats and resources of the water column and substrate located within any waters less than or equal to 50 fathoms in total depth.

Coral Reef Ecosystem Management Area *(CRE management area, or management area)*: all Hawaii, PRIA, American Samoa, CNMI and Guam EEZ waters (from surface to ocean floor) that are outside of state or territorial waters and within 200 miles from shore. Because the EEZ of the CNMI currently extends to the shoreline, it is separated into two zones: the inshore zone (0-3 miles from shore) and the offshore zone (3-200 miles from shore), with federal management of the coral reef ecosystem proposed for the offshore zone only. The inshore zone would continue to be managed by local authorities. The CNMI government should manage the inshore zones

because (1) cooperation between the local governments and the Council relies on recognition of local management authority of nearshore waters, (2) the CNMI-based small vessel fishermen are best managed by a local regime with hands-on interaction and knowledge of the issues, and (3) this regime retains consistency with the other areas under Council jurisdiction.

Coral Reef Ecosystem Management Unit Species (*CRE MUS or MUS*): an extensive list of coral reef organisms, many included by family. Includes some management unit species from existing FMPs (bottomfish, crustaceans, precious corals) for which primary management would remain under their current FMPs but ecosystem effects would be addressed via the CRE-FMP. CRE MUS are listed in two categories: Currently Harvested Coral Reef Taxa (CHCRT) and Potentially Harvested Coral Reef Taxa (PHCRT).

Coral Reef Ecosystem General Permit (CRE general permit, or general permit): a permit which would be required under some alternatives if deemed necessary by the Council to harvest Currently Harvested Coral Reef Taxa from all non-MPA coral reef management areas. This permit would involve simple application procedures and reporting requirements.

Coral Reef Ecosystem Special Permit (CRE special permit, or special permit): a permit which would be required under some alternatives to (1) fish for any coral reef MUS (both Currently Harvested and Potentially Harvested Taxa) within low-use MPAs (with some exceptions), and (2) fish for any Potentially Harvested Coral Reef Taxa outside of MPAs. This permit would be approved and issued on a case-by-case basis and would have more complex application procedures and reporting requirements.

Coral Reef Resources: The currently or potentially exploitable resources in coral reef ecosystems.

Council: The Western Pacific Regional Fishery Management Council (WPRFMC).

Critical Habitat: Those geographical areas that are essential for bringing an endangered or threatened species to the point where it no longer needs the legal protections of the Endangered Species Act (ESA), and which may require special management considerations or protection. (That is, the critical habitat consists of those areas that must be managed to permit an endangered or threatened species to recover to a level where it is safe, for the foreseeable future, from the danger of extinction.)

Currently Harvested Coral Reef Taxa (CHCRT): A sub-category of management unit species (MUS) including species that have been reported on commercial fishery catch report records for federal EEZ waters but are not MUS under any of the Council's already-implemented FMPs. Membership in this group is based on two criteria: (1)

More than 1,000 lbs. annual harvest for all members of a taxon, based on commercial fishery catch reports. These taxa are families or subfamilies. (2) Within these taxa particular genera or species are identified, based on their appearance on catch reports.

Dealer: One who buys and sells species in the fisheries management unit without altering their condition.

Depleted Coral Reef Taxon: Species or taxon that is locally in low abundance but not overfished (by definition).

Dip Net: A hand-held net consisting of a mesh bag suspended from a circular, oval, square or rectangular frame attached to a handle. A portion of the bag may be constructed of material, such as clear plastic, other than mesh.

Ecology: The study of interactions between an organism (or organisms) and its (their) environment (biotic and abiotic).

Ecological Integrity: Maintenance of the standing stock of resources at a level that allows the ecosystem processes to continue. Ecosystem processes include replenishment of resources, maintenance of interactions essential for self-perpetuation and, in the case of coral reefs, rates of accretion that are equal to or exceed rates of erosion. Ecological integrity cannot be directly measured but can be inferred from observed changes in coral reef ecology.

Economic Discards: Coral reef resources that are the target of a fishery but which are not retained because they are of an undesirable size, sex or quality or for other economic reasons.

Ecosystem: The interdependence of species and communities with each other and with their non-living environment.

Ecosystem-Based Fishery Management: Fishery management actions aimed at conserving the structure and function of marine ecosystems, in addition to conserving the fishery resource.

Ecotourism: Observing and experiencing, first hand, natural environments and ecosystems in a manner intended to be sensitive to their conservation.

Environmental Impact Statement (EIS): A document required under the National Environmental Policy Act (NEPA), that assesses alternatives and addresses the impact on the environment of a proposed major federal action.

Essential Fish Habitat (EFH): Those waters and substrate necessary to coral reef resources for spawning, breeding, feeding or growth to maturity.

Exclusive Economic Zone (EEZ): The zone established by Proclamation numbered 5030, dated March 10, 1983. For purposes of application, the inner boundary of that zone is a line coterminous with the seaward boundary of each of the coastal states, commonwealths, territories or possessions of the United States.

Existing CRE Fishery: A fishery targeting organisms that are currently harvested from coral reef areas, but not covered by existing FMPs

Exporter: One who sends species in the fishery management unit to other countries for sale, barter or any other form of exchange (also applies to shipment to other states, territories or islands).

Fish: Finfish, mollusks, crustaceans and all other forms of marine animal and plant life other than marine reptiles, marine mammals and birds.

Fishery: One or more stocks of fish that can be treated as a unit for purposes of conservation and management and that are identified on the basis of geographical, scientific, technical, recreational and economic characteristics; and any fishing for such stocks.

Fishery Management Plan (FMP): A plan prepared by a Regional Fishery Management Council or by NMFS (if a Secretarial plan) to manage fisheries.

Fishery Management Unit Species (MUS): The coral reef resources in the FMP, including fish, corals, certain species associated with live rock, reef-associated invertebrates and plants.

Fishing: The catching, taking or harvesting of fish; the attempted catching, taking or harvesting of fish; any other activity that can reasonably be expected to result in the catching, taking or harvesting of fish; or any operations at sea in support of, or in preparation for, any activity described in this definition. Such term does not include any scientific research activity that is conducted by a scientific research vessel.

Fishing Community: A community that is substantially dependent on or substantially engaged in the harvest or processing of fishery resources to meet social and economic needs and includes fishing vessel owners, operators and crews and United States fish processors that are based in such community. The FMP defines fishing communities as: American Samoa, the Northern Mariana Islands and Guam, and each of the inhabited main Hawaiian Islands.

Food Web: Inter-relationships among species that depend on each other for food (predator-prey pathways).

Framework Measure: Management measure listed in an FMP for future consideration. Implementation can occur through an administratively simpler process than a full FMP amendment.

General Permit: Permit, for possible future implementation under the framework process, to harvest and report take of coral reef taxa in non-MPA areas, issued upon meeting basic minimum requirements.

Ghost Fishing: The chronic and/or inadvertent capture and/or loss of fish by lost or discarded fishing gear.

Habitat: Living place of an organism or community, characterized by its physical or biotic properties.

Habitat Area of Particular Concern (HAPC): Those areas of EFH identified pursuant to Section 600.815(a)(9). In determining whether a type or area of EFH should be designated as a HAPC, one or more of the following criteria must be met: (1) ecological function provided by the habitat is important; (2) habitat is sensitive to human-induced environmental degradation; (3) development activities are, or will be, stressing the habitat type; or (4) the habitat type is rare.

Hand Harvest: Harvesting by handline.

Harvest: The catching or taking of a marine organism or fishery MUS by any means. Marine organisms or MUS that are caught but immediately returned to the water free, alive and undamaged are bycatch.

Hook-and-line: Fishing gear that consists of one or more hooks attached to one or more lines.

Incidental Catch: Any non-targeted species harvested while fishing for the primary purpose of catching a different species.

Large Fishing Vessels: a vessel equal to or greater than 50 ft length overall. (These vessels are prohibited from anchoring on Guam's southern banks.)

Live Rock: Any natural, hard substrate (including dead coral or rock) to which is attached, or which supports, any living marine life-form associated with coral reefs.

Longline: A type of fishing gear consisting of a main line which is deployed horizontally from which branched or dropper lines with hooks are attached.

Low-Use MPA: Marine Protected Area zoned to allow limited fishing activity controlled under special permit.

Main Hawaiian Islands (MHI): The high islands of the State of Hawaii consisting of Niihau, Kauai, Oahu, Molokai, Lanai, Maui, Kahoolawe, Hawaii and all of the smaller associated islets (from 154° W longitude to 161°20' W longitude).

Marine Protected Area (MPA): Designated area within the federal EEZ, which is used as a management measure to allow or prohibit certain fishing activities.

Maximum Sustainable Yield: A management goal specifying the largest long-term average catch or yield (in terms of weight of fish) that can be taken, continuously (sustained) from a stock or stock complex under prevailing ecological and environmental conditions, without reducing the size of the population.

National Marine Fisheries Service (NMFS): The component of the National Oceanic and Atmospheric Administration (NOAA), Department of Commerce, responsible for conservation and management of living marine resources.

No-Take MPA: Marine Protected Area where no fishing or removal of living marine resources is authorized.

Northwestern Hawaiian Islands (NWHI): The EEZ of the Hawaiian islands archipelago lying to the west of 161°20'W longitude.

Optimal Economic Productivity: The greatest long-term net economic benefit from the resources. Economic benefits are defined as both market price-based benefits and non-market benefits.

Optimum Yield (OY): With respect to the yield from a fishery "optimum" means the amount of fish that (a) will provide the greatest overall benefit to the nation, particularly with respect to food production and recreational opportunities and taking into account the protection of marine ecosystems; (b) is prescribed as such on the basis of the MSY from the fishery, as reduced by any relevant economic, social or ecological factor; and (c) in the case of an overfished fishery, provides for rebuilding to a level consistent with producing the MSY in such fishery.

Overfishing: Fishing at a rate or level that jeopardizes the capacity of a stock or stock complex to produce maximum sustainable yield on a continuing basis.

Pacific Island Area: American Samoa, Guam, Hawaii, the Commonwealth of the Northern Mariana Islands, Baker Island, Howland Island, Jarvis Island, Johnston Atoll, Kingman Reef, Midway Island, Wake Island or Palmyra Atoll, as applicable, and includes all islands and reefs appurtenant to such island, reef or atoll.

Pacific Remote Islands (PRIAs): Baker Island, Howland Island, Jarvis Island, Johnston Atoll, Kingman Reef, Midway Island, Wake Island and Palmyra Atoll and includes all islands and reefs appurtenant to such islands, reefs and atolls.

Passive Fishing Gear: Gear left unattended for a period of time prior to retrieval (e.g., traps, gill nets).

Plan Team (PT): A team appointed by the Council to help prepare an FMP under the direction of the Council. The PT utilizes input from all committees and panels as well as outside sources in developing the FMP and amendments.

Potentially Harvested Coral Reef Taxa (PHCRT): A sub-category of MUS. These are coral reef organisms that are not known to be currently caught, or for which very little fishery information is available. Several Currently Harvested Coral Reef Taxa (listed by family/subfamily) are also PHCRT. All genera or species in these taxa that are not listed as CHCRT are by default PHCRT.

Precautionary Approach: The implementation of conservation measures even in the absence of scientific certainty that fish stocks are being overexploited.

RA: Regional Administrator, NMFS Southwest Region

Recreational Fishing: Fishing primarily for sport or pleasure.

Recruitment: A measure of the weight or number of fish which enter a defined portion of the stock such as fishable stock (those fish above the minimum legal size) or spawning stock (those fish which are sexually mature).

Reef: A ridgelike or moundlike structure built by sedentary calcareous organisms and consisting mostly of their remains. It is wave-resistant and stands above the surrounding sediment. It is characteristically colonized by communities of encrusting and colonial invertebrates and calcareous algae.

Reef-obligate Species: An organism dependent on coral reefs for survival.

Regulatory Discards: Any species caught that fishermen are required by regulation to discard or to retain but not sell.

Regulatory Impact Review (RIR): Assessment of all costs and benefits of available regulatory measures, including the alternative of not regulating (per Executive Order 12866). The emphasis of the analysis is on the changes in the stream of net benefits that will occur as a result of each of the alternative management measures. NOAA requires that this analysis, through a Regulatory Impact Review, be done for all regulatory actions that are of public interest, such as those associated with new fishery management plans.

Resilience: The ability of a population or ecosystem to withstand change and to recover from stress (natural or anthropogenic).

Restoration: The transplanting of live organisms from their natural habitat in one area to another area where losses of, or damage to, those organisms has occurred with the purpose of restoring the damaged or otherwise compromised area to its original, or a substantially improved, condition; additionally, the altering of the physical characteristics (e.g., substrate, water quality) of an area that has been changed through human activities to return it as close as possible to its natural state in order to restore habitat for organisms.

Rock: Any consolidated or coherent and relatively hard, naturally formed, mass of mineral matter.

Rod-and-Reel: A hand-held fishing rod with a manually or electrically operated reel attached.

Scuba-assisted Fishing: Fishing, typically by spear or by hand collection, using assisted breathing apparatus.

Secretary: The Secretary of Commerce or a designee.

Sessile: Attached to a substrate; non-motile for all or part of the life cycle.

Slurp Gun: A self-contained, typically hand-held, tube–shaped suction device that captures organisms by rapidly drawing seawater containing the organisms into a closed chamber.

Small Fishing Vessel: a vessel less than 50 ft length overall. (These vessels are exempt from alternatives prohibiting anchoring on Guam's southern banks.)

Social Acceptability: The acceptance of the suitability of the FMP by stakeholders, taking cultural, traditional, political and individual benefits into account.

Spear: A sharp, pointed, or barbed instrument on a shaft, operated manually or shot from a gun or sling.

Special Permit: Permit with stringent criteria for issuance and operation. Required for fishing for coral reef taxa in low-use MPAs or for potentially harvested coral reef taxa in non-MPA areas. Also required for harvesting live hard coral for aquaculture seed stock, traditional indigenous use, scientific collecting and bioprospecting.

State: Recognizing that the Council Region comprises several different political entities—a state, a commonwealth, two territories, and unincorporated federal territory—hereafter, as shorthand, these constituent parts (excluding federal territory) will be generically referred to as states.

Stock Assessment: An evaluation of a stock in terms of abundance and fishing mortality levels and trends, and relative to fishery management objectives and constraints if they have been specified.

Stock of Fish: A species, subspecies, geographical grouping or other category of fish capable of management as a unit.

Submersible: A manned or unmanned device that functions or operates primarily underwater and is used to harvest fish.

Subsistence Fishing: Fishing primarily to obtain food for personal use rather than for sale or recreation.

Sustainable Use: The use of components of an ecosystem in a way and at a rate that does not lead to the long-term decline of biological diversity, size structure or abundance of any of its components, thereby maintaining their potential to meet the needs and aspirations of present and future generations.

Target Resources: Species or taxa sought after in a directed fishery.

Total Allowable Level of Foreign Fishing (TALFF): The portion of the OY on an annual basis that will not be harvested by U.S. vessels.

Trophic Web: The network that represents the predator/prey interactions of an ecosystem.

Trap: A portable, enclosed, box-like device with one or more entrances used for catching and holding fish or marine organism.

Unincorporated U.S. Island Possessions: Johnston Island, Wake Island, Midway Island, Palmyra Atoll, Kingman Reef, Jarvis Island, and Howland and Baker Islands.

Western Pacific Regional Fishery Management Council (WPRFMC or Council): Representatives from the State of Hawaii, the Territories of American Samoa and Guam and the Commonwealth of the Northern Mariana Islands with authority over the fisheries in the Pacific Island Area EEZ.

1.7.2 List of Acronyms

B:	Stock biomass
B_{FLAG}:	Minimum Biomass Flag
B_{MSY}:	Biomass Maximum Sustainable Yield
B_{OY}:	Biomass Optimum Yield
^0C:	Degrees Celsius
CITES:	Council on International Trade and Endangered Species
cm:	centimeters
CNMI:	Commonwealth of the Northern Mariana Islands
CPUE:	Catch per unit effort
$CPUE_{MSY}$:	Catch per unit effort Maximum Sustainable Yield
$CPUE_{REF}$:	Catch per unit effort
CRAMP:	Coral Reef Assessment and Monitoring Program
CRE:	Coral Reef Ecosystem
CRE-FMP:	Coral Reef Ecosystem Fishery Management Plan
CRTF:	Coral Reef Task Force
CDP:	Community Development Plan
DAR:	Division of Aquatic Resources, Department of Land and Natural Resources, Hawaii
DAWR:	Division of Aquatic and Wildlife Resources, Department of Agriculture, Guam
DBOR:	Division of Boating and Ocean Resources, Department of Land and Natural Resources, Hawaii
DEIS:	Draft Environmental Impact Statement
DFW:	Division of Fish and Wildlife, Department of Land and Natural Resources, CNMI
DLNR:	Department of Land and Natural Resources, Hawaii
DMWR:	Department of Marine and Wildlife Resources, American Samoa
DOC:	Department of Commerce
DOI:	Department of the Interior
E:	Effort
E_{AVG}:	Effort average
EEZ:	Exclusive Economic Zone
EFH:	Essential Fish Habitat
EIS:	Environmental Impact Statement
E_{MSY}:	Effort Maximum Sustainable Yield
ENSO:	El Niño Southern Oscillation
EO:	Executive Order

EPAP:	Ecosystem Principals Advisory Panel
ESA:	Endangered Species Act
F:	Fishing mortality
F_{MSY}:	Fishing mortality Maximum Sustainable Yield
F_{OY}:	Fishing mortality Optimum Yield
FEP:	Fishery Ecosystem Plan
FDM:	Farallon de Medinilla, CNMI
FFS:	French Frigate Shoals, NWHI
FLPMA:	Federal Land Policy Management Act
fm:	fathoms
FMP:	Fisheries Management Plan
g:	grams
GIS:	Geographic information systems
HAPC:	Habitat Areas of Particular Concern
HCRI:	Hawaii Coral Reef Initiative Research Program
HINWR:	Hawaiian Islands National Wildlife Refuge
HIR:	Hawaiian Islands Reservation
ICRI:	International Coral Reef Initiative
IRFA:	Initial Regulatory Flexibility Analysis
km:	kilometers
lbs.	pounds
m:	meters
maxFMT:	maximum fishing mortality threshold
MHI:	Main Hawaiian Islands
min SST:	minimum spawning stock threshold
mm:	millimeters
MMPA:	Marine Mammal Protection Act
MPA:	Marine Protected Area
MSFCMA:	Magnuson-Stevens Fisheries Conservation and Management Act
MSY:	Maximum Sustainable Yield
mt:	metric ton
MUS:	Management Unit Species
NDSA	Naval Defensive Sea Area
NEPA:	National Environmental Policy Act
nm or nmi:	nautical miles
NMFS:	National Marine Fisheries Service
NMFS-HL:	National Marine Fisheries Service - Honolulu Laboratory
NOAA:	National Oceanic and Atmospheric Administration
NWHI:	Northwestern Hawaiian Islands
NWR:	National Wildlife Refuge
NWRAA:	National Wildlife Refuge Administration Act
OY:	Optimum Yield
PIAO:	Pacific Islands Area Office
PRA:	Paperwork Reduction Act

PRIA:	Pacific Remote Island Areas
PT:	Plan Team (for FMP development)
RA:	Regional Administrator, NMFS
RFA:	Regulatory Flexibility Act
RIR:	Regulatory Impact Review
SFA:	Sustainable Fisheries Act
SLA:	Submerged Lands Act
SPR:	Spawning Potential Ratio
SSC:	Scientific and Statistical Committee
TALFF:	Total Allowable Level of Foreign Fishing
TSLA:	Territorial Submerged Lands Act
USFWS:	United States Fish and Wildlife Service
USCG:	United States Coast Guard
VMS:	Vessel Monitoring System
WpacFin:	Western Pacific Fisheries Information Network
WPRFMC:	Western Pacific Regional Fishery Management Council

CHAPTER 2

DESCRIPTION OF THE CORAL REEF ECOSYSTEM

2.1 Coral Reef Ecosystems

Coral reefs are carbonate rock structures at or near sea level that support viable populations of scleractinian or reef-building corals. Apart from a few exceptions, coral reefs are confined to the warm tropical and sub-tropical waters lying between 30° N and 30° S. Coral reef ecosystems are arguably the oldest and certainly the most diverse and complex ecosystems on earth. Their complexity is manifest on all conceptual dimensions, including geological history, growth and structure, biological adaptation, evolution and biogeography, community structure, organism and ecosystem metabolism, physical regimes, and anthropogenic interactions (see sources cited by Hatcher *et al.* 1989). There is a voluminous and expanding literature on coral reefs and coral reef ecosystems (Birkeland 1997a), beginning with Charles Darwin's 1842 volume, *The Structure and Distribution of Coral Reefs*, which remains the seminal volume on reef formation and structure, including reefs in the Western Pacific Region. The symbiotic relationship between the animal coral polyps and algal cells known as zooxanthellae is a key feature of reef building corals. Incorporated into the coral tissue, these photosynthesizing zooxanthellae provide much of the polyp's nutritional needs, primarily in the form of carbohydrates. Most corals supplement this food source by actively feeding on zooplankton or dissolved organic nitrogen, due to the low nitrogen content of the carbohydrates derived from photosynthesis.

The corals and coral reefs of the Pacific are described in Wells and Jenkins (1988) and Veron (1995). The number of coral species declines in an easterly direction across the Western and Central Pacific in common with the distribution of fish and invertebrate species. Over 330 species are contained in 70 genera on the Australian Barrier Reef, compared with only 30 coral genera present in the Society Islands of French Polynesia, and 10 genera in the Marquesa and Pitcairn Islands. Hawaii, by virtue of its isolated position in the Pacific, also has relatively few species of coral (about 50 species in 17 genera) and, more importantly, lacks most of the branching or "tabletop" *Acropora* species that form the majority of reefs elsewhere in the Pacific. The *Acropora* species provide a large amount of complex three-dimensional structure and protected habitat for a wide variety of fishes and invertebrates.

Most forms of coral reef development can be found in the Western Pacific Region, including barrier reefs in Guam and Saipan, fringing reefs in the Samoas and Hawaii, and patch and submerged reefs, banks and shoals throughout the region, but particularly abundant in the NWHI and within the EEZ of the Northern Mariana Islands. Other habitats commonly

associated with coral reefs include mangrove forests, particularly in estuarine areas. The natural eastern limit of mangroves in the Pacific is American Samoa, although the red mangrove *Rhizophora mangle*, was introduced into Hawaii in 1902 and has become the dominant plant within a number of large protected bays and coastlines on both Oahu and Molokai (Gulko 1998). Apart from the usefulness of the wood for building, charcoal, and tannin, mangrove forests stabilize areas where sedimentation is occurring and, from a fisheries perspective, are important as nursery grounds for peneaeid shrimps and some inshore fish species, and form the habitat for some commercially valuable crustaceans.

Sea grasses are common in all marine ecosystems and are a regular feature of most of the inshore areas adjacent to coral reefs in the Pacific Islands. According to Hatcher *et al.* (1989), sea grasses stabilize sediments because leaves slow current flow, thus increasing sedimentation of particles. The roots and rhizomes form a complex matrix that binds sediments and stops erosion. Sea grass beds are the habitat of certain commercially valuable shrimps, and provide food for reef-associated species such as surgeonfishes (Acanthuridae) and rabbitfishes (Siganidae). Sea grasses are also important sources of nutrition for higher vertebrates such as dugongs and green turtles. A concise summary of the seagrass species found in the western tropical South Pacific is given by Coles and Kuo (1995). From the fisheries perspective, the fishes and other organisms harvested from the reef coral and associated habitats such as mangroves, seagrass beds, shallow lagoons, bays, inlets, and harbors, and the reef slope beyond the limit of coral reef growth, contribute to the total yield from coral reef-associated fisheries. Unlike other Council FMPs, which are broadly species-based, this FMP is ecosystem-based. It is concerned not only with the health of target stocks, but also with the preservation of the coral reef ecosystems within the Western Pacific Region. To do this requires an understanding of the ecosystem components and how these various components interact.

2.1.1 Reef Productivity

Coral reefs are among the most biologically productive ecosystems in the world. The global potential for coral reef fisheries has been estimated at 9 million mt per year, which is impressive given the small area of reefs compared to the extent of other marine ecosystems, which collectively produce between 70 - 100 million mt per year (Munro 1984; Smith 1978). An apparent paradox of coral reefs, however, are their location in the nutrient deserts of the tropical oceans. In these areas the water is very clear because gross primary productivity is low, generally ranging between 20 to 50 $gCm^{-2}yr^{-1}$. Coral reefs themselves are characterized by the highest gross primary production in the sea, with reef flats and margins sustaining primary production rates of between 1,800-3,700 $gCm^{-2}yr^{-1}$, and sand and rubble zones about 370 $gCm^{-2}yr^{-1}$. The main primary producers on reefs are the benthic microalgae, macroalgae, symbiotic microalgae of corals, and other symbiont-bearing invertebrates. Zooxanthellae living in the tissues of hard corals make a substantial contribution to primary productivity in zones rich in corals due to their density—greater than 10^6 cells cm^{-2} of live coral surface—and the high rugosity of the surfaces on which they live, as well as their own photosynthetic potential. However, zones of high coral cover make up only a small part of

entire coral reef ecosystems, and so their contribution to total reef gross primary productivity is small.

Although the ocean's surface waters in the tropics generally have low productivity, these unproductive waters, which bathe coral reefs, are continually moving. Reefs therefore have access to substantial open-water productivity. Thus, particularly in inshore continental waters, shallow benthic habitats such as reefs must not always be considered the dominant sources of carbon for fisheries. Outside sources may be important for reefs, and while this significance is rarely estimated, its input may be in living (plankton) or dead (detrital) forms. In coastal waters detrital matter from land, plankton, and fringing marine plant communities are particularly abundant. There may be passive advection of particulate and dissolved detrital carbon onto reefs, and active transport onto reefs via fishes that shelter on reefs but feed in adjacent habitats. There is, therefore, greater potential for nourishment of inshore reefs than offshore reefs by external carbon sources, and this inshore nourishment will be enhanced by large land masses.

For most of the Pacific Islands, rainfall typically ranges from 2,000 to 3,500 mm per year. Low islands, such as *makateas* and atolls, tend to have less rainfall and may suffer prolonged droughts. Further, when rain does fall on coral islands and *makateas* that have no major catchment area, there is little allochthonous nutrient input into surrounding coastal waters and lagoons. Lagoons and embayments around high islands are therefore likely to be more productive than atoll lagoons. There are however, some exceptions. Both Palmyra Atoll and Rose Atoll are unique in that they may receive up to 4,300 mm of rain per year. These atolls are among the few wet atolls in the world. The productivity of high island coastal waters, particularly where there are lagoons and sheltered waters, is possibly reflected in the greater abundance of small pelagic fishes such as anchovies, sprats, sardines, scads, mackerels, and fusiliers. Furthermore, the range of different environments that can be found in the immediate vicinity of the coasts of high islands also contributes to the greater range of bio-diversity found in such locations.

Studies on coral reef fisheries are relatively recent, commencing with the major study by Munro and his co-workers during the late 1960s in the Caribbean (Munro 1983). Even today, only a relatively few examples are available of in-depth studies on reef fisheries. It was initially thought that the maximum sustainable yields for coral reef fisheries were in the range of 0.5-5 $t/km^{-2}yr^{-1}$, based on limited data (Marten and Polovina 1982; Stevenson and Marshall 1974). Much higher yields of around 20 $t/km^{-2}yr^{-1}$, for reefs in the Philippines (Alcala 1981; Alcala and Luchavez 1981) and American Samoa (Wass 1982), were thought to be unrepresentative (Marshall 1980), but high yields of this order have now been independently estimated for a number of sites in the South Pacific and Southeast Asia (Dalzell and Adams 1997; Dalzell *et al.* 1996). These higher estimates are closer to the maximum levels of fish production predicted by trophic and other models of ecosystems (Polunin and Roberts 1996). Dalzell & Adams (1997) suggest that the average MSY for Pacific reefs is in the region of 16 $t/km^{-2}yr^{-1}$ based on 43 yield estimates where the proxy for fishing effort was population density.

However, Birkeland (1997a) has expressed some scepticism about the sustainability of the high yields reported for Pacific and south east Asian reefs. Among other examples, he notes that the high values for American Samoa reported by Wass (1982) during the early 1970s were followed by a 70% drop in coral reef fishery catch rates between 1979 and 1994. Saucerman (1995) ascribed much of this decline to a series of catastrophic events over the same period. This began with a crown of thorns infestation in 1978, followed by hurricanes in 1990 and 1991, which reduced the reefs to rubble, and a coral bleaching event in 1994, probably associated with the El Niño phenomenon. These various factors reduced live coral cover in American Samoa from a mean of 60% in 1979, to between 3-13% in 1993.

Further, problems still remain in rigorously quantifying the effects on yield estimates of factors, such as primary productivity, depth, sampling area, or coral cover. Polunin *et al.* (1996) noted that there was an inverse correlation between estimated reef fishery yield and the size of the reef area surveyed, based on a number of studies reported by Dalzell (1996). Arias-Gonzales *et al.* (1994) have also examined this feature of reef fisheries yield estimates and noted that this was a problem when comparing reef fishery yields. The study noted that estimated yields are based on the investigator's perception of the maximum depth at which true reef fishes occur. Small pelagic fishes, such as scads and fusiliers, may make up large fractions of the inshore catch from a particular reef and lagoon system, and if included in the total catch can greatly inflate the yield estimate. The great variation in reef yields summarized by authors such as Arias-Gonzales et al (1994), Dalzell (1996) and Dalzell and Adams (1997) may also be due in part to the different size and trophic levels included in catches.

Another important aspect of the yield question is the resilience of reefs to fishing and recovery potential when overfishing or high levels of fishing effort have been conducted on coral reefs. Evidence from a Pacific atoll where reefs are regularly fished by community fishing methods, such as leaf sweeps and spearfishing, indicated that depleted biomass levels may recover to pre-exploitation levels within one to two years. In the Philippines, abundances of several reef fishes have increased in small reserves within a few years of their establishment (Russ and Alcala 1994; White 1988), although recovery in numbers of fish is much faster than recovery of biomass, especially in larger species such as groupers. Other studies in the Caribbean and South East Asia (Polunin *et al.* 1996) indicate that reef fish populations in relatively small areas have the potential to recover rapidly from depletion in the absence of further fishing. Conversely, Birkeland (1997a) cites the example of a pinnacle reef off Guam fished down over a period of six months in 1967 that has still not recovered thirty years later.

Estimating the recovery from, and reversibility of fishing effects over large reef areas appears more difficult. Where growth overfishing predominates, recovery following effort reduction may be rapid if the fish in question are fast growing, as in the case of goatfish (Garcia and Demetropolous 1986). However, recovery may be slower if biomass reduction was due to recruitment overfishing because it takes time to rebuild adult spawning biomasses and high fecundities (Polunin and Morton 1992). Further, many coral reef species have limited distributions; they may be confined to a single island or a cluster of proximate islands.

Widespread heavy fishing could cause regional extinctions of some such species, particularly if there is also associated habitat damage. Unfortunately, the majority of species with a limited range are also valuable to the aquarium trade, and in the future restrictions on capture, possibly through CITES listing, may be appropriate to prevent overfishing.

2.1.2 Extent and Distribution of Coral Reefs

Roughly 70% of the world's coral reefs, or 420,000 km^2 are located in the Pacific Ocean (Bryant *et al.* 1998). Of all reefs under U.S. jurisdiction, 94%, or an estimated 15,852 km^2 of reef area, are associated with U.S. Pacific Islands (Clark and Gulko 1999; Hunter 1995). Table 1.1 shows their geographical distribution. Note that many of these coral reefs are located in areas where there is no human population, like the NWHI and the PRIAs, or in island archipelagos, like American Samoa and the CNMI, where population is concentrated on one or two islands.

2.2 Coral Reef Ecological Characteristics and Resource Dynamics

Coral reefs and reef-building organisms are confined to the shallow upper photic zone. Maximum reef growth and productivity occurs between 5-15 m (Hopley and Kinsey 1988) and maximum diversity of reef species occurs at 10-30 m (Huston 1985). Thirty meters has been described as a critical depth below which rates of growth (accretion) of coral reefs are often too slow to keep up with changes in sea level. This was true during the Holocene transgression over the last 10,000 years, and many reefs below this depth drowned during this period. Coral reef habitat does extend deeper than 30 m, but few well developed reefs are found below 50 m. Many reefs in the world are bordered by broad areas of shelf habitat between 50-100 m. Many of these shelf habitats were formed by wave erosion during periods of lower sea level during the Pleistocence period. Today, extensive areas of shelf habitat exist in the NWHI. These habitats consist primarily of carbonate rubble, algae and micro-invertebrate communities, some of which may be important nursery grounds for some coral reef fish, as well as habitat for several species of lobster. However, the ecology of this habitat is poorly known and much more research is needed in this zone. This will help in defining the lower depth limits of the coral reef ecosystem, which by inclusion of shelf habitat, could be viewed as extending to 100 m.

Available biological and fishery data are poor for all species and areas covered by the CRE-FMP; therefore, it is not possible to implement the Fishery Ecosystem Plan action item 4, elaborated by EPAP.[2] Furthermore, high biological and environmental variability is a natural characteristic of coral reef ecosystems around the U.S. Pacific Islands, with or without fishing. Irregular pulses of new recruits (Walsh 1987) cause cycles in the abundance and

[2]As discussed on page 14 in this FMP, FEP action item four states "Calculate total removals—including incidental mortality—and show how they relate to standing biomass, production, optimum yields, natural mortality, and trophic structure."

harvest potential of individual reef species. Environmental variability is both spatial, related to differences in the quality of habitat (Friedlander and Parrish 1998a), and temporal, related to monthly moon phase, seasonal and longer-term environmental changes (Friedlander and Parrish 1998b).

Polovina *et al.* (1994) examined a large-scale climatic shift that affected coral reef resources in the NWHI from the mid-1970s to the late 1980s. During this period, the central North Pacific experienced increased vertical mixing, with a deepening of the wind-stirred surface layer into nutrient-rich lower waters and probable increased injection of nutrients into the upper ocean. Resulting increased primary productivity likely provided a larger food base for fish and animals at higher tropic levels. In the NWHI, changes of 60-100% over baseline levels in productivity for lobsters, sea birds, reef fish, and monk seals were observed and attributed to deeper mixing during 1977-1988.

The highest quality habitat on a coral reef is often where abundant living coral has created high bottom relief. Natural disturbance cycles in areas exposed to large storm waves can dramatically alter habitat quality. For example, periodic storms in the NWHI reduce live coral cover to 10% in some areas. Coral cover eventually returns to 50% or more, depending on how protected the area is (R. Grigg, 104th Council meeting, June 2000).

Unlike pelagic ecosystems, which are driven primarily by oceanographic forces operating on a large scale, coral reef ecosystems are strongly influenced by biological processes, habitat utilization, and environmental conditions at a relatively small scale. Innumerable animals and plants shelter, attach, or burrow into the reef structure, creating some of the most biologically diverse and complex ecosystems on earth.

2.2.1 Ecological Relationships

Coral reef ecosystems have existed in geological terms for nearly twice as long as flowering plants, and some of the coral genera are more ancient than any grasslands. Therefore, the ecological relationships have had more time to develop complexity in coral reefs. A major portion of the primary production of the coral reef ecosystem comes from complex inter-kingdom relationships of animal/plant photo-symbioses hosted by animals of many taxa, most notably stony corals. Most of the geological structure of reefs and habitat is produced by these complex symbiotic relationships.

Complex symbiotic relationships for defense from predation, removal of parasites, building of domiciles, and other functions are also prevalent. About 32 of the 33 animal phyla are represented on coral reefs (only 17 are represented in terrestrial environments) and this diversity produces complex patterns of competition. The diversity also produces a disproportionate representation of predators, which have strong influences on lower levels of the food web in the coral reef ecosystem (Birkeland 1997c). Figure 2.1 shows, in a schematic fashion, inter-relationships between reef fishes and with the surrounding environment, and how these relationships can affect population dynamics during different life phases.

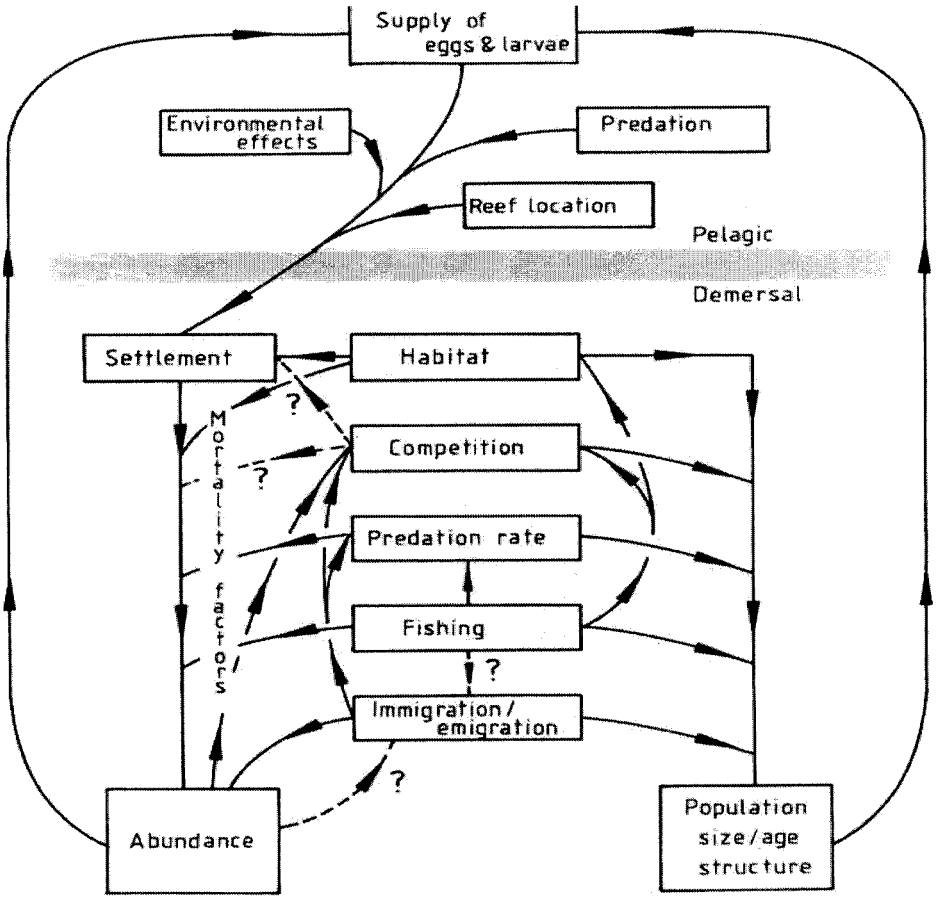


Figure 2.1: Interrelationships within the coral reef ecosystem. Flow diagram illustrating factors determining the abundance and size/age structure of populations. Arrows show direction of effects. Dashed lines with ? indicated expected relationships but without supporting evidence. (Source: Polunin and Roberts 1991.)

In areas with high gross primary production but low net primary production or yield—such as rain forests and coral reefs—animals and plants tend to have a higher variety and concentration of natural chemicals as defenses against herbivores, carnivores, competitors, and microbes. Because of this tendency, and the greater number of phyla in the system, coral reefs are now a major focus for bioprospecting, especially in the southwest tropical Pacific (Birkeland 1997c).

2.2.2 Coral Reef Habitat

Even within a thriving coral reef habitat, not all space is occupied by corals or coralline algae. Reefs are typically patchworks of hard and sediment bottoms. A reef provides a variety of environmental niches, or combination of resources. The wide variety of survival strategies employed by coral reef organisms allows different species to exploit some combination of resources better than their competitors. The ecosystem is dynamic, however. If conditions

change, a very specialized species may not be able to survive the rigors of the new environment or may be forced out by another species more adept at using the available resources, including space, food, light, water motion, and temperature.

2.2.3 Long-term Ecosystem Variability

Climate and ecosystem shifts may occur over decadal scale cycles or longer, meaning that resources management decisions need to consider changes in target level productivity over the long-term as well as short-term inter-annual variation. For example, the climatic shift that occurred in the central North Pacific in the late 1980s (see Section 2.20 produced an ecosystem shift in the NWHI to a lower carrying capacity, with a 30-50% decline in productivity (Polovina *et al.* 1994). This in turn reduced recruitment and survival of monk seals, reef fish, albatross, and lobsters. Under lower carrying capacity regime, fishing alters the age-structure of the population and may also lead to stock depletion.

At Laysan Island, where lobster fishing is prohibited, spawning biomass of lobsters was also depleted by natural mortality. This suggests that marine reserves may not guarantee the protection that is typically assumed (Polovina and Haight 1999). In response to this natural variability, the Council adjusted its management measures (e.g., limited entry, annual quota) to reduce catch and effort to about 25% of its 1980's level.

The destruction of coral reefs around Tutuila, the principal island in American Samoa, forced fishermen to move into predominantly pelagic fishing, initially trolling, and later, small-scale longline fishing. As a result, much of the reef fish consumed in American Samoa now comes from Western Samoa. The reduction of fishing on coral reefs may also aid in the recovery of live coral cover, but the long-term recovery of the reefs around Tutuila will principally depend on a benign climate and marine environment over the next decade. Furthermore, these destructive events occurred during a long-term shift in the physical environment of the equatorial Pacific Ocean, which began in 1977 (Miller *et al.* 1994). Conditions included more clouds, more rainfall, warmer sea surface temperatures, and weaker trade winds, similar to a weak decadal El-Niño state. They were most pronounced in the central equatorial Pacific, so American Samoa was close to the center of this shift, which persisted until 1999, when conditions began to change. Whether 1999 marks another regime shift will not be known for several years (Polovina pers. comm.).

The destruction of American Samoan coral reefs included, in 1994, a coral bleaching episode. This phenomenon also affected reefs in the Cook Islands and French Polynesia, and was due to unseasonably high sea water temperatures. Coral bleaching occurs when corals lose or expel their zooxanthellae in large numbers, usually due to some trauma such as high or low temperatures or lower than usual salinities (Brown 1997). The corals that lose zooxanthellae also lose their color, becoming white and hence the term 'bleaching.' Although first described in the 1900s, interest in this phenomenon was heightened in the 1980s and 1990s after a series of major bleaching events in the Atlantic and Pacific Oceans. Some of these episodes were linked to the El-Niño Southern Oscillation or ENSO events (Gulko 1998).

When bleaching occurs, some corals are able to regain zooxanthellae by slowly re-infecting themselves with the algae, or through the reproduction of remaining zooxanthellae within the colony. Frequently, the loss of large amounts of symbiotic algae results in the colony becoming energy deficient; it expends more energy than it is consuming. If this occurs over the long term the colony dies (Brown 1997; Gulko 1998). Coral bleaching events require only a 1-2° C increase in water temperature. Thus, due to global warming, bleaching may become more common. According to Goreau *et al.* (1997), similar events in the Atlantic and the Indian Oceans suggest that worldwide corals are acclimated close to their upper temperature limits. As a result, they are unable to adapt rapidly to an anomalous warming (Goreau *et al.* 1997). Consequently, global warming represents a very serious threat to the survival of coral reefs.

Other physical phenomena that may bring long-term change to coral reef systems include the impact of hurricanes and tectonic uplift. Bayliss-Smith (1988) describes the changes in reef islands at Ontong-Java Atoll over a 20-year period following a severe hurricane. Most atoll islands are on reef flats in what are frequently high wave-energy locations near to seaward reef margins. Unless composed of coarse shingle and rubble, these islands are unstable. Hurricanes will destroy such small cays and scour *motu* beaches, and strip small or narrow islands of fine sediment during over-wash periods. Bayliss Smith (1988) notes that while hurricanes tend to erode islands, they also produce the material for their reconstruction. More frequent, lower magnitude storms contribute to the process by transporting the rubble ramparts thrown up by hurricanes. This reconstructs scoured beaches and eroded shorelines. Clearly, such destruction and reconstruction activity on reef flats will have an effect on reef organisms, including fish and invertebrates, particularly where large areas of reef are smothered by sand and silt following a hurricane.

The process of tectonic uplift can profoundly influence coral reef systems. It is a much slower process, however, taking several centuries or even millennia to significantly change coral reefs. Tectonic uplift can push a productive reef flat above the water's surface, producing an exposed limestone terrace. This reduces the amount of reef area available for fishing, as occurred at Niuatoputapu and in the Tonga archipelago (Kirch and Dye 1979). Tectonic uplift was also partially responsible for changing Tongatapu Island's central lagoon from a marine to a brackish water environment. This resulted in the loss of an important reef mollusc resource, *Anadara antiquata,* which could not survive the reduced salinity. A similar event occurred at Tikopia in the Solomon Islands. There, a circular bay with a narrow entrance became a brackish coastal lake as the bay entrance was sealed through a combination of tectonic uplift and increased sedimentation caused by agricultural runoff from neighboring slopes. Again, this major habitat change wiped out reef- and lagoon-associated molluscs, a major food source for the indigenous people (see sources cited in Dalzell 1998).

2.3 Coral Reef Communities

Coral reef communities are among the most diverse and ecologically complex systems known. The structure of reef communities is usually defined in terms of the diversity and

relative abundances of species characteristic of a habitat type. Commonly, only a few species compose over half the abundance, while hundreds of others are present in low numbers.

2.3.1 Life History

The literature on coral reef fish life histories is voluminous, but convenient entries into the literature are provided by Sale (1991), Polunin and Roberts (1996), and Birkeland (1997b). The life of a coral reef fish includes several stages. Typically, spawning occurs in the vicinity of the reef and is characterized by frequent repetition throughout a protracted time of the year, a diverse array of behavioral patterns, and extremely high fecundity. The eggs of many species are fertilized externally and dispersed directly into the pelagic environment as plankton. Other species have demersal eggs, which upon hatching disperse larvae into the pelagic realm. Planktonic mortality is very high and unpredictable. Recruitment is the transition stage from the planktonic larval life to demersal existence on a coral reef. Recruitment is both spatially and temporally highly variable. This is when post-larval juveniles begin their residence on reefs where many remain for life. Highest predation mortality occurs in the first few days or weeks, thus rapid growth out of the juvenile stage is a common strategy.

Terrestrial animal populations are usually dispersed by adults, who deposit eggs or build nests in selected locations. In contrast, the most frequent pattern for coral reef organisms is dispersion of eggs and larvae in water currents, which determines the final locations of adults. The adults are often sedentary or territorial. The differences in factors that bring about success in these two life history phases complicate fisheries management (Birkeland 1997c).

2.3.2 Species Distribution and Abundance

Species diversity declines eastwards across the Pacific from the locus of maximum species richness in Southeast Asia (especially in the Philippines and Indonesia), and is related in part to the position of land masses in relation to the Pacific Plate, the earth's largest lithospheric plate (Springer 1982). In general, species richness is greatest along the plate margin and declines markedly on the plate itself. As a result, islands in the Central Pacific generally have a lower reef organism diversity, but also a high degree of endemism. For example, Guam has about 269 species of zooxanthellate Scleractinian corals, about 40 Alcyonacea and just under a thousand species of fishes; Hawaii has far fewer in comparison. The proportion of endemic species increases in the opposite direction. For example, the Hawaiian Islands have about 18% endemic zooxanthellate corals, 60% endemic Alcyonacea and 25% endemic reef fishes. The proportion of alien species in Hawaiian waters is also greater, and it is increasing (Birkeland 1997c).

As noted above, among the diverse array of species in each taxa on coral reefs, there are usually only a few that are consistently abundant, with the relative abundance of species within a taxa possibly approximating a log-normal distribution. The majority of species are relatively uncommon or only episodically abundant, following unusually successful recruitment (Birkeland 1997c).

Individual sub-populations of larger stocks of reef species may increase, decrease, or cease to exist locally without adversely affecting the overall population. The condition of the overall populations of particular species is linked to the variability among sub-populations: the ratio of sources and sinks, their degrees of recruitment connection, and the proportion of the sub-populations with high variability in reproductive capacity. Recruitment to populations of coral reef organisms depends largely on the pathways of larval dispersal and "downstream" links. In considering recruitment mechanisms one must ask: Are the connections sufficient to actually restock distant sub-populations or only enough to maintain a homogenous genetic stock?

2.3.3 Reproduction and Recruitment

The majority of coral reef animals are very fecund, but temporal variations in recruitment success have been recorded for some species and locations. Many of the large, commercially-targeted coral reef animals are long-lived and reproduce for a number of years. This is in contrast to the majority of commercially-targeted species in the tropical pelagic ecosystem. Long-lived species adapted to coral reef systems are often characterized by complex reproductive patterns like sequential hermaphroditism, sexual maturity delayed by social hierarchy, multi-species mass spawnings, and spawning aggregations in predictable locations (Birkeland 1997c).

2.3.4 Growth and Mortality Rates

Recruitment of coral reef species is limited by high mortality of eggs and larvae, and also by competition for space to settle out on coral reefs. Predation intensity is due to a disproportionate number of predators, which limits juvenile survival (Birkeland 1997c). In response some fishes—such as scarids (parrotfish) and labrids (wrasses)—grow rapidly compared with most coral reef fishes. But they still grow relatively slowly compared to pelagic species. In addition, scarids and labrids may have complex haremic territorial social structures that contribute to the overall effect of harvesting these resources. It appears that many tropical reef fishes grow rapidly to near-adult size, and then often grow relatively little over a protracted adult life span; they are thus relatively long-lived. In some groups of fishes, such as damselfish, individuals of the species are capable of rapid growth to adult size, but sexual maturity is still delayed by social pressure. This complex relationship between size and maturity makes resource management more difficult (Birkeland 1997c).

2.3.5 Community Variability

High temporal and spatial variability is characteristic of reef communities. At large spatial scales, variation in species assemblages may be due to major differences in habitat types or biotopes. Seagrass beds, reef flats, lagoonal patch reefs, reef crests, and seaward reef slopes may occur in relatively close proximity, for example, but represent notably different habitats.

As suggested in Section 2.2.3, reef fish communities from the geographically isolated Hawaiian Islands are characterized by low species richness, high endemism, and exposure to large semiannual current gyres, which may help retain planktonic larvae. The NWHI is further characterized by: (1) high latitude coral atolls; (2) a mild temperate to subtropical climate, where inshore water temperatures can drop below 18° C in late winter; (3) species that are common on shallow reefs and attain large sizes, which to the southeast occur only rarely or in deep water; and 4) inshore shallow reefs that are largely free of fishing pressure.

2.4 Ecosystem Models

Several approaches to model multi-species fisheries have been used by coral reef fishery scientists with varying levels of success. The simplest approach has been to treat a community as the sum of its species. These general multi-species models have been applied by several researchers to estimate yields in coral reef fisheries. They are based on simultaneous Lotka-Voltera equations, which incorporate the impact of each species' population size on every other species through use of shared resources. Researchers have also incorporated predation and harvesting effects into these models. Unfortunately, with highly diverse systems such as coral reefs, this leads to an extremely complex model with potentially hundreds of parameters. Nonetheless, these approaches are mentioned as possible avenues for future assessment methodologies, although at present the lack of data limits confidence in their results.

An alternative is to divide the assemblage into separate trophic levels and model the energy flow through the system to estimate potential yields. The two linked models described in more detail below take this approach.

2.4.1 ECOPATH

ECOPATH is a simple mathematical model that estimates mean annual biomass, production, and food consumption for major components—defined in terms of species groups—of a coral reef ecosystem (Polovina 1984). Polovina used the following species groups to model the ecosystem at French Frigate Shoals in the NWHI: tiger sharks, monk seals, seabirds, reef sharks, sea turtles, small pelagics, jacks, reef fish (and octopus), lobsters and crabs, deepwater bottomfish, nearshore scombrids, zooplankton, phytoplankton, heterotrophic benthos, and benthic algae. A box model illustrates a biomass budget schematic for major predator-prey pathways and lists annual production and annual biomass for each group. The model shows a high percent of internal predation, which partially explains why fishery yields

from coral reefs are generally low despite high primary productivity. The allocation of species to trophic compartments constrains the ECOPATH approach because it imposes an artificial structure that may not coincide with actual community structure. This approach is also data intensive and requires information on each species' diet, mortality, and growth rates.

Extensive field work from French Frigate Shoals provided estimates of parameters used to validate the model. Application of ECOPATH to French Frigate Shoals found that the coral reef ecosystem is controlled mainly by predation from the top down and primary production is controlled mainly by nutrients, photosynthetic rate limits, and habitat space (Grigg *et al.* 1984). Fishery yields can be maximized by targeting lower trophic levels and cropping top predators to release pressure on prey. Thus, a fishery targeting tiger sharks at French Frigate Shoals should help ease predation pressure on endangered Hawaiian monk seals and threatened green turtles. Coral reef ecosystems are susceptible to overfishing due to high levels of natural mortality and low net annual production. A study of coral reef fish communities on patch reefs at Midway Atoll found that they were relatively resilient to several years of fishing pressure on top predators, while some control by predation was detected (Schroeder 1989).

2.4.2 ECOSIM

ECOSIM is a computer model that uses the output of the ECOPATH model. Input parameters by species (or species group) include natural and fishing mortality, diet composition, and production to biomass ratio. The vulnerability level of prey to predators can be adjusted and gear selectivity levels can also be set. Predation levels are then determined. In order to determine qualitative changes in the structure of the resource community, the model can be run for several decades. Applying various levels of fishing pressure can reveal which target and non-target species increase and which decrease in abundance, considering predator-prey interactions (Kitchell *et al.* 1999).

2.5 Ecosystem Overfishing

The special vulnerability of targeted coral-reef resources comes from life-history traits of these economically valuable species, which live in diverse communities with strong predatory and competitive forces. Coral reef species are adapted to reproduce often because so few of their progeny are likely to survive. Therefore, they grow slowly, delay first reproduction, and are more territorial than pelagic species. These life history traits make recovery from overfishing very uncertain. Some coral reef ecosystems, driven by biological interactions, have not recovered for decades following intensive harvest, and there are no indications that they will recover. In contrast, pelagic fisheries, driven by oceanographic processes, usually do recover. For example, black-lipped pearl oysters at Pearl and Hermes Atoll in the NWHI were over-harvested to commercial extinction in the late 1920s; according to recent surveys, stocks have still not recovered after 70 years. Holothuroids (sea cucumbers) were over-harvested in the late 1930s in Chuuk, Eastern Caroline Islands, and recent surveys there also

show no recovery after 60 years. Dalzell *et al.* (1996) cite several other examples from the Pacific Islands where pearl oyster and sea cucumber populations have failed to recover from over-harvesting, even after several decades of no fishing.

Some fishing activities, such as overfishing, may degrade coral reef ecosystems and ultimately affect ecosystem processes. For example, the removal of herbivorous fishes can lead to the overgrowth of coral by algae, eventually destroying some coral reef resources. Munro (1983; 1999) has suggested that overfishing of predatory reef species may lead to a decline in the natural mortality of herbivores; in response, their biomass increases. When the herbivores are in turn overfished, algal production is uncontrolled. Most of the resulting increase in algae and sea-grass biomass then turns to detritus. However, there are few well documented examples of such effects cascading through ecosystems.

Munro (1999), cites the north coast of Jamaica as an example of reefs almost entirely overgrown by macro-algae and where the cover of live coral is extremely low. Although scientists do not fully agree, it appears that this can be attributed to the long-term effects of overfishing. The very narrow island shelf (less than one kilometer wide) was covered by flourishing coral reefs until 1984. Then several events combined to change the situation. First, the herbivorous long-spined sea urchin, *Diadema antillarum,* spread rapidly throughout the Caribbean. Then the north coast of Jamaica took a direct hit from a major hurricane. The reefs were pulverized by heavy seas and large corals were stripped of tissue. Macro-algae colonized all these newly exposed surfaces. In the absence of sea urchins and herbivorous fish, the macro-algae have remained dominant (Hughes 1994). Other parts of the Caribbean with less heavily exploited fish stocks also lost their urchin populations and suffered hurricanes, but these reefs were not massively overgrown with algae. While it cannot be proven that overfishing was the cause of this catastrophe, the evidence points in that direction.

The MSFCMA requires managers to identify the individual species composing a fishery management unit and calculate Maximum Sustainable Yield (MSY) for each. But on coral reefs, although there are thought to be thousands of economically valuable species, many of them have not been named or described by scientists. However, bio-prospectors—the major near-term users of reef resources—will try to find as many pharmaceutically useful species as possible, whether or not they have been officially described by scientists. If managers have to name each species, and estimate their MSY, it will be many decades before an FMP can be completed and these kinds of economic uses can begin. Thus, the sort of ecosystem-level approach espoused by EPAP is well suited to the complex multi-species coral reef ecosystem.

In concert with the ecosystem approach, an alternative overfishing definition seems most appropriate for the CRE-FMP. In contrast to the single-species approach, the ecosystem overfishing concept considers how fishing pressure can cause changes to species composition in a multi-species setting, often resulting in changes in ecosystem function (DeMartini *et al.* 1999). This can be detected by shifts in species composition or trophic web dynamics. Using this concept can also guard against single-stock recruitment overfishing, where applicable.

There are other reasons for adopting this approach. First, the loss of some species in the multi-species coral reef ecosystem—due to overfishing or other human impacts—could allow often less valuable generalist species to predominate. As in the example cited above, these types of changes to heavily fished reefs have been reported for a number of tropical stocks from various areas around the world. Second, multi-species systems become more vulnerable to environmental fluctuations as exploitation increases.

CHAPTER 3

DESCRIPTION OF THE FISHERY AND FISHING COMMUNITIES

3.1 Introduction

Chapter 2 of this FMP outlined the biology and ecology of coral reefs. This chapter describes how people use and depend on those resources. The discussion is divided into two parts. The first part, Sections 3.2 through 3.5, describe various aspects of regional fisheries as they relate to coral reef resources. The next section provides an overview of the many uses of coral reefs in the region and identifies those uses—defined as "sectors"—that the management measures in this plan will directly affect. Section 3.3 summarizes the available data that can be used to characterize regional fisheries, and using these data briefly describes two important fisheries sectors. Section 3.4 reviews the ex-vessel value of regional fisheries under Council management and Section 3.5 describes bycatch by coral reef fisheries with special attention to the main gear types employed in these fisheries. The second part of this section, comprising Sections 3.6 and 3.7 describes fishing communities in the region and how they depend on coral reef resources. This discussion, in Section 3.6, provides a regional overview and descriptions specific to each of the jurisdictional areas in the Council region. Section 3.7 contains a brief statement about the definition of communities, as required by the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), and their dependence on coral reef resources.

3.2 Description of Coral Reef Uses

Ecosystem-based fisheries management—the principle that informs this FMP—recognizes that fisheries and other forms of resource harvest affect more than just the target species. Because of ecological linkages, other species and their habitats are affected too, and these effects may be felt in other reef-related fisheries. An ecosystem approach should also take into account value that accrues from not extracting resources, such as scenic or recreational use. In the summary that follows, current and potential uses of coral reef resources are called "sectors." Since the Council only manages fisheries, and this FMP covers the coral reef ecosystem, management measures in this FMP only apply to the fishery sectors summarized in the first category below. (These fisheries are defined as those that take coral reef MUS in depths between 0 and 50 fathoms. When coral reef fisheries are discussed in the remainder of this section this definition bounds the resources under consideration.) This includes coral reef MUS caught incidentally by other FMP-managed fisheries. The first two sectors, food and sport, are briefly described in the next section. (The remaining four coral reef fishery sectors—religious, ornamentals, natural products, and mariculture—have not yet developed in the EEZ.) Non-fishery sectors are described elsewhere, as indicated in the descriptions below.

Coral Reef Fishery Sectors[1]

Food	All commercial, subsistence, and recreational coral reef resource harvests generally for food production.
Sport	Fishing for coral reef resources mainly motivated by recreation.
Religious/ceremonial	Harvest of coral reef resources for use in traditional religious ceremonies by indigenous cultures.
Ornamentals	Harvest of coral reef resources, including fishes, invertebrates, and live rock for use as ornamentals, for home and local use and commercial trade.
Natural products	Harvest of coral reef resources for all other purposes, such as coral for bone grafts and production of pharmaceuticals.
Mariculture	At-sea mariculture of coral reef resources, and harvest of coral reef resource broodstock for land-based mariculture.

Non-coral Reef Fishery Sectors

Deep-water bottom fisheries	Fisheries for finfish, crustaceans and precious corals, in benthic environments deeper than 50 fathoms, including for food, sport, and ornamentals, as described above for coral reef fisheries.
Pelagic fisheries	Fisheries for finfish in pelagic ecosystems, including for food and sport. In general, the pelagic fisheries are not directly related to the coral reef ecosystem.

Non-fishery Sectors

Tourism (non-fishing)	Visitors engaging in scuba diving, snorkeling, boating, swimming, viewing of coral reefs, and other coral reef-related activities, including eco-tourism. The economic value of tourism to different island areas is discussed in

[1] The Coral Reef Fishery Sectors listed here are categorized by the primary motivation of the fishery. Based on MSFCMA definitions, the natural products and mariculture fishery sectors as described above would be primarily commercial fisheries. The food, sport and ornamental sectors would encompass both recreational and commercial fisheries. The religious/ceremonial sector is unique in that the motivation is not for commerce, sport or pleasure, but for spiritual purposes including medicinal uses, social unity, and cultural perpetuation (self-identity).

	Section 3.6, which details fishery-related economic and social conditions in each of the Council's member jurisdictions.
Recreation (non-fishing)	Residents engaging in scuba diving, snorkeling, boating, swimming, viewing of coral reefs and other coral reef-related activities. Non-consumptive values and uses are discussed in Section 5.11 of the Environmental Impact Statement.
Mining	Extraction of fossil coral and sand from the coral reef ecosystem. The effects of dredging, mining and filling is discussed in Section 6.4 of the FMP.
Breakwater	Coral reef ecosystems functioning to protect shorelines from erosion and to provide shelter for navigation and mooring, and other activities. The value of coral reef ecosystems functioning to protect shorelines from erosion is not discussed in the FMP.
Ecological support	Coral reef ecosystems functioning as nursery areas, spawning areas, or otherwise in support of resources, protected species, essential fish habitat, fisheries, and ecological services in other ecosystems. Ecosystem effects on MUS are discussed in Sections 3.0 and 5.2 of the EIS.
Information	Coral reef ecosystems providing values associated with gaining and sharing information, or the non-extractive, "discovery" aspects of research and education, and the values associated with the consequential development and production of marine natural products.
Biodiversity	Coral reef ecosystems providing values associated with varied genetic resources. The biodiversity of coral reef ecosystems is discussed in section 3.1.2. of the EIS.

3.3 Summary of Data Describing Fisheries in the Council Region

3.3.1 Available Data

The ability to describe, assess, and manage fisheries depends on the amount and quality of available fisheries data. Local jurisdictions in the Council Region collect much of the data used for management. Most coral reef ecosystem resources in the EEZ are beyond the reach of the average recreational fisherman. Recreational fishing is limited and generally confined to shallow and deep-reef slope species which occur primarily in state or territorial waters. Data collection

systems employed by the various local jurisdictions are discussed below. Table 3.1 summarizes data availability for each area described.

The State of Hawaii requires fishermen who sell any portion of their catch to hold a commercial marine license and to complete and submit a monthly Division of Aquatic Resources' Fish Catch Report for every trip conducted during that period. The licensee must report the type of fishing gear used (e.g., trap, diving, net), number and/or weight of each species caught, and the area fished. In order to gather data on areas fished, the State of Hawaii employs a fisheries statistical grid chart which covers the Pacific Ocean from 10° to 32° North latitude and from 150° to 178° West longitude. Each grid is approximately 60 nautical miles^2 and is further divided into 20 x 20 nautical mile^2 blocks. Fishermen often sub- divide each block into smaller 10 mile^2 quadrants to report areas fished. However, this method of collection does not allow for precise separation between nearshore (0-3 nm) from offshore (3-12 nm) landings.

Hawaii is one of the few coastal states that does not require a marine recreational fishing license and associated reporting. Therefore, obtaining estimates of the recreational catch or effort in the coral reef fisheries is very difficult. However, there is some information available on the nearshore recreational catch from past creel surveys. Several of these surveys have shown the recreational catch to be the equivalent or greater than that reported in the commercial fisheries landing data (Friedlander 1996).

Table 3.1: Summary of data availability for major fishing sectors in the Western Pacific Region.

	Commercial	Recreational/subsistence	Charter
American Samoa	Yes	Yes	N/A
Guam	Yes	Yes	Yes
Hawaii	Yes	Limited**	Yes, needs improvement*
CNMI	Yes	Limited***	Yes, under improvement

* Data collected through reporting forms but no separated from commercial information
** Some recreational information available from past creel surveys
***Data only available from boat-based fishing activity. Current survey program does not collect information from shore based fishers.

In American Samoa, the Offshore Creel Survey administered by the Department of Marine and Wildlife Resources (DMWR) collects fishery information from both commercial and recreational boat-based fishermen on the number and weight of each species, method of fishing, time fished, and area fished. In addition, the survey includes information on the disposition of the catch. Coral reef fishing in American Samoa is conducted on the plateaus and slopes of nearshore reefs within territorial waters (0-3 nmi from shore). Fishing for coral reef species in federal waters (3-200nm) is conducted at several well known banks and seamounts. Consequently, DMWR creel surveys can readily distinguish between nearshore and offshore landings. This is also true for reef fish landings in Guam and CNMI. DMWR applies a set of algorithms to estimate the commercial landings based on the estimate of total landings and catch disposition information derived from the survey. DMWR also directly monitors the commercial fishery by collecting "trip-ticket" receipts from fish sales to local fish markets, stores, hotels, and restaurants.

In Guam, the Division of Aquatic and Wildlife Resources (DAWR) administers both the Offshore and Inshore Creel Surveys. The surveyors interview fishermen to collect information on the length and weight of each species caught during fishing trips, method of fishing, number of gear used, time fished, area fished, and weather conditions. Nearly all of the available coral reef habitat around Guam is in the nearshore waters. There are however, a few areas in the EEZ containing coral reef habitat which are clearly beyond three nautical miles. This geographical separation allows surveyors to precisely distinguish between nearshore and offshore reef fish landings. The disposition of the catch is only recorded as part of the Offshore Creel Survey; therefore, differentiating commercial and recreational landings in the inshore fishery is almost impossible. Total landings are estimated from survey data by applying fairly complex stratum-based expansion factors, which are calculated by integrating data collected from participation surveys with the creel intercept and interview data. DAWR also collects information on commercial landings through a voluntary trip ticket receipt program with major fish dealers. Estimates of total commercial landings are calculated by applying expansion factors to the receipt book data.

In the Commonwealth of the Northern Mariana Islands, data on commercial landings are collected by the Division of Fish and Wildlife (DFW) through the Commercial Sales Receipt or "Trip ticket" Program, which, like Guam and American Samoa, documents local fish sales to commercial establishments. Landings, species composition, revenue, and the number of fishermen or boats selling catch are estimated from information provided on the forms. The Offshore and Inshore Creel Surveys administered by DFW were suspended in 1996. The information collected from surveys included the number and weight of each species caught during commercial and recreational fishing trips, fishing method used, number of gear used, area fished, fishing time, weather conditions and percentage of the total catch that is sold. In 2000, the boat-based Offshore Creel Survey was reimplemented and redesigned to include charter boats in addition to recreational and commercial vessels. The Council supports DFW's efforts to reestablish the inshore survey to collect information on coral reef fisheries.

No other recreational fishing surveys have been conducted recently in U.S. Pacific to supplement information collected by local creel survey programs, and the Council fully supports proposals by NMFS to conduct such marine recreational fishing surveys. For the time being, the portion of the catch reported as sold in creel surveys is considered the commercial component, whereas the unsold portion represents the recreational/subsistence component. According to the MSFCMA, unsold fish should be classified as commercial if traded or bartered. However, it is not practical or appropriate for data collection systems in the region to make this distinction. The customary exchange of fish with no immediate expectation of return is not regarded in Pacific Island societies as a commercial activity, but represents a traditional use.

The Council considers the current reporting systems collected by local governments in the region to be adequate in collecting data for all major coral reef fishery sectors in the region. However, there are areas where data collection can be improved. These include the collection of information from shore-based fishers, obtaining more accurate recreational/subsistence fishing catch and effort data, and more clearly defining areas fished.

To begin the collection of this data, this FMP will require detailed reporting in a logbook as a condition for holding a permit to harvest coral reef resources in the EEZ. The Council recommends that no exception be granted for subsistence fishermen from permitting or reporting. This revision should not greatly affect exclusive subsistence fishermen since they generally do not fish in federal waters. The logbook would report types and quantities of gear used, numbers and weights of species kept, number released alive, number released unknown, specific areas fished, length of trip, specific effort information and other information required as a condition of holding the permit. The annual report required under the CRE-FMP would summarize and analyze the information collected.

3.3.2 Food Sector

Pooley (1993b) noted that "the distinction between 'commercial' and 'recreational and subsistence' fishing in Hawaii is a weak distinction." The same is true of other U.S. Pacific Islands. The coastal fisheries of the region are dominated, at least in terms of numbers, by small-scale part-time fishermen who have variously mixed motivations to fish. They derive benefits as both producers and consumers—that is, consumers of both seafood and enjoyment. For example, the category of small-boat fishermen in Hawaii termed expense fishermen by Hamilton and Huffman (1997) sell at least part of their catch to offset their fishing expenses, but their expenses still outweigh their revenues. These fishermen are undoubtedly receiving enough consumer surplus (i.e., enjoyment) to offset monetary losses.

In each of the island areas it is almost impossible to label the majority of these fishermen or fishing vessels as commercial or recreational as many "expense fishermen" often fish switch between commercial and pure recreational/subsistence. It is more appropriate to categorize the fish caught as commercial or recreational/subsistence during a particular trip. Most of the fish caught in 'recreational fisheries' are not released alive, but rather retained for home consumption.

Although some harvest occurs in the EEZ, existing fisheries for coral reef resources are concentrated in the nearshore waters (0-3 miles) around American Samoa, Guam, Hawaii and CNMI. However, the volume of trips made by recreational fishermen to fish for coral reef species in federal waters, or on reefs under local government jurisdiction is unknown. Hamilton and Huffman (1997) present data which shows in their survey of small boat fishing in Hawaii, about one quarter of trips by purely recreational fishermen were to catch coral reef fish. Hamilton and Huffman also noted that between 0.2 and 0.9% of fishing trips made by commercial fishermen in their survey were for recreational fishing on coral reefs.

Low levels of recreational and/or subsistence fishing occur at Palmyra and Johnston Atoll, Wake Island, and Midway Atoll. In all of these areas, inner boundary of the EEZ extends to the shoreline. Both shore-based and boat-based fishing for coral reef species occur at Palmyra and Johnston Atoll and Wake Island. Fishing at these locations is conducted primarily for food and recreation by temporary workers stationed there. Irons *et al.* (1990) reported that *Holocentridae, Acanthuridae, Carangidae Mullidae and Scaridae* comprised the majority of targeted coral reef taxa at Johnston Atoll. The gear types employed to harvest coral reef species varied with the targeted species and included hook-and-line fishing, spearfishing and thrownets. Although no

recent fishery statistics are available for the other areas, the species targeted and gear types used are probably similar to those at Johnston Atoll. The no-take zone MPAs proposed for the other Pacific Remote Island Areas (see Section 5.2.) will deter future tourism development as it prohibits extraction of all coral reef resource at these remote locations.

Recreational fishermen tend to harvest a greater variety of species than do commercial fishermen, so the diversity of the recreational catch is underestimated in commercial databases. For example, in a recent study conducted in nearshore state waters, the Hawaii DAR database contained only 28 commercial taxa for Hanalei Bay, whereas a creel survey of the area included 95 taxa, although the catches of many taxa were trivial (Friedlander 1996). Table 3.2a summarizes estimates of recreational/subsistence fishing for CRE management unit species in the Western Pacific Region. Currently, the proportion of the number recreational/subsistence vessels fishing for CRE management unit species in the EEZ is unquantifiable. However, most coral reefs in the EEZ are beyond the reach of the average recreational fishermen.

Table 3.2a: Summary of recreational/subsistence fishing for CRE management unit species in the Western Pacific Region (includes all landings from 0-3 nm and 3-200 nm)*

Area	Number of vessels	Total annual trips	CRE species targeted	Fishing location (miles from shore)	Total annual catch (pounds)
American Samoa	66	N/A	Jacks, surgeonfish, mullet, octopus, other mollusks and echinoderms	Shoreline	225,000
Guam	2,250**	N/A	Surgeons, jacks, emperors, snappers	Shoreline and banks	200,000
CNMI	142	N/A	Emperor, parrotfish, surgeonfish, rabbitfish	Shoreline and banks	16,500
Hawaii	14,000***	N/A	Jacks, goatfish, squirrelfish, octopus	Shoreline and banks	1,017,000
NWHI (Midway)	5	N/A	Jacks	Shoreline and banks	N/A
PRIAs	13	N/A	soldierfish, jacks, surgeonfish, parrotfish, bonefish	Shoreline	N/A

* Estimates of total non-commerical catches for Hawaii, Guam, American Samoa and CNMI are given in WPRFMC 2000a. The CRE-MUS component of the non-commercial catch is estimated from the product of the percentage of coral reef species in the total commercial landings data in 1999 for Hawaii, Guam, American Samoa and the CNMI (website: wpacfin.nmfs.hawaii.edu/), and the total non-commercial catch in the four island areas.
** Estimate based on vessels registered with the Guam Police Department and DAWR port surveys.
*** Estimate based on data from State of Hawaii Department of Boating and Ocean Recreation.

Commercial and recreational components employ the same fishing methods, although the recreational fishery typically utilizes a wider range of harvesting methods than the commercial fishery (Friedlander 1996). Inshore gear types with the highest proportion of commercially sold catch (more than 50%) are fish traps, crab nets, surround nets, and gill nets. Spearing and mid-depth handline are less important for commercial harvest (30–35% of catch sold) and casting is almost exclusively for recreation (less than 6% of commercial catch) (Friedlander 1996 after (Hamm and Lum 1992). Creel surveys show that gear types used primarily for recreational/subsistence purposes contribute much more to the total catch than the gear types used for commercial purposes (Green 1997).

3.3.3 Sport Sector

Of the five regions within the Western Pacific Region, American Samoa is the only area without a real charter boat fleet. Infrequently, private vessels are used for "charter" trips, but to a very limited extent. Recently, in addition to the traditional trolling charters, a bottomfishing charter fishery developed in Guam to target the deep and shallow-water bottomfish MUS such as emperors, groupers and snappers, as well a variety of coral reef species including wrasses, squirrel fish, triggerfish. The size of the vessels range from typical charter boats carrying three to six anglers to larger party boats accommodating up to 30 persons. During the tourist season, boats make one to three trips per day at two to six hours each trip generally within territorial waters. Fish are frequently released on shallow-water bottomfishing charters. DAWR estimates 1,700 charter trips in 1999 totaling 4,000 hours bottomfishing. From an effort of 35,000 gear-hours and a total catch of 13,000 lbs., the catch rate was estimated at 0.38 lbs. per gear-hour.

Of the dozen or so charter vessels in the CNMI, several are targeting bottomfish. DFW reports that shallow-water charters generally last two hours and are conducted up to four times per day that could include occasional night trips. Charters generally fish outside the barrier reef in 80-200 feet of water from Chalan Kanoa in the south, up to areas off Nikko Hotel in the north. Given the distance to the nearest coral reef habitat in the EEZ and the frequency of trips, it is likely that charters remain well within CNMI territorial waters. In 2000 there were two vessels that strictly charter for shallow-water bottom/reef fish. With the re-implementation of the offshore creel survey, routine sampling of the charter fleet includes detailed interviews for bottomfish charters, including numerating and measuring all retained catch.

Shallow-water bottomfish charters have also recently begun in Hawaii. Charter vessels range from smaller boats accommodating four to six passengers to larger party boats of 30 or more. Trips are generally four hours long and conducted twice daily. Vessels routinely operate within three miles of their port. Average depth of operation is from 80 to 200 feet. It is estimated that less than a dozen bottomfish charters operate in Hawaii.

Catch and effort information from bottomfish charter operators are collected through the HDAR Commercial Marine Licenses or sales reporting forms (C-3 forms). However, because bottomfish chartering is relatively new in Hawaii, HDAR cannot tell whether reported bottomfish landings are taken during a charter trip or commercial trip. Fish sold from a bottomfish charter operation would be included on a C-3 form and probably credited toward a normal commercial

trip. The C-3 form does not require bottomfish charter operators to indicate if the fish was taken during a charter trip. Fish that are released or consumed may not be reported under the current system. A new form may need to be specifically developed to ensure catch and effort data is collected from the Hawaii bottomfish charter sector. HDAR has developed and will soon implement a new charter troll report form.

Sportfishing is a major attraction at Midway Atoll for ecotourists. Recreational charter fishing for coral reef species takes place primarily from the shoreline and within the boundaries of the Midway Atoll National Wildlife Refuge. Recreational fishing rules established by the U.S. Fish and Wildlife Service allow: catch and release pole and line fishing (unless world record setting); hand harvest of lobsters for on island consumption (1 lobster per person per day); and the taking of one fish per person on fishing boats per day. The recreational fishing rules prohibit the catch of bottomfish and other coral reef species (i.e. octopus, urchins, corals etc.) however, the U.S. Fish and Wildlife Service permits catch and release fishing for jacks (*Carnax spp.*) which are frequently caught in the shore-based recreational and boat-based charter fishing. As of 1998, there were 5 vessels used in the Midway charter fishery. The number of annual recreational and charter trips vary depending on the number of anglers visiting the atoll and seasonal weather conditions. Catch data for the recreational and charter fishery are collected by the U.S. Fish and Wildlife Service. Table 3.2b summarizes the estimates of charter fishing for coral reef management unit species in the Western Pacific Region.

Table 3.2b: Summary of charter fishing for CRE management unit species in the Western Pacific Region.

Area	Number of vessels	Total annual trips	CRE species targeted	Fishing location (miles from shore)	Total annual catch (pounds)
American Samoa	1	N/A	N/A	N/A	N/A
Guam	73	1700	wrasse, squirrel, trigger	<3	13,000 (all species combined)
CNMI	2	2000	N/A	<3	N/A
Hawaii	<12	N/A	N/A	Shoreline and banks	N/A
NWHI(Midway)	5	N/A	Jacks	Shoreline and banks	N/A
PRIAs	N/A	N/A	N/A	N/A	N/A

3.4 Ex-vessel Value of Coral Reef Resources

Tables 3.3 and 3.4a-3.4f summarize the recent approximate total annual ex-vessel value for each of the domestic marine fisheries of the Western Pacific Region's island groups. They focus on fisheries for coral reef resources. But rough estimates of the crustacean and precious coral

fisheries (categorized as deep-bottom), and pelagic fisheries, also appear. This allows these fisheries to be compared to coral reef fisheries. It also highlights the potential follow-on effects of the management measures in this FMP. Table 3.3 is a regional summary, while tables 3.4a-3.4f break down the information by island area. Monetary value is expressed in 1999 dollars. Ex-vessel values are the estimated total annual gross value of landings from each fishery, whether sold or not. The ex-vessel values for the sport sector represents charter fees. The landings value for these fisheries are included in the food sector. It should be noted that there is a variable, and in some cases quite high, level of uncertainty as to the accuracy of values in Tables 3.4a-3.4f.

The total annual ex-vessel value of the region's fisheries for coral reef resources in recent years has been about $15 million, $14 million of this derived from food fisheries (mostly bottomfish and lobsters), $1 million from ornamentals (from 0.5 million pieces) and $0.6 million from sport fisheries (from 12,000 angler-trips). The deep bottom fisheries (mostly bottomfish and lobsters harvested from greater than 50 fathoms) realized an approximate annual ex-vessel value of $4 million annually. The value of the natural products and mariculture sectors are assumed to be minimal, but more in-depth investigation might reveal otherwise.

Hawaii's share of total coral reef resource harvests is about 77 %, or $12 million, of which 88% comes from the main islands and 12% from the Northwestern Hawaiian Islands. The ex-vessel value of Guam's harvested coral reef resources is about $1.6 million, the CNMI's about $1.3 million, and American Samoa's about $0.7 million.

Overall, it is very roughly estimated that 10% of the total ex-vessel value of harvested coral reef resources is taken in federal waters (or the "management zone" of the CNMI). The estimated percentages of total ex-vessel value caught in the FMP area are 1% in American Samoa, 4% in the CNMI, 8% in Guam, and 11% in Hawaii.

Table 3.3: Summary of annual ex-vessel value for Western Pacific Region fisheries ($1,000/year).

	Am. Samoa		CNMI		Guam		MHI		NWHI		Other islands		All islands	
	Total	FMP	Total	FMP	Total	FMP	Total	FMP	Total	FMP	Total	FMP	Total	FMP
Coral reef:														
Food	671	8	1,217	54	1,214	118	9,391	1,075	1,295	12	22	21	**13,809**	**1,287**
Sport	m	0	80	4	306	15	71	7	159	159	0	0	**616**	**186**
Ornamentals	10	0	m	0	48	0	1,004	0	0	0	m	m	**1,062**	**m**
Natural	0	0	0	0	0	0	?	?	0	0	0	0	**?**	**?**
Mariculture	m	0	0	0	0	0	?	0	0	0	0	0	**m**	**0**
Total coral reef	**681**	**8**	**1,297**	**58**	**1,567**	**133**	**10,465**	**1,082**	**1,454**	**171**	**22**	**21**	**15,486**	**1,472**
Deep bottom														
Food	64	0	166	0	158	0	1,455	0	1,161	0	0	0	**3,004**	
Sport	m	0	30	0	306	0	707	0	m	0	0	0	**1,043**	
Ornamentals	0	0	0	0	0	0	0	0	0	0	0	0	**0**	
Total deep	**64**	**0**	**196**	**0**	**463**	**0**	**2,162**	**0**	**1,161**	**0**	**0**	**0**	**4,047**	
Pelagic:														
Food	444	0	950	0	858	0	48,200	0	8,764	0	10	0	**59,226**	
Sport	10	0	900	0	1,238	0	14,000	0	159	0	0	0	**16,307**	
Total pelagic	**454**	**0**	**1,850**	**0**	**2,096**	**0**	**62,200**	**0**	**8,923**	**0**	**10**	**0**	**75,533**	
TOTAL	**1,199**	**8**	**3,343**	**58**	**4,127**	**133**	**74,827**	**1,082**	**11,538**	**171**	**32**	**21**	**95,066**	**1,472**

Values are approximate, recent, annual gross values of the production side of these fisheries, expressed in 1999 dollars (x 1,000).
"m" means minimal and unquantifiable.

Table 3.4a: American Samoa fisheries by area, annual volume, and ex-vessel value.

	Annual Total		% of harvest from FMP area	FMP portion	
	Volume (lbs)	Value ($1,000)		Volume (lbs)	Value ($1,000)
Coral reef area harvests:					
Food					
Finfish:					
live	0	0	0	0	0
dead	216,000	393	2	4,000	8
Crustaceans:	7,000	26	0	0	0
lobster					
other crustaceans					
Echinoderms	43,000	87	0	0	0
Molluscs:	73,000	146	0	0	0
mother-of-pearl					
other molluscs					
Other invertebrates	2,000	20	0	0	0
Seaweeds	min	min	0	0	0
Sport	min	min	0	0	0
Ornamentals					
Fishes and other	5,000	10	0	0	0
Hermatypic coral/live	min	min	0	0	0
Black coral	0	0		0	0
Marine natural products	0	0		0	0
Mariculture	min	min	0	0	0
Total coral reef area		**681**			**8**
Deep bottom area harvests:					
Food	27,000	64	0	0	0
Sport	min	min	0	0	0
Ornamentals	0	0	0	0	0
Total deep bottom		**64**			**0**
Pelagic fisheries:					
Food	400,000	444	0	0	0
Sport	120	10	0	0	0
Total pelagic harvests		**454**			**0**
Total all fisheries		**1,199**			**8**

All volume figures are in pounds per year, except the sportfishing sectors, which are in number of angler-trips per year, and ornamentals (except black coral), which are in number of pieces or organisms per year. "min" means minimal.

Table 3.4b: Northern Mariana Islands fisheries by area, annual volume and ex-vessel value.

	Annual Total		% of harvest from FMP area	FMP portion	
	Volume (lbs)	Value ($1,000)		Volume (lbs)	Value ($1,000)
Coral reef:					
Food					
Finfish:					
live	0	0		0	0
dead	446,000	1,070	5	22,000	54
Crustaceans:					
lobster	4,000	19	0	0	0
other crustaceans					
Echinoderms	25,000	68	0	0	0
Molluscs:					
mother-of-pearl	20,000	60	0	0	0
other molluscs					
Other invertebrates					
Seaweeds	min	min	0	0	0
Sport	1,600	80	5	80	4
Ornamentals					
Fishes and other inverts	min	min	0	0	0
Hermatypic coral/live	min	min	0	0	0
Black coral	0	0		0	0
Marine natural products	0	0		0	0
Mariculture	0	0		0	0
Total coral reef		**1,297**			**58**
Deep bottom:					
Food	50,000	166	0	0	0
Sport	300	30	0	0	0
Ornamentals	0	0		0	0
Total deep bottom		**196**			**0**
Pelagic:					
Food	500,000	950	0	0	0
Sport	9,000	900	0	0	0
Total pelagic		**1,850**			**0**
Total all fisheries		**3,343**			

All volume figures are in pounds per year, except the sportfishing sectors, which are in number of angler-trips per year, and ornamentals (except black coral), which are in number of pieces or organisms per year
"min" means minimal.

Table 3.4c: Guam fisheries by area, annual volume and ex-vessel value.

	Annual Total		% of harvest from FMP area	FMP portion	
	Volume (lbs)	Value ($1,000)		Volume (lbs)	Value ($1,000)
Coral reef:					
Food					
Finfish:					
live	0	0		0	0
dead	400,000	1,176	10	40,000	118
Crustaceans:					
lobster	5,000	19	0	0	0
other crustaceans					
Echinoderms					
Molluscs:					
mother-of-pearl	3,000	6	0	0	0
other molluscs	4,000	9	0	0	0
Other invertebrates	1,000	2	0	0	0
Seaweeds	some	unknown	0	0	0
Sport	10,000	306	5	510	15
Ornamentals					
Fishes and other inverts	24,000	48	0	0	0
Hermatypic coral/live	min	min	0	0	0
Black coral	0	0		0	0
Marine natural products	0	0		0	0
Mariculture	0	0		0	0
Total coral reef		**1,567**			**133**
Deep bottom:					
Food	45,000	158	0	0	0
Sport	10,000	306	0	0	0
Ornamentals	0	0			0
Total deep bottom		**463**			
Pelagic:					
Food	660,000	858	0	0	0
Sport	21,000	1,238	0	0	0
Total pelagic		**2,096**			**0**
Total all fisheries		**4,127**			**133**

All volume figures are in pounds per year, except the sportfishing sectors, which are in number of angler-trips per year, and ornamentals (except black coral), which are in number of pieces or organisms per year. "min" means minimal.

Table 3.4d: Main Hawaiian Islands fisheries by area, annual volume and ex-vessel value.

	Annual Total		% of harvest from FMP area	FMP portion	
	Volume (lbs)	Value ($1,000		Volume (lbs)	Value ($1,000
Coral reef:					
Food	1,004,900	9,391		540,001	1,076
Finfish:					
live					
dead	443,900	7,571	10	439,000	750
Crustaceans:					
lobster	10,000	128	0	0	0
other crustaceans	100,000	417	41	41,000	173
Echinoderms	1,000	11	3	0	0
Molluscs:					
mother-of-pearl					
other molluscs	369,000	925	16	60,000	150
Other invertebrates					
Seaweeds	81,000	339	1	1	3
Sport	500	71	10	50	7
Ornamentals					
Fishes and other	430,000	937	0	0	0
Hermatypic coral/live	min	min	0	0	0
Black coral	3,000	66	0	0	0
Marine natural products	unknown	unknown	unknown	unknown	unknown
Mariculture	unknown	unknown	0	0	0
Total coral reef		**10,465**			**1,082**
Deep bottom:					
Food	418,000	1,455	0	0	0
Sport	5,000	707	0	0	0
Ornamentals	0	0		0	0
Total deep bottom		**2,162**			**0**
Pelagic:					
Food	22,000,00	48,200	0	0	0
Sport	99,000	14,000	0	0	0
Total pelagic		**62,200**			**0**
Total all fisheries		**74,827**			**1,082**

All volume figures are in pounds per year, except the sportfishing sectors, which are in number of angler-trips per year, and ornamentals (except black coral), which are in number of pieces or organisms per year.

Table 3.4e: Northwestern Hawaiian Islands fisheries by area, volume and ex-vessel value.

	Annual Total		% of harvest from FMP area	FMP portion	
	Volume (lbs)	Value ($1,000)		Volume (lbs)	Value ($1,000)
Food					
Finfish:					
live	0	0		0	0
dead	19,000	14	82	16,000	11
Crustaceans:					
lobster	246,000	1,280	0	0	0
other crustaceans	min	1	51	min	min
Echinoderms	0	0		0	0
Molluscs:					
mother-of-pearl					
other molluscs	0	0		0	0
Other invertebrates	0	0		0	0
Seaweeds	0	0		0	0
Sport	375	159	100	375	159
Ornamentals					
Fishes and other inverts	0	0		0	0
Hermatypic coral/live rock	0	0		0	0
Black coral	0	0		0	0
Marine natural products	0	0		0	0
Mariculture	0	0		0	0
Total coral reef		**1,454**			**171**
Deep bottom:					
Food	371,000	1,161	0	0	0
Sport	min	min	0	0	0
Ornamentals	0	0		0	0
Total deep bottom		**1,161**			**0**
Pelagic:					
Food	4,000,00	8,764	0	0	0
Sport	375	159	0	0	0
Total pelagic		**8,923**			**0**
Total all fisheries		**11,538**			**171**

All volume figures are in pounds per year, except the sportfishing sectors, which are in number of angler-trips per year, and ornamentals (except black coral), which are in number of pieces or organisms per year. "min" means minimal.

Table 3.4f: Other islands fisheries by area, annual volume and ex-vessel value.

	Annual Total		% of harvest from FMP area	FMP portion	
	Volume (lbs)	Value ($1,000)		Volume (lbs)	Value ($1,000)
Coral reef:					
Food					
Finfish:					
live	0	0		0	0
dead	10,000	20	100	10,000	20
Crustaceans:					
lobster	200	1	0	0	0
other crustaceans	200	min	100	200	min
Echinoderms	0	0		0	0
Molluscs:					
mother-of-pearl					
other molluscs	100	min	100	100	min
Other invertebrates	0	0		0	0
Seaweeds	0	0		0	0
Sport	0	0		0	0
Ornamentals					
Fishes and other inverts	min	min	100	min	min
Hermatypic coral/live rock	min	min	100	min	min
Black coral	0	0		0	0
Marine natural products	0	0		0	0
Mariculture	0	0		0	0
Total coral reef		**22**			**21**
Deep bottom:					
Food	min	min	0	0	0
Sport	0	0		0	0
Ornamentals	0	0		0	0
Total deep bottom		**0**			**0**
Pelagic:					
Food	5,000	10	0	0	0
Sport	0	0		0	0
Total pelagic		**10**			**0**
Total all fisheries		**32**			**21**

All volume figures are in pounds per year, except the sportfishing sectors, which are in number of angler-trips per year, and ornamentals (except black coral), which are in number of pieces or organisms per year "min" means minimal.

3.5 Description of Fishing Gear Used and Associated Bycatch

3.5.1 Existing Bycatch Management Measures

Although the Council's existing FMPs do not specifically address coral reef fisheries, there are aspects of these plans and their amendments that may have an influence on coral reef fishery bycatch and on the potential for reporting bycatch. Measures in the Council's Bottomfish, Crustaceans, and Pelagic FMPs are summarized below.

The Bottomfish FMP prohibits certain destructive fishing techniques—including explosives, poisons, trawl nets, and bottom-set gillnets—all of which have the capacity to generate high levels of bycatch, especially the use of trawl nets. Bottomfishing, and hence the volume of resulting bycatch, is regulated by the Bottomfish FMP. The permit and reporting systems for bottomfish fisheries in the NWHI and Guam allow the reporting of catch and discards.

The Crustaceans FMP, adopted in 1983, included a minimum size limit for spiny lobster in the NWHI trap fishery. A minimum size for slipper lobsters was implemented later under Amendment 5. The amendment banned the taking of egg-bearing females and established a mandatory logbook program. Bycatch from the NWHI fishery initially included regulatory discards of undersized or egg-bearing females, while the logbook program provided a means to monitor the bycatch of target species. Amendment 9 to the FMP implemented a retain-all fishery, thus minimizing the volume of undersized or egg-bearing female discards. Some discarding was believed to take place through high-grading, but subsequent observer records from the fishery showed that this was minimal. Potentially, a large range of coral reef fishes and invertebrates can be taken in lobster traps, but the use of escapement panels in these traps minimizes the retention of other non-target species. A limited entry program implemented through Amendment 7 to the FMP, and a more recently established annual harvest guideline for the NWHI fishery, limit total catch volume and therefore the associated bycatch.

Fishing activity targeting highly migratory species rarely interacts with reef fishes. However, some of the provisions of the Pelagics FMP and amendments have tangentially influenced potential bycatch from coral reefs. Currently, the FMP management unit contains four shark families—Alopiidae, Lamnidae, Sphyrnidae, and Carcharhinidae—which include many inshore shark species found on and around coral reefs. The FMP contains a ban on the use of drift gillnets, which can take large numbers of sharks. Some of the species caught by drift gillnets—such as tiger sharks, Galapagos sharks, and hammerheads—are commonly found on and around coral reefs. The FMP also established a 50 nm longline closed area around the NWHI and a 50-75 nm closed area around the MHI, which also reduce the likelihood that longliners will catch sharks common to nearshore areas and coral reefs. Lastly, one of the measures in Amendment 9 to the FMP, although pending implementation, would ban bottom set longline fishing in federal waters which in the past has targeted coastal shark species. Many of these species are also part of the CRE-FMP management unit. Amendment 2 of the FMP implemented a logbook program, which includes a provision to record catch and discards, including shark species.

As part of CRE-FMP implementation, it is recommended that the Pelagics FMP be amended so that those coastal shark species belonging to the families Carcharhinidae and Sphyrnidae—currently classified as Pelagic MUS—be reclassified coral reef ecosystem MUS, managed under this FMP. Additionally, the Pelagic FMP will specifically list nine species of sharks as Pelagic MUS.

3.5.2 Coral Reef Fisheries Bycatch

All gears used to catch coral reef species are essentially artisanal in nature. Catch rates are minimal, usually only a few pounds per man-hour or other unit of effort. Large catches thus depend on fishing methods employing a lot of people, such as driven-in-net fishing or group spear fishing. Because of the characteristics of gear and methods, in most cases coral reef fishing generates very little bycatch. Bycatch is further reduced because almost all reef fish taken are eaten. For more detailed information consult Appendix A, which catalogs fishing gears and their impact on essential fish habitat.

In the Pacific Islands, discards, where they occur, are usually due to cultural or practical reasons. In some cultures customary taboos may still adhere. For example, people may avoid nearshore copraphageous scavengers, such as surf perches (Theraponidae) for this reason. Taboos may also stem from the association between a species and gender, as is the case with moorish idols (Zanclidae).

Reef fish preference is also strongly influenced by urbanization: many city dwellers eat a narrower range of reef fish than their brethren in traditional villages on the same island or of the same culture. For example, in Guam triggerfish, butterflyfish, angelfish, and damselfish are typically rejected because they are considered too boney and lacking sufficient meat, while in rural areas in Micronesia these species are readily consumed. Some reef fish in Hawaii state waters are also subject to minimum size and weight restrictions for sale or for capture by spearfishing. These include species of parrotfish, goatfish, jacks, surgeonfish, mullet, milkfish, and threadfins.

In other cases, fish may be avoided due to toxicity. Puffers, toad fish, and porcupine fish (Tetraodontidae, Diodontidae) carry ichthyotoxins, while ichthyosarcotoxicity due to ciguatoxins and related toxins cause people to avoid a wide range of species, including the snapper *Lutjanus bohar*, surgeon fish *Ctenochaetus* spp., moray eels (Muraenidae), groupers (Serranidae), amberjack (*Seriola dumerilli*), and barracuda (Sphyraenidae). Trianni (pers. comm.) suggests that in the Mariana Islands, the red snapper *Lutijanus bohar*, groupers of the genus *Variola* and *Cephalopholis*, jacks, and large barracuda are avoided due to ciguatera. More or less the same species are avoided for the same reason in American Samoa.

People in the Western Pacific Region consume a wide range of invertebrates. Titcomb (1972) catalogs an extensive list of invertebrates used by Native Hawaiians, including many types of crustaceans, sea cucumbers, sea urchins sponges, corals, and various marine worms. In the Samoan Islands, the annual appearance of the gonadal stage of the marine polychaete worm, or

palolo, is eagerly anticipated because it is regarded as a delicacy (Itano and Buckley 1988). Some traditionally-consumed marine invertebrates may be avoided by some people in the Western Pacific, particularly as dietary habits become more Westernized. Also, some religions, like the Seventh Day Adventist faith, follow dietary rules similar to the kosher dietary restrictions and avoid pork and shellfish. Inadvertent catches of shellfish would likely be discarded by Adventists and may be included as bycatch.

Three fishing gears predominate in Pacific Island coral reefs and lagoons: hook-and-line or handline, spearguns and gillnets. The bycatch characteristics of each of these gear types is summarized below.

Hook-and-Line Catches

Hook-and-line catches generally target carnivorous species of fish, although herbivores can be enticed to take baited hooks. Catch and selectivity of hook-and-line gear is a function of hook size, bait used, and the depth fished. Hook size and bait can select for size, with larger hooks and harder baits tending to catch larger fish. Similarly, fish size tends to increase with depth on the reef slope, although species diversity tends to decrease. Fishermen may use combinations of these factors to sharpen the focus of their fishing, particularly targeting bottomfish on the deep reef slope.

The amberjack *Seriola dumerilii*, frequently a part of deep-slope bottomfish catches in the NWHI, are discarded because they are thought to carry worms and the ciguatera toxin which makes marketing this species difficult. This is reinforced by the selectivity of fish by the fish auction at Honolulu which do not accept these fish. However, small amount of amberjack may be retained for use as bait in crab pots. The other major discard in this fishery is the thick-lipped trevally or *butaguchi* (*Pseudocaranx dentex*), which has a fairly short shelf life and commands a low price in local markets. Therefore, it is often discarded in the early days of a trip to avoid losing room for more valuable fishes, but are retained in the later days to fill fish holds if necessary.

Spearfishing

Underwater fishing with spearguns—either with scuba or snorkels—is extremely selective, since the act of capture involves a deliberate choice of target. Bycatch is likely restricted to speared fish that escape with minor wounds. Spearfishing tends to select by size, with a bias towards larger size fish and larger sizes of a given species (Dalzell 1996). Catch composition may also be different between day and night when different groups of fish are active or sedentary. Night divers can take advantage of the sleeping habits of some parrotfish to cluster in "dormitories" on the reef and therefore be especially vulnerable to spearing.

Hawaiian spearfish catches are dominated by parrotfish, surgeonfish, octopus, and squirrelfish. In areas with greater reef fish diversity, such as Guam, spearfish catches are still mainly

dominated by surgeonfish, and parrotfish. Other common families—such as rabbitfish, emperors, snappers, and jacks—also contribute to catches.

Fish Traps

Fish trapping for finfish is not widely practiced in the Western Pacific Region, and is only conducted with any frequency in Hawaii. Traps, like nets, take a large random assortment of different species that probably reflects the proportions of different species groups on coral reefs. Surgeonfish dominate catches in Hawaii, making up 31% of commercial landings, and are comparable to reef fish catches in traps elsewhere in the Pacific (Dalzell 1996).

The main commercial trap fishery on Hawaii's coral reefs is in NWHI. It targets spiny lobster and slipper lobster, rather than reef fish. The fortunes of this fishery have waxed and waned over two decades, with catches in excess of a million lobsters annually in the 1980's, but with much more modest catches of between 100,000 and 300,000 lobsters in the late 1990's. The lobster traps also catch a wide range of other coral reef species, mainly reef fish and reef crustaceans. In the initial years of the fishery, many octopus were also caught and kept, but octopus catches dropped off to negligible amounts by the 1990's because of the use of escape vents. The lobster traps are two-piece plastic halves joined with pins that dissolve in seawater, preventing ghost-fishing by lost traps. They also have a series of small holes in the trap walls to allow undersized lobster and other small bycatch species to escape. Polovina (1993) reports that an estimated 2,000 traps are lost annually in the NWHI. Parrish and Kazama (1992) found that while lobsters may enter these traps, they were also able to exit and there were no observed mortalities associated with ghost fishing. These researchers concluded that lobsters utilized the traps as shelter.

Selection effects in traps are a function of the soak time, mesh size, materials used to construct the traps, trap design, and the depth and position of the set. Traps set in relatively shallow water with little or no bait will generally maximize catches within 4-5 days. Traps baited with fish such as *aku* (skipjack tuna) or sardines and set on deep reef slopes may catch sizeable quantities of fish in a matter of hours rather than days, but the composition is very different, reflecting the generally large highly mobile carnivore complex of the deep reef slope. Lost traps may become a problem through ghost fishing, although eventually ingress and egress from the traps reaches an equilibrium. As with the lobster traps, seawater-degradable pins or panels can be built into traps so that they lose their ability to hold fish.

Nets

In Hawaii, gillnets mostly catch the bigeye scad or *akule*. Other dominant species include surgeonfish, snappers, goatfish, and rudderfish. Goatfish, surgeonfish, parrotfish, and siganids are dominant features of gillnet catches in Guam. There are differences between night and day gillnet catches, with some nocturnally active species such as slipmouths composing part of night gillnet sets.

For smooth fusiform—or cigar-shaped—fish, gillnets tend to select a normally distributed size range, with the lower and upper size limits dependant on mesh size. Spiny fishes may be very vulnerable to gillnet catches, regardless of mesh size, because of tangling. Seasonality can also influence gillnet catches. Fish become more vulnerable during spawning season because gonad development increases their girth and spawning changes behavior (Ehrhardt and Die 1988). The selection effects of gillnets are further complicated by the type of material used, the hanging ratio or measure of meshes per unit of length, the way the net is deployed on a reef, the time of day set, and length of soak. If gillnets are not checked regularly, bycatch may increase. Entangled fish build up in the net; if they are not removed, they are either preyed on or rot and become unsaleable.

Seine nets are actively deployed around schools of fish, as opposed to gillnets, which—like fish traps—are a passive gear. Beach seines, as the name implies, are set in an arc from the beach. Both wings are drawn together on the beach and hauled to concentrate the fish in the head of the net, from where they can be bucketed ashore. Seine nets can also be used for drive-in-net, or muro-ami, fishing. A barrier net is set in the lagoon or on a reef, and fish are driven with scare lines into the apex of the net, which is then closed to catch the fish. The amount of bycatch from this type of fishing depends on whether people are largely urbanized and used to eating a narrow range of reef fish, or whether they mainly rely on fishing for subsistence and eat a broader range of fish.

Surround seines can also be set on open schools in a lagoon in the same manner as a beach seine. This fishing method is employed in Hawaii to catch schools of big-eye scad or *akule*, which are located by spotting from light aircraft. This method of fishing is extremely selective, bycatch results when not all the captured school is kept and excess fish will be released. In such cases the release of fish is commendable since they are not wasted as dead bycatch.

Lastly, cast or throw nets are also common in parts of the Pacific, where fishermen want to make modest catches, usually of small nearshore schooling reef species. These catches are taken mainly for subsistence, and fishermen will select and stalk on foot schools of fish such as surgeonfish, herrings, rabbitfish, and mullets in the hope of obtaining a catch (Dalzell *et al.* 1996). As with spearfishing, there is a high degree of selectivity in the target catch, so bycatch is negligible.

3.5.3 Bycatch Reduction

It is important to understand that virtually all coral reef fisheries production in the western Pacific comes from state waters and not from waters under federal control. Consequently, it might be argued that there is no bycatch problem for coral reef fisheries under federal control. However, under the MSFCMA there is no minimum acceptable threshold for bycatch. Whatever the bycatch, the Council must try to reduce it, where practicable. However, using the simple gears deployed on coral reefs in a way that catches only the target species is difficult, if not impossible. Specialized gears, such as kites and spider-web lures that catch garfish, are used in the Pacific Islands, but many of the other universally employed gears will invariably take species that people generally refuse to eat.

Incentives to reduce bycatch are limited. People will not eat suspected ciguatoxic fish and may regard any attempts to subvert taboos on other species as culturally insensitive. Coral reef fisheries are composed of many fishermen and small vessels without observer programs. This makes it difficult to enforce regulations mandating a "take-all fishery" to eliminate bycatch. Further, where fish are suspected of being ciguatoxic, prudence dictates that catches should continue to be discarded. Ciguatera test kits exist, but these are relatively expensive and are designed for amateur fishermen who want to test individual fish. It is not a test that can be applied wholesale on a cost-effective basis to even a modest commercial reef fish catch.

It probably makes the most sense to focus regulations and incentives on those gears that usually produce the most bycatch, especially on passive gears, such as traps and gillnets. Fish traps may be regulated by varying mesh size to exclude undersize fish and non-target species, or requiring escape vents for the same purpose. As mentioned earlier, some kind of degradable panel or fastening can be employed to open traps after a given amount of time, thus minimizing ghost-fishing by lost traps. The number of traps that a person is allowed to set could also be limited. Specifying the maximum soak time could also reduce the number of fish unnecessarily lost or killed due to a long set time. By the same token, not only could gillnet mesh size be regulated, but also the length of the net and the duration of soak time.

Education campaigns might be run to alert fishermen to the bycatch issue and encourage them to avoid damaging fish that must be returned to the sea. Where fish have suffered as a result of raising them from depth, fishermen may be convinced to return fish by first deflating distended swim bladders. Similarly, greater care and attention to releasing fish from the common gears may minimize release mortality. Circle hooks, for example, because they hook in the mouth instead of the stomach or gills, could effectively reduce bycatch mortality of discarded handline-caught fish. Trap-caught reef fishes can also be returned to the sea in good condition, if handled appropriately, with gloves, and rapidly removed from traps with minimal trauma.

It is difficult, however, to conceive of ways in which speared fish can be safely released without trauma, although release has been successful in some reef fish tagging experiments. But the selection by fishermen of fish to spear should minimize most spearfishing bycatch. It is more difficult to release fish from gillnets and other seines in good condition if fish are gilled or tangled. Aside from the measures outlined above, there is very little direct regulatory action that will minimize bycatch. Instead, making fishermen more aware of the need to minimize discard volume and mortality might be more effective. Fortunately, traditional Pacific Island societies usually abide by this ethic already.

3.5.4 Reef Fish Bycatch Data

The WPacFIN program has recently begun to collect data on bycatch in American Samoa, Guam and the CNMI as part of the routine creel surveys carried out by local agencies. Members agreed at recent Council Plan Team meetings that the most critical and plausible information to collect on bycatch during creel surreys was the species name, the number of fish discarded, and whether they were discarded alive or dead/injured. The overall coverage rates of these surveys and the

experience of the personnel involved is sufficient to achieve good estimates of bycatch species and bycatch rates in most fisheries. Voluntary observer programs are also being discussed to obtain more reliable estimates from certain sectors, such as the charter bottomfish fishery.

In Hawaii, the main commercial catch database does not, in general, contain discard data, except for the NWHI bottomfish catch. This fishery has also been monitored in the past by observers. However, creel surveys—initially focused on shoreline catches on the Big Island of Hawaii—are being expanded to Maui and will also include boat landings. The surveys will include questions on discards in common with those in the CNMI and the territories, and there are plans to seek funding to expand the surveys to all the MHI archipelago.

3.6 Description of Island Areas in the Council Region: Economy, Fishing Communities, and Use of Reef Resources

This section describes fishery-related economic and cultural characteristics of each of the five jurisdictions in Council region. Section 3.6.1 provides a regional overview, describing the nature of contemporary island communities, how they depend on coral reef resources, and how they used these resources in the past and continue using them today. Section 3.6.2 generally repeats this format for each of the five jurisdictions in the Council Region: American Samoa, the CNMI, Guam, Hawaii, and the PRIAs.

The whole of Section 3.6, then, concerns the socio-cultural aspects of the fishery, which includes shared technology, customs, terminology, attitudes, and values. Fishermen may be the most direct beneficiaries of the fishing lifestyle, but the broader social context also needs to be considered. Those who participate in the marketing or consumption of fish, or in the provision of fishing supplies, may also share in the fishing culture. An integral part of this web of interactions is the broad network of interpersonal social and economic relations through which the cultural attributes of a fishery are transmitted and perpetuated. The relations that originate from a shared dependence on fishing and fishing-related activities to meet economic and social needs can have far-reaching effects in the daily lives of those involved.

Island cultures are maintained by systems of interdependence and social reciprocity, including sharing of seafood gathered by fishing. Beyond their dietary importance, fish have value for exchange and gift-giving that promotes social harmony, community cohesion, and cultural identity. Various types of seafood served on holidays or during celebrations may become imbued with specific symbolic meanings.

Finally, the socio-cultural context of fishing may include the contribution fishing makes to the cultural identity and continuity of the broader community or region. As a result of this contribution, the activity of fishing may have existence value for some members of the general public. Individuals who do not fish themselves, and are never likely to, may derive satisfaction and enjoyment from knowing that this activity continues to exist. They may value the knowledge that the traditions, customs and life ways of fishing are being preserved (URS Corp. in press).

3.6.1 Regional Overview

Island Communities in the U.S. Pacific

The Contemporary Socio-economic Context

The social and economic histories of the populated U.S. Pacific Islands differ considerably from that of the continental U.S. The Samoan, Hawaiian, and Mariana Islands were originally settled in ancient times by seafaring peoples. In most areas, the dearth of terrestrial resources led to great dependence on fishing for food security. This dependence, over thousands of years, have shaped the social organization, cultural values and spiritual beliefs of the indigenous populations.

The era of European discovery brought the island cultures in direct conflict with western traditions of proprietorship. Repeated contact with western culture eroded the stability of the social structures and subsistence economies created by indigenous people. The beginning of the twentieth century brought American administrators to the Pacific and accelerated the process of westernization.

World War II caused dramatic changes in all of the populated U.S. Pacific Island groups. It also caused an influx of Caucasians into Hawaii. New harbors, airports, and other infrastructure tied the islands closer to the U.S. mainstream. This increased the imports of goods, and exposure to American laws, education, media, and technology. The islands moved rapidly away from subsistence and toward cash economies.

For centuries, native cultures of the U.S. Pacific Island have relied on seafood as their principle source of protein. Archeological records indicate that reef and lagoon fisheries can and have supported long-term sustainable exploitation. With the shift from subsistence to cash economies, and limited terrestrial resources, native cultures are once again looking towards the ocean as a source of food and as means to support their island economies. However, the availability of many traditional seafood has been significantly diminished as a result of environmental degradation of the nearshore reefs areas since western contact. Localized overfishing is blamed for some of the adverse impacts, but coastal construction, industrial discharges, and poor watershed management and other impacts attributed to population growth are believed to contribute greatly to coral reef habitat damage near population centers.

Polunin and Roberts (1996) report that direct and indirect fishing impacts to fish and invertebrate populations are often reversible with time. Additionally, Dalzell and Adams (1997) also reported that while some gears such as gill nets and spearfishing under certain circumstances lead to rapid reduction in reef fish populations, these appear to recover rapidly if fishing effort is reduced.

Ultimately, the integration of a multi-disciplinary approach to coastal fisheries management on an ecosystem basis must be fortified in order to sustain long-term harvest of coral reef fisheries.

Table 3.5a: Major demographic and economic characteristics of American Samoa, Guam, Hawaii, and the CNMI.

	American Samoa	CNMI	Guam	Hawaii
Population	**57,291**	**69,221**	**154,805**	**1,193,001**
Indigenous Population (%)	**89%**	**29%**	**47%**	**19%**
Land Area (sq. mi.)	**77**	**179**	**212**	**6,423**
Reef Area (sq. mi.)	**296**	**579**	**179**	**(MHI) 2,535 (NWHI) 11,535**
GDP (U.S.$ million)	**253.00**	**664.60**	**3,065.80**	**35,146.40**
GDP Per Capita ($)	**4,295**	**8,367**	**18,766**	**29,164**
Major Income Sources	**Tuna canneries, government services, remittances from Samoans overseas.**	**Tourism, garment manufacturing, trade and services.**	**Tourism, military, trade and services.**	Tourism, services, trade, Government, military.
Political Status	**U.S. territory since 1899, Samoans are U.S. citizens but do not vote in U.S. national elections.**	**After WWI under Japanese Mandate. 1947-became part of UN TTPI (U.S. administered). 1978-Commonwealth. Islanders are U.S. citizens but do not vote in U.S. elections.**	**U.S. territory since 1898, 1950-Guam Organic Act conferred citizenship but no voting privileges in U.S. national elections. Organic Act never ratified by Guam referendum.**	**Kingdom overthrown by American businessmen,1893. Annexed in 1898 by "Newlands Resolution." Organic Act in 1900 creates U.S. Territory. 1959-Admissions Act creates State of Hawaii.**
Major Investment Sources	**U.S.**	**Japan, Korea, Hong Kong, U.S.**	**U.S., Japan, Korea**	**U.S., Japan, Australia**

Table 3.5b: Statute mile distances between population centers in the Region, and to Washington, D.C.

	Garapan, CNMI	Pago Pago, American Samoa	Honolulu, Hawaii	Washington, D.C.
Agana, Guam	136	3,598	3,812	7,396
Garapan, CNMI		3,604	3,717	7,802
Pago Pago, American Samoa			2,598	7,028
Honolulu, Hawaii				4,835

With the exception of American Samoa—and small enclaves in Guam, Hawaii, and the CNMI—the contemporary descendants of indigenous Pacific Islanders are dispersed as part of cosmopolitan populations. Island societies have become pluralistic, and many aspects of their economies and cultures have evolved in modern times. Yet, the vast majority of contemporary island inhabitants continue to depend on coral reef resources for consumptive and non-consumptive uses. Most are consumers of seafood and many are at least part-time fishermen. In addition to providing food and recreation, the harvest of coral reef resources is also important as a means of preserving and perpetuating indigenous cultural identities and values. Table 3.5a-b provide general socio-economic and geographic data for the four populated jurisdictions in the Council Region.

Fishing Communities in the U.S. Pacific

The U.S. Pacific Islands vary significantly in land area, population levels, and the size of their associated EEZs. They have had significantly different courses of political development and historical relationships with the U.S., but they share a common economic and social dependence on marine fisheries, especially coral reef resources. This dependence traces back thousands of years, when the islands were first settled by sea-faring peoples. Their dependence on fishing for food security shaped the social organization, cultural values and spiritual beliefs of the indigenous cultures. Contemporary island societies are pluralistic in population and culture and few people depend solely on fish catches for protein.

Contemporary communities result from webs of social interaction that people create by taking advantage of shared cultural understanding and identity. Fishing communities in the U.S. Pacific Islands are based on shared participation in fishing-related activities that occur over larger geographical scales than single villages or towns. At least one-third of the resident population of the U.S. Pacific Islands participates in some level of fishing, and all towns and villages include some proportion of residents who are part-time fishermen. Fishermen from one town travel to other parts of the island and between islands to visit family and friends. Fishing is one of the most common shared activities at such gatherings. Fishermen frequently trailer small boats from one side of an island to the other to take advantage of seasonal fish availability and weather

conditions. Fishing cooperatives in the U.S. Pacific Islands have island-wide memberships and seafood markets are supplied by widespread on-and off-island harvesters.

Community Participation in Coral Reef Fisheries

Contemporary participation in coral reef fisheries in the U.S. Pacific Islands has grown out of ancient traditions. Near the more populated islands, however, the impacts of fishing have been magnified by population growth and the introduction of modern, manufactured gear (e.g., monofilament nets, scuba).

Coral reef products that enter commercial markets typically undergo very little processing and the chain of sale is very short, from harvesters to retailers to consumers. There are no known participants whose primary business is processing coral reef products. Wholesalers of coral reef products are also rare. The predominant use of coral reef resources is for subsistence, where the product moves directly from harvester to consumer, often within the same family or village.

The harvest and consumption of coral reef resources has been a part of the way of life since the islands were first settled several thousand years ago. Pacific Islanders of old were considered masters in their knowledge of fish, their habits, and the means of capturing them. Through oral tradition, one generation taught the next about the dynamics of inshore marine resources and passed on the skills needed to harvest them. Based on their familiarity with specific places and through trial and error, the Pacific Islanders were able to devise social controls to foster, in modern terminology, "sustainable use" of marine resources in localized areas. Periods of scarcity brought about an early awareness that marine resources were limited. This reinforced a shared social obligation to exercise self-restraint in resource exploitation. Irresponsible resource use was tantamount to denying future generations their birthright and means of survival. Virtually every method utilized in modern fisheries management was in use in the Pacific Islands centuries ago. Many of the ancient fishing techniques survived into the twentieth century, but today these traditional management measures are rarely applied in the U.S. Pacific Islands.

The methods and patterns of coral reef fisheries that have evolved over the years in the U.S. Pacific Islands grew out of these traditions. Fishing for pelagic fish in offshore waters is constrained by the need for seaworthy vessels, distance to fishing grounds and weather. In contrast, nearshore coral reef resources can be harvested with low capital outlay, and less time and risk. Relative to other fisheries resources in theU.S.Pacific Islands, coral reefs are more accessible and are used by a larger and more diverse population of fishermen, which employs a wider variety of gear. Table 3.6 lists a broad spectrum of coral reef taxa, which are harvested for many purposes.

Table 3.6: Coral reef taxa harvested by indigenous and contemporary fishermen in the U.S. Pacific islands.

Taxa	Harvested by:	
	Indigenous People	Contemporary Fishermen
Acanthuridae (Surgeonfish)	F, C, M, (1)	F, A
Algae (Seaweeds)	C, F, M, B	F, A
Annelid (Seaworms)	M	B, A
Antipathes spp. (Black coral)	M	A
Apogonidae (Cardinal fishes)	F	F, A
Architeconicidae (Sundial shells, Sea hares)	F, C	A
Aulostomidae (Trumpetfish)	F	A
Balistidae (Triggerfish)	F	A
Blennidae (Blennies)	B	B, A
Carangidae (Jacks, Trevally)	F	F, A
Carcharhinidae (Sharks)	F, C, (1)	F, M, (1)
Cassididae (Helmet Shell)	F, T	F, A
Chaetodontidae (Butterflyfish)		A
Cheloniidae (Sea turtles)	F, M, T	F, A
Cirrhitidae (Hawkfish)	F	A
Clupeidae (Herrings)		B
Cnidara (Sea anemones)	F	A
Conidae (Cone shells)	F, A, T	A
Crustacea (Crabs, shrimps, lobsters)	B, F, M	B, F, A
Cypraeidae (Cowries)	F, A, T, M	A, T

(1) Skins of some species used for drums

A. Aquaria or ornamental uses
B. Used for bait
C. Ceremonial Uses
F. Used for Food
M. Medicinal Uses
T. Tool Uses

Table 3.6 (cont.)

Taxa	Harvested by:	
	Indigenous People	Contemporary Fishermen
Dasyatididae		
Myliobatidae		F, A
Mobulidae (Rays)	F	
Decapterus/Selar spp (Scads)	B, F	B, F
Echinoderms (Sea cucmbers,sea Urchins)	B, F, T,	F, A
Engraulidae (Anchovies)		B
Fasciolariidae (Spindleshell)	T	A
Fistularidae (Cornetfish)		A
Gobiidae (Gobies)	B, F, C	B, A
Holocentridae (Soldierfish)	F	F
Kuhliidae (Flagtail)	C, F	F
Kyphosidae (Rudderfish)	F, M,	F
Labridae (Wrasses)	F, C	F
Lethrinidae (Emperor fish)	F	F
Littorinidae (Kukae kolea)	F	
Lutjanidae (Snappers)	F	F
Melampidae (Oe)	F	
Moringidae	F	
Muraenidae	F	B
Chlopsidae		

(1) Skins of some species used for drums

A. Aquaria or ornamental uses
B. Used for bait
C. Ceremonial Uses
F. Used for Food
M. Medicinal Uses
T. Tool Uses

Table 3.6 (cont.)

Taxa	Harvested by	
	Indigenous Fishermen	Contemporary Fishermen
Congridae	F	F,B
Ophichthidae (Eels)	F	F, A, B
Mullidae (Goatfishes)	F	F
Neritidae (Snails)	F, A, T	F, A
Octopodidae (Octopus)	F	F
Patellids (Opihi)	F, M, C, T	F
Polynemidae (Threadfin)	F	F
Pomacanthidae spp (Angelfish)		A
Pomacentridae spp (damselfish)		A
Priacanthidae (Bigeye)	F	F
Pteridae (Oysters)	F, T	F, A
Scaridae (Parrotfish)	F	F
Scorpaenidae (Scorpion fishes)	F	F, A
Serranidae (Grouper, Sea bass)	F	F, A
Siganidae (Rabbitfish)	F	F
Sphyraenidae (Barracuda)	F	F
Terebridae (Auger shells)	T	
Verenidae (Clams)	F, T	F
Zanclidae (Moorish Idol)		A
Zooanthids (Soft Corals)	M	A

(1) Skins of some species used for drums

A. Aquaria or ornamental uses
B. Used for bait
C. Ceremonial Uses
F. Used for Food
M. Medicinal Uses
T. Tool Uses

Historical and Contemporary Coral Reef Uses

Coral reef resources sustained indigenous populations in the U.S. Pacific Islands for hundreds to thousands of years before European contact. More recently, coral reef resources have been harvested for recreational and commercial purposes as well. Reef species have been harvested for food, the aquarium trade, construction materials, curios, jewelry, pharmaceuticals and traditional medicines.

In modern times, some reefs have been degraded by a range of human activities. Comprehensive lists of human threats to coral reefs in the U.S. Pacific Islands are provided by Maragos *et al.* (1996), Birkeland (1997b), Grigg (1997), Jokiel *et al.* (1999), and Clark and Gulko (1999). In general, reefs closest to human population centers are more heavily used and are in worse condition than those in remote locations (Green 1997). Table 3.7 summarize coral reef use in the various jurisdictions in the Council region.

Table 3.7: Summary of coral reef resource use levels in nearshore areas (0-3 nmi from shore) and offshore areas (3-200 nmi from shore) in sub-areas of the U.S. Pacific Islands (modified from Green, 1997).

Location	0-3 nmi	3-200 nmi
American Samoa	Nil-Moderate	Nil-Light
CNMI	Nil-Heavy	Nil-Heavy
Guam	Light-Heavy	Nil-Heavy
Hawaii		
Main Hawaiian Islands	Light-Heavy	Nil-Heavy
Northwestern Hawaiian Islands	Mostly Nil	Nil-Moderate
Remote Islands	Nil-Light	Mostly Nil
Overall	Nil-Heavy	Nil-Moderate

3.6.2 Island Area Descriptions

American Samoa

Socio-economic Overview

American Samoa is an unincorporated territory of the U.S. comprising seven islands with a total land area of only 77 square miles. Because most of the islands are mountainous, there is very little area suitable for a agriculture. The Territory's population is about 60,000, and is growing rapidly, with a doubling time of only 20 years (Craig *et al.* in press). (Table 3.8 provides basic demographic data for the Territory.) Of all the U.S. Pacific Islands, American Samoa has the lowest gross domestic product and highest donor aid per capita (Adams *et al.* 1999).

Table 3.8: 2000 U.S. Bureau of Census Data for American Samoa.

	Population (n)	Population (%)	Land Area (sq. miles)	Land Area (%)
American Samoa Total	57,291	100.0	77.4	100.0
Tutuila Island and Aunu'u Island	55,876	97.5	54.8	70.8
(Eastern District)	23,441	40.9	25.9	33.5
(Western District)	32,435	56.6	28.9	37.4
Manu'a Islands	1378	2.4	21.9	28.3
(Ofu and Nu'u Islands)	289	0.5	2.8	3.6
(Olosega Island)	216	0.3	2	2.6
(Ta'u Island)	873	1.5	17.1	22.1
Rose Island	0	0	0.1	0.1
Swains Island	37	<0.06	0.6	0.8

American Samoa has a small developing economy, dependent mainly on two primary income sources: the American Samoa government, which receives income and capital subsidies from the federal government, and two tuna canneries on the island of Tutuila. These two income sources have given rise to a third: a services sector that derives from and complements the first two. In 1993, the latest year for which American Samoa government has compiled detailed labor force and employment data, the local government employed 4,355 people, or 32.2% of total employment, followed by the two canneries with 3,977 people (29.9%) and the rest of the services economy with 5,211 workers (38.4%). Altogether, the three segments employed 13,543 workers, while 2,718 people were registered as unemployed (that is, actively seeking employment). This gives a total labor force of 16,621 and an unemployment rate of 16.7%. A large proportion of the territory's workers are from Samoa, formerly Western Samoa. While Samoans working in the territory are legally alien workers under U.S. law, they share a common culture, history, and family ties.

Because of its tuna canneries, Pago Pago is the leading U.S. port in terms of dollar value of fish landings. Star-Kist Samoa has become the largest tuna cannery in the world. Ancillary businesses associated with the tuna processing industry also contribute significantly to American Samoa's economy. Pago Pago Harbor supports mostly large fishing vessels, tankers, and container ships. Shoreside infrastructure for small domestic fishing vessels is minimal. Commercial fisheries for bottomfish and reef fish make a minor contribution to the Territory's overall economy. The social and cultural importance of coral reef resources in American Samoa dwarfs their commercial value.

With a total population estimated in 1993 at 52,900, the labor force represented 30.7% of the population, which is very low when compared with the overall U.S. labor force ratio (well over 50 percent) but typical of the smaller developing Pacific Island economies. Of the 31,822 residents 16 years or older, the total labor force was equivalent to 51.1%. That half of the 16 years-plus population is not in the labor force is explained by American Samoa's lack of major industry other than government and fish canning. Work opportunities are certainly limited, but not having a job in the money economy does not necessarily equate with unemployment because subsistence activity contributes to the extended family's total well-being.

Official data notwithstanding, by many measures American Samoa is not a poor economy. Its estimated per capita income of $5,000 is almost twice the average for all the Pacific Island economies (at $2,700) (Bank of Hawaii 1997a). Per capita income in American Samoa does not represent the same market basket and value as it would, for example, in Honolulu. There are aspects of work and the creation of value in communal societies of the Pacific Islands that are not captured by market measures. For instance, American Samoa's tightly organized *aiga* (extended family) system helps to keep young people from becoming economically unproductive and socially disruptive. Unlike the vast majority of youth in the Pacific Islands, American Samoan youth can emigrate to the United States, where an estimated 70,000 Samoans live, 20,000 of them in Hawaii.

The policy of the American Samoa government, as expressed in the Revised Constitution (1966), is "... to protect persons of Samoan ancestry against ... the destruction of the Samoan way of life ... [and] to protect the lands, customs, culture, and traditional Samoan family organization of persons of Samoan ancestry, and to encourage business enterprises by such persons...."

Community Participation in Coral Reef Fisheries

The majority of fishermen in American Samoa harvest coral reef resources for subsistence and do not sell their catches. Samoans have cultural obligations to extended families, traditional leaders, and village ministers that require the exchange of food and other resources. Undertaking fishing on a part-time basis, rather than as a full-time business, provides residents with the flexibility to fulfill these obligations, which are an integral part of *fa`a Samoa* (the Samoan way of life).

There are no data on the proportion of the population that engages in fishing, but the number must be greater than 50%. Interviews with men and women in 42 villages of Tutuila, revealed that most men and women fished in the reef environment between one and four times per week and that they ate meals of those fish between one and six times per week (Des Rochers and Tuilagi 1993). The number of sometime food fishermen probably ranges from 10,000 to 30,000, with less than 1% of these involved in commercial harvesting.

Fishing has been interwoven with all aspects of Samoan community life and cultural identity since the islands were first settled 3,500 years ago. It shaped the traditional Samoan religion, diet, material culture, oral traditions and calendar (Severance and Franco 1989). Fishing and its products also played a fundamental role in the social structure. Ceremonial and cultural demands

involve exchange of food and other resources to support extended families and traditional leaders. Participation in commercial activities, wage labor, and a cash economy has not weakened this network of social obligations as much as provided new opportunities for customary exchange of goods and services within American Samoa's tightly held *aiga* (extended family) system.

Fishing contributes not only to the extended family's welfare, but also to social cohesion within the broader island community. It offers individuals an occupation that is consistent with Samoan cultural values and the island lifestyle. Furthermore, to the extent that unemployment among the younger population can cause both economic and social ills, commercial fishing provides an additional opportunity for young people to be economically productive and socially responsible.

In contemporary Samoa, seafood harvested from inshore coral reefs continues to be a major component of the local diet. Wass (1982) reported that annual per capita consumption of seafood in American Samoa is 148 lbs., which is several times higher than the U.S. national average. Local catches are insufficient to meet such high demand, and they are supplemented by imports of reef fish and bottomfish from neighboring Samoa.

Despite increasing commercialization, fishing continues to contribute to the perpetuation of Samoan culture and social cohesion of American Samoa communities. The role of fishing in cultural continuity is at least as important as the contributions made to the nutritional and economic well-being of island residents. Continuing access to fish is important for the perpetuation of *fa`a Samoa* (the Samoan way of life), as well as for food.

Traditional Samoan values still exert a strong influence on when and why people fish, how they distribute their catch, and the meaning of fish within the culture. Fishing has become increasingly commercialized, but fish, whether caught or purchased, remains a significant component of the customary exchange system. Fish catches are distributed according to a strict protocol. Even the fish that is sold may be fulfilling obligations to friends and members of the extended family. A recent survey of American Samoan fishermen revealed that a significant portion of the catch that is sold is done so at a reduced price to friends and kinsmen as an expression of a established social relationship (Severance et. al. 1998). When distributed, fish and other resources move through a complex and culturally embedded exchange system that supports the food needs of the *aiga*, and enhances the status of the *matai* and village ministers. (The *matai* is the authority, chief, or specialist on land, while the *tautai* is the authority, chief, or specialist on the sea (Severance *et al.* 1998). A range of separately named types of customary exchange have been documented.

Meyer (1987) emphasizes that reef-associated fish are not important just as food resources but that "fish and fishing are embedded in Samoan culture and wisdom." Both Severance and Franco (1989) and Meyer (1987) illustrate the importance of fish in Samoan culture through long lists of proverbs that feature fish and fishing gear. An important community event, and one of the few remaining group fishing activities, is the harvest of *palolo* worms (*Eunice viridis*). During just a few nights each year, the reef-burrowing polychaete releases egg- and sperm-filled body segments that are delicacies in Samoa (Des Rochers and Tuilagi 1993).

Historical and Present Coral Reef Uses

Coral reef fishes and invertebrates are harvested in subsistence and small-scale commercial fisheries. In 1994, the only year when both components of this fishery were measured, catches were 86 mt and 76 mt, respectively, and consisted primarily of surgeonfish, parrotfish, groupers, octopus and sea urchins (Craig *et al.* in press). Sixty-nine different taxa were harvested in 1991. The migratory *atule* (*Selar crumenophthalmus*, or bigeye scad) is an important catch component (Green 1997).

As recently as 20 years ago, the harvest of reef fish and invertebrates from reef flats fronting the most densely populated section of coast on Tutuila was as high as 26.6 mt/km^2 per year (Wass 1982). A decreasing trend in reef-related fish catches was observed in the early 1990's. Giant clams, and perhaps other favored invertebrates, have been overfished in most areas, except Rose Atoll (Craig *et al.* in press). In general, the reefs adjacent to population centers on Tutuila Island appear to be in worse condition than those near less populated or unpopulated islands (Green and Craig 1996).

Most of the coral reef fisheries in American Samoa occur in nearshore waters. Much of the bottomfishing activity by small boats is conducted on banks in the EEZ, and some of the shallow-water snappers and emperors they catch can be considered reef fish species. At present, the catch from this fishery is minor (Green 1997). Ornamental fish collection has occurred on a small scale in recent years. Live rock taken from shallow reef areas was exported during 1999, but this fishery has since been prohibited by the *fono* (American Samoa Legislature).

Fisheries statistics show that in recent years coral reef fisheries have accounted for 62% of the annual catch of 154 mt and 70% of the $619,000 annual catch value. This estimate is low because it does not include the shoreline subsistence harvest, which is assumed to be substantial. Nor does the estimate include shallow-water species of bottomfish, which are taken in a commercial small-boat fishery. The annual harvest of the latter fishery has been small in recent years (11 mt valued at $46,000), so the contribution to the total reef fish harvest is insubstantial.

Most of the landings in the known reef-related fisheries in American Samoa are fish (98 mt/year), molluscs (33 mt/year) and echinoderms (19 mt/year), but small amounts of crustaceans (3 mt/year) are also reported (Green 1997). A much smaller commercial fishery, using ten-meter boats, catches bottomfish (principally emperors and snappers) around the islands and offshore banks, using hook-and-line. In 1997, this fishery harvested 12 mt (Craig et. al. 1999). Chambered nautilus has occasionally been taken by researchers and public aquaria at depths of about 200 m on offshore reef slopes (Itano pers. comm.). Virtually nothing is known about the reefs on these offshore banks because they are relatively inaccessible. It is assumed, however, that they are in better condition than the nearshore reefs because they are deep and remote from most human activities.

Coral reefs around American Samoa are recovering from a series of natural disturbances that occurred over the past two decades: a crown-of-thorns invasion (1978), three hurricanes (1986, 1990, 1991), and mass coral bleaching (1994), as well as chronic human-induced impacts along

the populated coasts. Beaches, wetlands, and coral reefs have been extensively altered due to highway construction and urban expansion, particularly along the south shore of Tutuila. Coastal erosion is amplified by the removal of large quantities of beach sand and coral rubble from the shoreline for use around homes. Together, these shoreline alterations have largely eliminated the use of the central south coast by nesting sea turtles. Direct losses of coral reef habitats are related to dredging for harbors and filling to build the international airport runway.

Possible degradation of reefs has also occurred due to chronic water quality and sedimentation problems. Because of the main islands' steep terrain and high rainfall, hillside runoff causes heavy sedimentation in adjacent coastal waters. Landfills, sewage disposal, and—in Pago Pago Harbor—discharges from shoreside industries and spills from vessels in port have also had a major impact on the reef environment (Craig *et al.* in press). Remote Rose Atoll, protected as a National Wildlife Refuge (established through a cooperative agreement between the Territory of American Samoa and the U.S. Fish and Wildlife Service in 1973), was damaged in 1993 by a ship grounding and related oil spill.

The condition of nearshore reefs around American Samoa varies according to location. Reefs on the main island of Tutuila are in the worst condition because of a combination of natural and human effects (hurricanes, coral bleaching, pollution, sedimentation), whereas the reefs on the more remote and less populated islands tend to be in good condition (Green 1997). Evidence from recent fisheries statistics, scientific resource surveys, and interviews with village elders and fishermen suggests that the more accessible coral reefs are seriously overfished. Scuba-assisted fishing is a major contributor to this problem, especially at night. Green sea and hawksbill turtle populations have seriously declined due to harvesting of turtles and eggs and degradation of nesting and inshore habitats.

Commonwealth of the Northern Mariana Islands

Socio-economic Overview

The Northern Mariana Islands was part of the former Trust Territory of the Pacific Islands, administered by the U.S., before becoming a commonwealth by plebiscite in 1998. It has a total land area of 179 square miles spread over 264,000 square miles of ocean and consists of three main islands, Saipan, Tinian, and Rota, and several small islands and atolls. The southernmost island, Rota, lies some 50 miles northeast of Guam and 430 miles south of CNMI's northernmost island, Uracus. The small islands of the northern part of the chain are lightly populated. In 1990, the population of the northern islands was 36, but has dwindled down to only 6 according to 2000 Census Bureau Data. The main islands are grouped together in the southern part of the chain. The Commonwealth's capital is Saipan, but no locality on that island is recognized specifically as the capital; several government offices are located in the CDP of Capital Hill, but the legislature meets in Susupe. Ninety percent of its of 69,221 residents live on the island of Saipan and almost al the rest on Tinian and Rota. (Table 3.9 provides basic demographic data for the Commonwealth). Chamorro is the most commonly spoken native language.

Table 3.9: 2000 Bureau of Census Data for the Northern Mariana Islands and Guam.

	Population (n)	Population (%)	Land Area (sq. Miles)	Land Area (%)
CNMI Total	69,221	100.0	179	100.0
Northern Islands	6	<0.01	59.8	33.4
Rota Island	3,283	4.8	33	18.4
Saipan Island	62,392	90.1	44.6	24.9
Tinian Island	3,540	5.1	41.7	23.3
Guam total	154,805	100	212	100

The Bureau of the Census estimates that the population of the Northern Mariana Islands grew by 25,867 persons between the 1990 census and 2000 to an estimated 69,221 persons. It is estimated that approximately 59% of this increase is a result from migration to the islands, principally from Asian countries. The Chamorro and Carolinan ethnic groups native to the islands represented some 29% of the CNMI's population (Bureau of Census, International Data Base, 12/29/99).

The early history of the Northern Mariana Islands parallels that of Guam. Spanish and other explorers first visited the islands in the sixteenth century, and they were colonized by Spain in the seventeenth century. Spain sold the islands in 1899 to Germany, following the end of the Spanish-American War. In 1914, Japan entered World War I on the side of the Allies and took possession of the islands. After the war, Japan retained the islands under a League of Nations Mandate. In 1944, the United States gained control of the islands from Japan and in 1947, along with other parts of U.S.-controlled Micronesia, these islands became a United Nations Trust Territory under U.S. administration. The islands were administered by the Defense Department until 1961. However, administrative authority was vested in the Department of the Interior in 1951. In 1978, a separate government for the Northern Mariana Islands was established and Commonwealth status was granted in 1986.

The main islands are each organized as a single municipality, with its own elected mayor and municipal council. Saipan's municipal council also serves the Northern Islands municipality. In 1990, there were 16 CDP's identified at the time of the Census. Each of these communities had locally recognized boundaries, a population of more than 300 people, and was enumerated in the decennial and economic censuses.

The aboriginal people of the CNMI include the indigenous Chamorros, original inhabitants of the islands, and the Carolinians, who are Micronesians that resettled on Saipan during the 1840s. Carolinians are a small minority of the population, but they are known for their seafaring and fishing skill. Their fishing activity largely centered on the harvest of lagoon and reef species, but small paddling canoes were sometimes used to fish a short distance outside the reef (Amesbury and Hunter-Anderson 1989). In the two decades since these islands achieved commonwealth status their demographic, economic, and social structure has changed dramatically. When the

CNMI opened to foreign capital and labor, it was transformed from a small economy supported largely by subsistence and government to a large regional tourist destination and a garment-manufacturing haven. Although tourism has been CNMI's largest income source, the Asian financial crisis of the late 1990s caused visitor arrivals from Japan and Korea to drop by one-third. At present, garment production is CNMI's fastest growing industry and is credited with preventing an economic depression following the decline of the tourist industry.

The development of tourist and garment industries based on foreign labor has had a dramatic impact on CNMI's population growth, which increased from 16,780 in 1980, to 79,429 in early 1999 (Bank of Hawaii 1997b). The majority of the current population are non-resident workers from the Philippines and other parts of Asia. There are also workers from Republic of Belau and the Federated States of Micronesia. Early 1999 data reveal that on Saipan only 28% of the population, and 22.6% of the labor force, are U.S. citizens. In addition to the garment industry, foreign workers hold most jobs in the construction, hotel, and retail sectors. The government provides approximately 12% of the jobs, and U.S. citizens make up most of this work force. They also make up 55% of the unemployed. The unemployment rate among Saipan's U.S. citizen labor force in early 1999 was 13.4%, compared to 3.2% among foreign workers (Bank of Hawaii 1997b). With the exception of a now defunct purse seine support base on the island of Tinian, CNMI has never had very much infrastructure dedicated to commercial fishing. Commercial domestic fisheries for reef fish and bottomfish make a minor contribution to the overall economy. The social and cultural importance of coral reef resources in the CNMI dwarfs their commercial value.

Community Participation in Coral Reef Fisheries

Under Japanese rule, the Northern Mariana Islands became a major fishing base, primarily for the harvest of skipjack tuna. However, the Chamorros or Carolinians of the Northern Marianas had little or no involvement in these industrial-scale fish harvesting or processing operations. According to Joseph and Murray (1951), Japanese colonial policy prohibited commercial fishing—and most other remunerative enterprises—by Chamorros and Carolinians. Presumably, during this period the Chamorros and Carolinians relied heavily on subsistence use of inshore marine resources (Amesbury and Hunter-Anderson 1989). When the Americans assumed control of the islands at the end of World War II, the fishing industry was left in the hands of Japanese civilian prisoners, until their repatriation in 1946.

The post-World War II years saw a gradual involvement of the Chamorros and Carolinians of the Northern Mariana Islands in commercial fishing. According to Orbach (1980), the Carolinians were the leaders in forming crews for fishing enterprises involving larger craft and offshore fishing. Orbach attributed the predominance of Carolinians in these initial offshore fishing ventures to the importance of fishing in traditional Carolinian culture. The closely-knit family and community structures within Carolinian settlements on Saipan facilitated cooperative fishing effort.

By 1980, several boats over 25 ft in length were actively engaged in commercial fishing for bottomfish and pelagic species (Orbach 1980). One vessel was operated by a Carolinian

company; one was owned and operated by the Tinian Fishing Cooperative, whose membership was Chamorro; and two other boats were skippered and crewed mainly by Japanese fishermen. In addition, some of the charter vessels that had been operating in the CNMI since 1978, catering to the Japanese tourists, were also being used to catch fish for sale to hotels and restaurants on Saipan (Orbach 1980).

Many of the early offshore commercial fishing ventures involving large vessels received support from the CNMI government in the form of loans and fishing supplies (Orbach 1980). However, all of the fishing enterprises failed within a few years because of inadequate markets, lack of management expertise, and other factors. After some time, a number of other large vessels entered the bottomfish fishery, but they too eventually dropped out. This considerable turnover pattern of entry and exit has continued over the past two decades. In 1999, there were two major bottomfish fishing operations. One of the owners suspended his entire operation toward the end of the year because of financial problems. The downturn in the Asian economy has had a severe impact on the tourism industry in the CNMI, and the demand for bottomfish by local hotels has declined. However, another company has started its own fishing operation with two multi-purpose vessels. In addition, another individual is considering converting a deep-sea shrimp boat to bottomfish fishing (Trianni pers. comm.).

The CNMI bottomfish fishery consists mainly of small (less than 24 ft) boats engaged in commercial and subsistence fishing within a 20-mile radius around the islands of Saipan, Tinian, and Rota. However, larger vessels that are capable of traveling to the northern islands have periodically entered the fishery. The larger vessels fish primarily for commercial purposes and target both deep-water and shallow-water bottomfish species, the latter primarily on the extensive banks and reefs surrounding Farallon de Medinilla (WPRFMC 1999). The smaller vessels fish both commercially and for subsistence and target shallow-water species.

The number of sometime food fishermen in the NMI may be from10,000 to as many as 30,000, depending on how actively the large population of non-resident Asian workers is engaged in fishing. Few depend on fishing for all of their income. The primary motivation for fishing is to provide food for home consumption and gifts to family and friends. According to Hamnett *et al.* (In press), each fishing trip had multiple purposes and the catch was used in a variety of ways, even though the primary reason for the fishing trip may have been associated with a specific event. Sixty-five percent of those surveyed contributed fish to a family or church fiesta. All of those who contributed fish to an event also took some of their catch home, gave fish to extended relatives, or sold some of their catch. Interviews with those surveyed revealed that fishermen who fished with the primary intent of making a contribution to an event, rarely sold part of their catch and usually took home fish for consumption.

Orbach (1980) notes that the fisheries in CNMI are inextricably involved with the lifestyles and plural-occupational patterns of the participants. Part-time fishing performed in conjunction with other activities has a prominent place in the socio-economic adaptations of local residents. People fish for bottomfish and pelagic species to supplement their family subsistence, which is gained by a combination of small-scale gardening and wage work (Amesbury and al 1989). Orbach suggests that the availability of economic activities like part-time fishing is among the

major reasons that CNMI has not experienced more of the problems of other island entities such as out-migration or high rates of crime and juvenile delinquency.

Because they are acculturated to fishing and seafood consumption practices in their home countries, Asians are likely to harvest a wider spectrum of coral reef resources for food and are less discouraged by declining catch rates. These attitudes are different from those of the indigenous islanders.

Fishing in Guam and the CNMI is still important, because it both contributes to the Chamorros' and Carolinians' subsistence needs and helps them to preserve their history and identity. Many aspects of traditional Chamorro and Carolinian culture have been lost. But fishing has helped Chamorros and Carolinians to keep alive what remains of their maritime tradition and maintain their connection to the sea and its resources.

The social obligation to share one's fish catch extends to part-time and full-time commercial fishermen. In Guam and the CNMI locally caught fish are often sold informally (Amesbury and al 1989; Amesbury and Hunter-Anderson 1989). The buyers are mainly friends, neighbors, and relatives, especially in the CNMI. This non-anonymous, very personal "market" tends to restrain the price asked and paid.

In 1980, an observer wrote that "although subsistence fishing is clearly not as prevalent as it has been in the past, subsistence and mixed economy fishing are important to all segments of the population as income and nutrition sources, as recreation, and as an integral part of family and community life and reinforcement of cultural traditions" (Orbach 1980).

The CNMI is well-known for its community celebrations known as fiestas, which are held on such occasions as birthdays, baptisms, marriages and village patron saints' days. The fiesta serves several social functions, one of which is to promote and cement social cohesion. A large assortment of food, including locally-caught reef fish, is served in prodigious quantities (McCoy 1997).

There continues to be high demand for coral reef resources as seafood in the CNMI because of the indigenous cultures and the presence of a large population of non-resident workers from Asia. Total seafood consumption in the CNMI has been estimated at about 56 lbs. per person (including tourists). Locally-harvested products accounted for slightly less than half of the total supply. Reef fish landings, by weight, are a more important component of the local catch than bottomfish or pelagic fish. Estimates of the annual catch of reef fish in the CNMI are about 150,000 lbs. for sale and 280,000 lbs. for subsistence. The major commercial outlets for locally-caught reef fish are small retail markets, hotels, and restaurants on Saipan. Chamorro and Carolinian consumers are the most important retail fish buyers (Radke and Davis 1995).

Historical and Present Coral Reef Uses

Before World War II, the Japanese exploited sea cucumbers, trochus (topshell), precious corals and many other coral reef resources in the Japanese Mandated Islands, which included the

present Commonwealth of the Northern Mariana Islands. Commercial fisheries for trochus and sea cucumbers were re-opened during the mid-1990s for the first time in recent history. Over an 18-month period in 1995-1996, 268,000 sea cucumbers were collected (Green 1997).

It is difficult to assess the total harvest of present-day coral reef fisheries in the CNMI because of shortcomings in fisheries statistics. Virtually no recent information is available for inshore subsistence and recreational catches of coral reef resources. This harvest is assumed to be substantial, especially in the more accessible areas like Saipan Lagoon. Coral reef fisheries in the CNMI are mostly limited to nearshore areas, especially off the islands of Saipan, Rota, and Tinian. Finfish and invertebrates are the primary targets but small quantities of seaweed are also taken. All of the recent data are for commercial landings: 62 - 80mt/year of reef fish and 1 -1.5 mt/year of spiny lobster. An unknown proportion of the bottomfish landings in the CNMI are shallow-water snappers, emperors, and groupers, which may be considered part of the coral reef fishery (Green 1997).

Little is known of the coral reef fisheries in the northern islands of CNMI, but the catch by domestic fishermen is believed to be minor. The exception was in 1995, when the nearshore reefs around six of the northern islands (especially Anatahan and Sarigan) were fished commercially for several months. During that time, these areas yielded a harvest of 15 mt of reef fish and 380 pieces of spiny lobster. Poaching by foreign fishing boats may occur in some places (Green 1997).

Coral reefs near some heavily populated areas in the southern islands of the CNMI have been degraded by heavy fishing, sedimentation, and tourist recreation (Green 1997). Limited information suggests that most of the nearshore reefs elsewhere in the CNMI are in good condition. Reefs off the southern islands experienced a massive starfish outbreak in late 1960s, but corals recovered rapidly from this disturbance. Reefs around the northern islands are in good condition because of their isolation from human activities. Local damage, on Pagan and Farallon De Medinilla for example, may have been caused by storm waves, volcanic eruptions, or military activities (Birkeland 1997c; Green 1997).

Virtually nothing is known about the condition of offshore reefs, but they are assumed to be in good condition because of their isolation. Offshore reefs generally receive little fishing pressure because of the limited range of the small boat fishery. The exceptions are banks that are relatively close to the main islands, like Esmeralda, and the extensive bank off Farallon de Medinilla, where a fishery for shallow water bottomfish is conducted by small boats.

Guam

Socio-economic Overview

Guam and the Mariana Islands were first settled about 3,000 years ago, but their present social and demographic structure is largely the result of colonial experiences of the last 300 years. Guam's total population is estimated to have reached 154,000 in 1999, nearly doubling the 1970 total of 85,000. Of the total reported labor force of 72,700 (June 1999), 61,460 were employed

and 11,060 were unemployed, for an official jobless rate of 15.2%. In September 1997, at the beginning of the current economic and employment downturn on Guam, the unemployment rate was only 9.2% (Bank of Hawaii 1997c).

Guam's economy has become so dependent on tourists from East Asia, particularly Japan, that any significant economic, financial and foreign exchange development in the region has had an immediate impact on the territory. During the mid- to late-1990's, as Japan experienced a period of economic stagnation and cautious consumer spending, visitor arrivals from Japan dropped, and the impact was felt as much on Guam as in Japan. The U.S. military presence on Guam has diminished to the lowest level in decades. Nevertheless, the military remains a vital stabilizing economic factor for Guam, particularly in times of regional economic crises. The Government of Guam currently supplies more than 20% of all civilian jobs in the territory. Recent deficits have resulted from a steady rise in government spending without a concomitant increase in tax revenues due to a stagnant tax base (Bank of Hawaii 1997c).

Guam's most significant commercial fishing attribute is its status as a regional tuna transshipment center and re-supply base for foreign tuna fleets (Hamnett and Pintz 1996). Guam is the fourth leading U.S. port in terms the dollar value of fish landings, which are mostly for transshipment to tuna markets in Japan. Commercial domestic fisheries for reef fish and bottomfish make a relatively minor contribution to the Guam economy. The social and cultural importance of coral reef resources in Guam dwarfs their commercial value. (Table 3.9 provides basic demographic data for Guam.)

Community Participation in Coral Reef Fisheries

Prior to the arrival of Europeans in Guam and the other Mariana Islands in the sixteenth century, the Chamorros, as the original inhabitants of these islands were called, possessed large sailing canoes that enabled them to fish on offshore banks and seamounts (Amesbury and Hunter-Anderson 1989). However, during the 1700's these large oceangoing canoes were systematically destroyed by the Spanish colonizers in order to concentrate the indigenous population in a few settlements, thereby facilitating colonial rule as well as religious conversion (Amesbury and Hunter-Anderson 1989). After the enforced demise of the sailing canoes, fishing for offshore species was no longer possible. By the mid-nineteenth century, there were only 24 outrigger canoes on Guam, all of which were used only for fishing inside the reef (Myers 1993). Another far-reaching effect of European colonization of Guam and other areas of the Mariana archipelago was a disastrous decline in the number of Chamorros, from an estimated 40,000 persons in the late seventeenth century to approximately 1,500 persons a hundred years later (Amesbury and Hunter-Anderson 1989).

After the U.S. acquired Guam in 1898, following the Spanish-American War, the U.S. colonial government held training programs to encourage local residents to participate in offshore commercial fishing (Amesbury and Hunter-Anderson 1989). However, because they lacked the capital necessary to purchase and maintain large enough boats, most couldn't participate. They were also largely unwilling to stay at sea for more than a day or so. Shortly after the end of World War II, the U.S. military assisted several villages in developing an inshore commercial

fishery using nets and traps. Post-World War II wage work enabled some fishermen to acquire small boats with outboard engines and other equipment for offshore fishing (Amesbury and Hunter-Anderson 1989). However, even as late as the 1970's, relatively few people in Guam fished offshore, even on the protected leeward side of the island, because boats and deep-sea fishing equipment were too expensive for most people (Jennison-Nolan 1979).

In the decades following the end of World War II, the ethnic composition of Guam's population changed markedly. By 1980, less than half of the inhabitants were Chamorros (Amesbury and al 1989). In the late 1970's, a group of Vietnamese refugees living on Guam fished commercially on a large scale, verifying the market potential for locally-caught reef fish, bottomfish, tuna, and mackerel (AECOS 1983). The Guam Fishermen's Cooperative Association began operations during that time. Until the co-op established a small marketing facility at the Public Market in Agana, fishermen were forced to make their own individual marketing arrangements after returning from fishing trips (AECOS 1983). In 1980, the co-op acquired a chill box and ice machine, and emphasized wholesaling. Today, the co-op's membership includes over 160 full-time and part-time fishermen, and it processes and markets (retail and wholesale) an estimated 80% of the local commercial catch (Duenas pers. comm.).

As Guam's tourism industry grew in the1980's, a fleet of marina-berthed charter vessels developed, which were used by tourists and residents for bottomfish fishing (Myers 1993). The charter boats made multiple two-hour to four-hour trips daily. Two types of charter bottomfish fishing trips were organized. The more typical charter boats involved three to six patrons, while the larger "party-boat" vessels carried as many as 30 patrons on a single trip. Most of these bottomfish charters operate out of the Agat Marina and primarily target the shallow-water bottomfish complex. Since most of the charter fishing trips are short, it is unlikely that many of these trips enter federal waters (WPRFMC 1999).

Participants in inshore reef fisheries are predominantly of indigenous Chamorro ancestry. Their harvest accounts for 79% of the non-commercial component of the inshore catch. One study concludes that "probably no one was supported full-time by this fishery, but probably a great many people added a useful income for themselves and their families through it" (Knudson 1987). In characterizing Guam's fisheries, Knudson (1987) concludes that "the commercial fishery on Guam is the product of many relatively small sales by a large number of 'semi-commercial' fishermen and that the non-commercial fishery is the product of a considerable pool of subsistence fishermen plus another sizeable pool of recreational fishermen," and that, "on the whole, catches in the Guam fishery are small, but that the number of participants is quite large." The number of sometime food-fishermen who harvest coral reef resources in Guam may be on the order of 20,000, with less than 1% engaged in commercial harvesting.

For the past two decades bottomfish fishing around Guam has been a highly seasonal small-scale commercial, subsistence, and recreational fishery. The majority of the participants in the bottomfish fishery operate vessels less than 25-ft long and primarily target the shallow-water bottomfish complex (WPRFMC 1999). The shallow-water component is the larger of the two in terms of participation because of the lower expenditure and relative ease of fishing close to shore (Myers 1993). Participants in the shallow-water component seldom sell their catch because they

fish mainly for recreational or subsistence purposes (WPRFMC 1999). The commercially-oriented highliner vessels tend to be longer than 25 ft, and their effort is usually concentrated on the deep-water bottomfish complex.

Fishing for coral reef resources has occurred throughout the island's history. Archaeological evidence reviewed by Amesbury *et al.* (1989) suggested "... an apparent tendency throughout prehistory and historic times for Mariana Island native groups to have relied more on inshore fish species than offshore ones ...."

In the late 1880s, the Spanish governor of the Mariana Islands wrote of Guam that "inside the reef (indigenous people) catch different varieties (of fish) all year long." Whether the preference for reef fishing had anything to do with restrictions on the use of ocean-going canoes is not clear. The Governor also noted the importance of the seasonal arrival of rabbitfish (*manahak*) in inshore areas ("the populace then appears en masse to fish"), which is still an important event in Guam's reef fishery in modern times. Hensley and Sherwood (1993) note that the traditional practice of sharing the catch of *atulai* (*Selar crumenophtalmus*) from a surround net continues today, with equal portions given to the owner of the net, the village where the fish were caught, and the group that participated in the harvest.

Amesbury *et al.* (1989) concluded that "in the decades prior to the Second World War, inshore but not offshore fishing was part of the subsistence base of the native people." One document they reviewed was a list of the "principal fishes of Guam" written by a scientifically trained naval officer. Nearly all the fishes listed were reef-associated. The first year that a pelagic fish species was included in the catch reports of the post-war Guam civilian government was 1956. Until then, all catch reports were of reef-associated species (Amesbury *et al.* 1989).

Based on creel surveys of fishermen, only about one-quarter to one-third of the inshore catch is sold. The remainder enters non-commercial channels (Knudson 1987). Reef fish continues to be important for social obligations, such as fiestas and food exchange with friends and families. One study found a preference for inshore fish species in non-commercial exchanges of food (Amesbury *et al.* 1989). The local harvest of reef fish is insufficient to meet commercial demand, and there are substantial imports from the Federated States of Micronesia and the Philippines. Annual seafood consumption in Guam is on the same order as that in the CNMI—56 lbs. per capita.

Over the centuries of acculturation, beginning with the Spanish conquest in the late seventeenth century, many elements of traditional Chamorro and Carolinian culture in Guam and the Northern Mariana Islands were lost. But certain traditional values and attitudes were retained and have been melded with elements of Western culture that are now a part of local life and custom. High value is placed on sharing one's fish catch with relatives and friends. Sometimes fish are sold in order to earn money to buy gifts for friends and relatives on important Catholic religious occasions such as novenas, births and christenings, and other holidays (Amesbury *et al.* 1989).

In addition, the people of Guam and the CNMI participate in many banquets throughout the year associated with neighborhood parties, wedding and baptismal parties, and especially the village fiestas that follow the religious celebrations of village patron saints. All of these occasions require large quantities of fish and other traditional foods (Orbach 1980).

Historical and Present Coral Reef Uses

Since World War II, Guam's coral reef fisheries have shifted from an exclusively subsistence focus to an artisanal fishery that blends subsistence, recreational, and commercial purposes (Hensley and Sherwood 1993). The more accessible reefs are considered overfished because of declining catch rates, declining size of target fish species, and greater prevalence of less desirable species (Birkeland 1997c; Green 1997; Katnik 1982).

Prior to World War II, trochus was taken in large quantities for food and jewelry work. By the 1970's, the trochus population had recovered sufficiently to allow a limited fishery that is currently regulated by size restrictions. Stony and precious corals have been harvested in the past for ornamental use and jewelry work. Residents and visitors, including foreign fishing crews, collect stony corals and mollusks as curios. Coral harvesting is illegal on Guam without a permit and several violators have been convicted (Green 1997).

Since the late 1970's, the percentage of live coral cover on Guam's reefs and the recruitment of small corals have decreased. This trend has been attributed to poor recruitment by coral larvae, increased sedimentation of reef habitat, and domination of reef habitat by fleshy algae. Corals have also been affected by natural disturbances (Birkeland 1997c). Pervasive events include starfish predation between 1968 and 1970 and exposure of corals due to extreme tides during El Niño events. Heavy wave action, associated with typhoons, has had more localized effects.

Shore-based fishing accounts for most of the fish and invertebrate harvest from coral reefs around Guam. In recent years, the estimated inshore harvest has ranged from 38 to 108 mt. This estimate excludes highly variable catches of juvenile rabbitfish and bigeye scad by traditional fisheries that are still practiced seasonally (Myers 1993). While spearfishing is the principal method of harvesting, it is highly seasonal because of weather conditions. In the fiscal years from 1985 to 1991, spearfishers mostly landed parrotfishes (36%), surgeonfishes (17%), and wrasses (7%) (Myers 1993).

The coral reef fishery harvests more than 100 species of fish, including the families *Acanthuridae, Carangidae, Gerreidae, Holocentridae, Kyphosidae, Labridae, Lethrinidae, Lutjanidae, Mugilidae, Mullidae, Scaridae*, and *Siganidae* (Hensley and Sherwood 1993). Myers (1997) noted that seven families (*Acanthuridae, Mullidae, Siganidae, Carangidae, Mugilidae, Lethrinidae, and Scaridae*) were consistently among the top ten species in any given year from FY91 to FY95 and accounted for 45% of the annual fish harvest. Approximately 40 taxa of invertebrates are harvested by the nearshore fishery, including 12 crustacean taxa, 24 mollusc taxa, and 4 echinoderm taxa (Hensley and Sherwood 1993; Myers 1997). Species that became rare on shallow reefs due to heavy fishing include bumphead parrotfish (*Bolbometopon*

muricatum), humphead wrasse (*Cheilinus undulatus*), stingrays, parrotfish, jacks, emperors, and groupers (Green 1997).

Many of the nearshore reefs around Guam appear to have been badly degraded by a combination of natural and human impacts, especially sedimentation, tourist overuse and overharvesting. In the last few years, there has been an increase in commercial spearfishing using scuba at night. Catch rates have increased because of improved technology (high capacity tanks, high tech lights, and bang sticks) that allows spearing in deeper water (30-42 m). As a result, many larger species that have already been heavily fished in shallow water—such as bumphead parrotfish, humphead wrasse, stingrays, and larger scarid species—are now reappearing in the fishery catch statistics (Green 1997).

Virtually no information exists on the condition of the reefs on offshore banks. On the basis of anecdotal information, most of the offshore banks are in good condition because of their isolation. Observations by divers suggest that anchor damage is having a major impact on branching coral formations on some of the offshore banks. Anchors dragged by small boats dig small furrows, but anchors from large fishing vessels leave large craters.

According to Myers (1997), less than 20% of the total coral reef resources harvested in Guam are taken from the EEZ, primarily because they are associated with less accessible offshore banks. Finfish make up most of the catch in the EEZ. Most offshore banks are deep, remote, shark infested, and subject to strong currents. Generally, these banks are only accessible during calm weather in the summer months (May to August/September). Galvez Bank is the closest and most accessible and, consequently, fished most often. In contrast, the other banks (White Tuna, Santa Rose, and Rota) are remote and can only be fished during exceptionally good weather conditions (Green 1997). Local fishermen report that up to ten commercial boats, with two to three people per boat, and some recreational boats, use the banks when the weather is good (Green 1997).

At present, the banks are fished using two methods: bottomfishing by hook-and-line and jigging at night for bigeye scad (*Selar crumenophthalmus*) (Myers 1997). In recent years, the estimated annual catch in these fisheries has ranged from 14 to 22 mt of shallow bottomfish and 3 to 11 mt of bigeye scad (Green 1997). The shallow-water component accounted for almost 68% (35,002 to 65,162 lbs.) of the aggregate bottomfish landings in FY92–94 (Myers 1997). Catch composition of the shallow-bottomfish complex (or coral reef species) is dominated by lethrinids, with a single species (*Lethrinus rubrioperculatus*) alone accounting for 36% of the total catch. Other important components of the bottomfish catch include lutjanids, carangids, serranids, and sharks. Holocentrids, mullids, labrids, scombrids, and balistids are minor components. It should be noted that at least two of these species (*Aprion virescens* and *Caranx lugubris*) also range into deeper water and some of the catch of these species occurs in the deepwater fishery.

The majority of bigeye scad fishing occurs in territorial waters, but also occasionally takes place in federal waters. Estimated annual offshore landings for this species since 1985 have ranged from 6,393 to 44,500 lbs., with no apparent trend (Myers 1997). It is unclear how much of this offshore bigeye scad fishery has occurred in the EEZ

Hawaii

Socio-economic Overview

Ocean resources are very important to Hawaii's economy. For example, tourism, the largest industry in Hawaii, is heavily dependent on oceanic resources. As important, both the indigenous and non-indigenous population depend upon the ocean and oceanic resources for recreation and social interactions. As a result, the State of Hawaii is broadly engaged in management of the ocean and ocean resources. However, Hawaii's economic situation changed dramatically in the 1990s. Several major economic sectors—such as plantation agriculture, tourism, and the military—suffered downturns. As a consequence, Hawaii never entered the period of economic prosperity that many U.S. mainland states experienced. Since 1998, Hawaii's tourism industry has recovered substantially, mainly because the strength of the national economy promoted growth in visitor arrivals from the continental US. Efforts to diversify the economy, and thereby render it less vulnerable to future economic downturns, have met with little success to date (Bank of Hawaii 1998). Commercial fishing has historically represented a small share of Hawaii's total economic activity. In contrast to the sharp decline in some industries of long-standing importance in Hawaii, however, the fishing industry has been fairly stable during the past decade. More importantly, fishery resources, especially coral reef resources, represent an important source of subsistence, providing food, income, opportunity for social interaction, and cultural exchange for Hawaii's residents during periods of economic recession. As a result of the rise in tourism-related ocean recreation in Hawaii, a premium has been placed on non-consumptive uses of nearshore marine resources (Pooley 1993b).

In 1998, Hawaii's ethnic makeup was 22% Caucasian, 21% Hawaiian or part Hawaiian, 18% Japanese, 13% Filipino, 7.3% Hispanic (1990), 3% Chinese, and 1% African-American; other ethnicities made up the balance (DBEDT 1999). (However, Office of Hawaiian Affairs data reveals that a significant part of the population lists their ethnicity as "other/unknown.") Hawaii's population has been growing at the rate of 7% during the past decade, and was estimated to be 1,193,001 in 1998. Table 3.10 provides additional demographic information.

By most statistical measures, people of Native Hawaiian ancestry have the lowest incomes and poorest health of any ethnic group in the State (OHA 1998). Federal, state, and private programs have been established to benefit Hawaiians. There is also an active cultural renaissance among Native Hawaiians, with efforts to restore the language, arts, and subsistence activities, including traditional fishing practices. As part of this renaissance, Native Hawaiians continue to assert their rights of access to oceanic resources. In Hawaii, all shoreline to the highwater mark and undeveloped areas *mauka* (inland, toward the mountains) are public areas that can be accessed for cultural and traditional practices, a holdover from the days of the kingdom. These Native Hawaiian gathering rights, including shoreline access, have been reaffirmed in court decisions.

The islands of the State of Hawaii were discovered and settled by Polynesians between the third and seventh centuries A.D. Captain James Cook, the first European to reach Hawaii, arrived in 1778. Europeans and Asians began to settle on the islands in the nineteenth century with the

development of pineapple and sugar plantations. In 1898 the islands were ceded to the United States and Hawaii became the fiftieth state in 1959.

Table 3.10: 1998 DBEDT estimates of population, employment and unemployment in Hawaii.

	Population	Population (%)	Civilian Labor Force	Unemployment (%)
State of Hawaii	1,193,001	100	597,800	6.2
City & County of Honolulu	872,478	73.13	427,650	5.4
Hawaii County	143,135	12.00	68,650	9.7
Maui County	120,785	10.12	71,650	6.6
Maui Island	105,336	8.83	66,850	n/a
Kauai County	56,603	4.74	28,700	9.8
Kauai Island	50,947	4.27	n/a	n/a
Molokai Island	6,838	0.57	3,050	n/a
Lanai Island	2,989	0.25	1,750	n/a
Niihau Island	230	0.02	n/a	n/a

Hawaii is a string of 137 islands extending in an arc across the Pacific Ocean from the northwest to the southeast. The eight largest islands—measured by size, population, and economic activity—are at the southeastern end of the arc, some 2,400 miles from the United States. They are divided into four municipal counties: Hawaii County, Maui County, City and County of Honolulu and Kauai County. The land area of the island chain is estimated to be 6,423 square miles.

Community Participation in Coral Reef Fisheries

Archaeological evidence reveals that seafood, particularly coral reef species, was part of the customary diet of the earliest human inhabitants of the Hawaiian Islands (Goto 1986). Fishing and related activities in traditional Hawaii were also often highly ritualized and important in religious beliefs and practices. The *Kumulipo*, or Hawaiian creation legend, says that fish were created after corals and mollusks, but before insects and birds (Beckwith 1951). Certain species of fish were venerated as personal, family or professional gods, called *aumakua*. Like the Native Hawaiians, nineteenth century Asian immigrants imbued fish with symbolic meaning, extending their cultural significance beyond their value as a dietary staple. Although no longer the only source of protein, seafood consumption in Hawaii is still at least twice as high as the U.S. national average (URS Corp., in prep).

The social and symbolic value of fish, reflected early Native Hawaiian traditions, is related to the sharing of fish in the extended family and community. This social responsibility remains an

important in the lives of many Native Hawaiians. It is regularly reenacted during weddings, communions, school graduations, funerals, or a child's first birthday (baby luau), where fish is considered an important customary food item (Glazier 1999). The importance of sharing fish is also found in other ethnic groups in Hawaii. For example, Japanese tradition dictates reciprocal exchanges of gifts according to an intricate pattern of established norms and procedures (Ogawa 1973). Those who neglect the obligation to reciprocate risk losing the trust of others, and eventually their support.

Commercial fishing has been part of Hawaii's economy for nearly two centuries and the socio-cultural context of fishing in Hawaii has been shaped by the multi-ethnicity of local fisheries. Although certain ethnic groups have predominated in Hawaii's fisheries in the past, and ethnic enclaves continue to exist in certain fisheries, the fishing tradition in Hawaii is generally characterized by a partial amalgamation of cultures. The remnants of the varied technology, customs, and values of Native Hawaiians and immigrant groups from Japan, China, Europe, America, the Philippines, and elsewhere appear in the methods used by contemporary Hawaii residents to harvest, distribute, and consume seafood.

A history of commercial fishing in Hawaii begins with the arrival of British and American whaling fleets during the early nineteenth century. Along with the introduction of a cash economy and the growth of the foreign—or non-Native Hawaiian—community, whalers fostered its development. Initially, commercial fishing in Hawaii was monopolized by Native Hawaiians, who supplied the local market with fish, using canoes, nets, traps, spears, and other traditional fishing devices (Cobb 1902; Jordan and Evermann 1902; Konishi 1930). However, the role that Native Hawaiians played in Hawaii's fishing industry gradually diminished through the latter half of the nineteenth century. During this period, successive waves of immigrants of various races and nationalities arrived in Hawaii, increasing the non-indigenous population from 5,366 in 1872 to 114,345 in 1900 (OHA 1998). The new arrivals included Americans, Chinese, Portuguese, and Filipinos.

The arrival of a large number of Japanese, in particular, had a long-term impact on the fishing industry. Like the majority of the early immigrants, they were contracted to work on Hawaii's sugar cane plantations. But many of these Japanese immigrants were also skilled commercial fishermen from the coastal areas of Wakayama, Shizuoka and Yamaguchi Prefectures in Japan. When their contract terms expired on the plantations, they turned to the sea for a living (Okahata 1971). Later, experienced Japanese fishermen came to Hawaii specifically to fish commercially. During much of the twentieth century Japanese immigrants to Hawaii and their descendants were preeminent in Hawaii's commercial fishing industry. Although these fishermen of Japanese ancestry became more Americanized, many Japanese fishing traditions persisted. As late as the 1970s, the full-time professional fishermen in Hawaii were predominately of Japanese descent (Garrod and Chong 1978). However, by then hundreds of local residents of various ethnicities were also participating in Hawaii's offshore fisheries as part-time commercial and recreational fishermen.

During the early years of the commercial bottomfish fishery, vessels restricted their effort to areas around the MHI. The fishing range of the sampan fleet increased substantially after the

introduction of motor powered vessels in 1905. Fishing activity around the NWHI began at least as early as 1913, when one commentator recorded: "Fishing for *ulua* and *kahala* is most popular, using bonito for bait, fishermen seek this (sic) species in a 500 mile range toward Tori-Jima (NWHI)" (Yamamoto 1970, p. 107). Within a few years, more than a dozen sampans were fishing for bottomfish around the NWHI (Konishi 1930). Fishing trips to the NWHI typically lasted 15 days or more, and the vessels carried seven to eight tons of ice to preserve their catch (Nakashima 1934). The number of sampans traveling to the more distant islands gradually declined due to the limited shelter the islands offered during rough weather, and the difficulty of maintaining the quality of the catch during extended trips (Konishi 1930). However, during the 1930's, at least five bottomfish fishing vessels, ranging in size from 65 to 70 ft, continued to operate in the waters around the NWHI (Hau 1984). These sampans harvested lobster, reef fish, turtles, and other marine animals in addition to bottomfish (Iverson et. al. 1989). During World War II the bottomfish fishery in Hawaii virtually ceased operations, but it recommenced shortly after the war ended (Haight *et al.* 1993). The late 1940s saw as many as nine vessels fishing around the NWHI, but by the mid-1950s, vessel losses and depressed fish prices, resulting from large catches, had reduced the number of fishery participants. But in 1948, the Pacific Ocean Fishery Investigation began researching potential commercial fisheries in the NWHI. In 1950, Leo Ohai, owner and captain of the Sea Queen, transported a small aircraft to French Frigate Shoals to support *akule* fishing and Buzzy Agard, using a DC3 cargo aircraft, flew catches of *akule* from French Frigate Shoals to Honolulu. He also captained the Koyo Maru to catch *akule* at Nihoa. During the 1960s, only one or two vessels were operating around the NWHI.

Commercial fisheries saw a rise and subsequent fall in both participation and landings during the first half of the twentieth century. There were 2,000 to 2,500 commercial fishermen in 1900 (Cobb 1902). In 1947, the number was about 3,500 (Hida and Skillman 1983), but by 1985 the number fell to about 2,600 (Shomura 1987). Thus, while Hawaii's motorized fleet grew remarkably during the twentieth century, participation in the commercial fisheries did not. Landings saw a similar rise and fall during this period. Hawaii's commercial catch statistics show an increase from about 6 million lbs. in 1900, to about 19 million lbs. in 1953, and a subsequent decrease to 11 million lbs. in 1986. Not surprisingly, most of the increase was in the pelagic fishery. The reported commercial catch of the "coastal" fishery—reef, bays, and nearshore habitats—in fact declined from about 3.6 million to 0.6 million lbs. from 1900 to 1986 (Shomura 1987).

There was renewed interest in harvesting the bottomfish resources of the NWHI in the late-1970s, following a collaborative study of the marine resources of the region by state and federal agencies (Haight *et al.* 1993). Several modern boats entered the NWHI fishery. As a result, the supply of high-valued bottomfish—such as *opakpaka* and *onaga*—increased. This regular and consistent supply of relatively fresh fish allowed the tourism-linked restaurant market to expand (Pooley 1993b). Markets for Hawaii bottomfish further expanded after wholesale seafood dealers began sending fish to the U.S. mainland. By 1987, 28 vessels were active in the NWHI bottomfish fishery, although only 12 were fishing for bottomfish full-time. Some of the part-time bottomfishing vessels also engaged in the pelagic or lobster fisheries (Iverson *et al.* 1989). In 1989, the WPRFMC developed regulations that divided the fishing grounds of the NWHI bottomfish fishery into the Ho'omalu Zone and Mau Zone. The Council established limited

entry programs for the Ho'omalu Zone and Mau Zone in 1989 and 1999, respectively, to avoid economic overfishing (Pooley 1993a). Since 1995, the number of vessels allowed to fish in the Ho'omalu Zone has been capped at seven. Currently, only ten vessels are allowed to bottomfish in the Mau zone (URS Corp. in press). The NWHI lobster fishery, centered around Necker Island, underwent a similar evolution. It developed in the late 1970s, reached a peak of 16 vessels in 1985 and 1986, and subsequently declined, with nine vessels active in 1997 (of 15 allowed under the limited access system) (Pooley and Kawamoto 1998).

The 1970's also saw major changes in the composition and operations of the bottomfish fishery around the main Hawaiian Islands. The fishery changed from one dominated, in terms of catch and effort, by a relatively small number of full-time professional fishermen to one dominated by hundreds of part-time commercial and recreational fishermen. This change was due to a number of factors. The popularity of offshore fishing increased in Hawaii with the increase in the availability of locally-built and imported small fiberglass boats. In addition, the rise in fuel prices during the 1970s made fishing for bottomfish particularly attractive to fishermen because it consumed less fuel than trolling and generated higher-value fish catches to offset fuel costs. Finally, as navigation systems, bottom-sounders, and hydraulic or electric powered reels became more affordable, the skill level and experience necessary to successfully fish for bottomfish were reduced and the labor associated with hauling up the long lines was considerably lightened.

The development of a much larger market for bottomfish in the early 1980s resulted in premium prices. This motivated fishermen on the main Hawaiian Islands fishing grounds to increase their landings (Pooley 1993b). However, the number of vessels participating in the MHI fishery declined after reaching a peak of 583 in 1985. This decrease in fishing effort suggests that some bottomfish fishermen perceived a growing shortage of bottomfish in the MHI fishery and switched to other fisheries. In 1998, concerns about decreasing catch rates led the State of Hawaii to close certain areas around the MHI to bottomfish fishing, including parts of Penguin Bank in the EEZ. In addition, new state rules established a recreational bag limit of five *onaga* or *ehu*, or a mix of both, per person.

In addition to these food fisheries, Hawaii is the only area of the U.S. Pacific Islands where a significant ornamental reef fish fishery has developed. The State of Hawaii regulates ornamental collecting by permit. Most of the commercial collecting occurs around the island of Hawaii (Miyasaka 1997). At least 60 businesses, employing at least 255 people, are involved in collecting, wholesaling, retailing, importing, and exporting ornamental reef products in Hawaii (Miyasaka 1991).

Hawaii also has a large and apparently still growing recreational fishery, which overlaps considerably with the commercial and subsistence components. A 1996 national survey of recreational fishing (in which "recreation" included charter fishing) estimated that 244,000 recreational marine anglers, about half of them residents of Hawaii, made 2.3 million angler-trips (2.9 million angler-days) in Hawaii (U.S. Fish and Wildlife Service and Bureau of the Census 1998).
The cultural significance of this history of commercial development is underlined by its significance in the collective memory of some of Hawaii's major ethnic groups—the Japanese

and Native Hawaiians in particular. In 1999, for example, the Japanese Cultural Center of Honolulu organized an exhibition commemorating the past involvement of Japanese in Hawaii's commercial fishing industry. Some Hawaii fishermen feel a sense of continuity with previous generations of fishermen and want to perpetuate the fishing lifestyle. A 1993 survey of participants in the NWHI bottomfish fishery found that half of the respondents who fish in the Ho'omalu Zone were motivated to fish by a long-term family tradition (Hamilton 1994). This sense of continuity is also reflected in the importance placed on the process of learning about fishing from "old timers," and transmitting that knowledge to the next generation.

The importance of seafood, and the discriminating tastes of Hawaii's consumers, have made quality—and quantity and variety too—hallmarks of Hawaii's seafood markets. As a result, fish markets have became important institutions in Hawaii society. Long-established fishing-related infrastructure in Honolulu, such as the fish market and the Kewalo Basin mooring area, have helped define the character of the city. Consequently, even though much fish retailing now occurs through self-service supermarkets, Honolulu's fish market has endured and continues to be a center of social interaction for some island residents. The retail market is mainly composed of single proprietorship-family type operations. Close social connections have developed between retailers and consumers. This stems from the need for successful fish dealers to maintain good relations with their customers and thus keep a stable clientele (Garrod and Chong 1978). The large variety of seafood typically offered in Hawaii's seafood markets reflects Hawaii's ethnic diversity and each ethnic group's preferences, traditions, holidays, and celebrations (URS Corp. in prep).

Given the historical significance of commercial fishing in Hawaii, it is likely that some residents consider the fishing industry an important part of the cultural identity and heritage of the islands. Even people who have never fished, and do not intend to, may nonetheless wish that others continue to fish because of its contribution to Hawaii's social, cultural, and economic diversity. This existence value may be expressed in various ways. For example, some people may engage in vicarious fishing through the consumption of books, magazines, and television programs describing the fishing activities that others are pursuing in the waters around Hawaii.

Just as Hawaii's fishing tradition is an integral part of the islands' heritage and character, Hawaii's image has become linked with some types of locally caught consumed seafood. Among the fish species that have become closely identified with Hawaii are *opakapaka* and *onaga*. As noted by a national seafood marketing publication, this symbolic association has an important economic aspect:

> "When it comes to selling seafood the Hawaiians have a distinct advantage. Their product comes with built-in aloha mystique, and while they've emphasized the high quality of the fish taken from their waters, they've also taken full advantage of the aura of exotic Hawaii itself in promotion on the mainland and, now, in Europe" (Marris 1992, p. 75).

The availability of seafood is also important to Hawaii's tourist industry, the mainstay of the state economy. Japanese tourists visiting Hawaii often want to enjoy the traditional foods and symbols of Japan while they vacation in Hawaii, including various types of high quality fresh fish

(Peterson 1973). Hawaii tourists from the U.S. mainland, and other areas where fish is not an integral part of the customary diet, typically want to eat seafood because it is part of the unique experience of a Hawaii vacation. Consuming fish that is actually caught in the waters around Hawaii further enhances that experience (WPRFMC 2000b).

Today, the people who participate in Hawaii's reef-related fisheries constitute an ethnically mixed and spatially dispersed community numbering thousands of individuals. A large percentage of the population harvests coral reef resources for subsistence and customary exchange of food with friends and family. Although it is hard to tell how many people this segment of the population represents, it has been estimated that some-time food fishermen range between 100,000 to 400,000 individuals.

There are a few rural villages in the state where most residents are at least partly dependent on fishing for their livelihood (Glazier 1999). But generally there are not particular towns or cities where the balance of the residents depend on or engage in fishing to make a living. Instead, fishing communities—in the sense of social groups whose members share similar lifestyles associated with fishing—are sub-populations within metropolitan areas or towns.

Today, Hawaii fishermen fish for a variety of reasons. In fact, the same person can cite a range of motivations (Glazier 1999). In the small boat fishery around the MHI the distinction between "recreational" and "commercial" fishermen is extremely tenuous (Pooley 1993b). Hawaii's seafood market is not as centralized and industrialized as U.S. mainland fisheries. Thus, it is has always been feasible for small-scale fishermen to sell any or all of their catch for a respectable price. Money earned from part-time commercial fishing is an important supplement to the basic incomes of many Hawaii families. Even full-time commercial fishermen cite other reasons, besides money, for why they fish. For example, a 1993 survey of owner-operators and hired captains who participate in the NWHI bottomfish fishery found that enjoyment of the lifestyle or work itself are important motivations for participants (Hamilton 1994).

Historical and Present Coral Reef Uses

In recent decades, there has been a notable decline in nearshore fishery resources in the main Hawaiian Islands (Shomura 1987). Overfishing is considered to be one of the major causes of this decline (Grigg 1997; Harman and Katekaru 1988), but coastal construction, sedimentation, and other effects of urbanization have caused extensive damage to coral reefs and benthic habitat in localized areas near the populated islands.

Fishing gear types that mainly target inshore and coastal pelagic species accounted for about 10% (or 1.5 million lbs.) of the mean annual commercial fish catch in the State of Hawaii from 1990 to 1995. Recreational and subsistence catches are not reported in Hawaii, but creel surveys at Kaneohe, Hanalei, and Hilo Bays suggest that the total inshore catch from reef areas is at least equivalent to the reported commercial catch, and may be two or three times greater than that (Friedlander 1996).

The majority of the total commercial catch of inshore fishes, invertebrates, and seaweed comes from nearshore reef areas around the MHI. The exceptions are crustaceans: over 90% of the spiny lobster landings come from the NWHI and over 50% of Kona crab landings from Penguin Bank. Nearshore reefs in the MHI are the focus for commercial reef ornamentals harvesting and black coral collecting (Friedlander 1996).

The collection of black coral from depths of 30 to 100 m by scuba divers has continued in Hawaii since black coral beds were discovered off Lahaina, Maui, in the late 1950's, although harvest levels have fluctuated with changes in demand. Since 1980, virtually all of the black coral harvested around the Hawaiian Islands has been taken from a bed located in the Auau Channel. Most of the harvest has come from State of Hawaii waters and no black coral diver has ever received a federal permit to harvest precious coral in the EEZ. However, a substantial portion of the black coral bed in the Auau Channel is located in the EEZ. Recently, with the growing popularity of household marine aquaria, the demand for small, immature black coral colonies has increased. In 1999, concern about the potential for greater harvesting pressure on the black coral resources led the State of Hawaii to prohibit taking from state waters black coral with a base diameter less than 3/4 inches. The Council has recommended that a minimum size limit also be established for black coral harvested in the EEZ (WPRFMC 1999).

Table 3.11: Mean actual catch (lbs) by gear type from Penguin Bank (2-200 nm), based on data from DAR reported commercial fishery catch statistics from 1991-1995 (modified from Friedlander 1996).

Gear Type	Catch (lbs/yr)
Offshore gear	
Aku pole & line	67,486
Trolling	26,607
Tuna handline	1,295
Subtotal	**95,388**
Inshore gear	
Deep handline	83,517
Net	14,191
Inshore handline	2,485
Other	573
Trap	493
Diving	22
Subtotal	**101,281**
Total	**196,670**

After two decades of minimal activity, the domestic fishery for pink, gold and bamboo precious corals in the EEZ of Hawaii resumed in December 1999. One company uses two one-man submersibles to survey and harvest the resource at depths between 400-500 m. These technologically advanced devices are capable of diving to 700 m, with a maximum bottom time of six hours. To date, they have only surveyed and begun harvesting in areas around two of the seven known beds between the islands of Oahu and Hawaii. The company has plans to search for additional beds in both the MHI and NWHI.

Table 3.12: Mean annual catch (lbs) of the most common reported inshore fish species from Penguin Bank (2-200 nm) based on reported DAR commercial fisheries catch statistics from 1991-1995 (modified from Friedlander 1996) and from 1996-2000 (D. Hamm, pers. comm.).

Species/Taxa	1991-1995	1996-2000
Bigeye scad *(Selar crumenophthalums)*	537	474
Goatfish (*Mulloidichthys vanicolensis*)	264	165
Surgeonfish (*Acanthurus xanthopterus*)	204	65
Scad (*Decapterus* spp.)	152	41
Wrasse *(Bodianus bilunulatus)*	149	62
Barracuda (*Sphyraena helleri*)	111	56
Wrasse (*Xyrichthys pavo*)	111	176
Sharks (misc.)	65	3,605
Other goatfish *(Parupeneus* spp.)	37	6
Big-eye-fish *(Priacanthus* spp.)	28	30
Parrotfish (*Scarid* spp.)	22	-
Trumpetfish (*Aulustoma chinensis*)	14	1
Soldierfish *(Myripristis* spp.)	12	31
Leatherback *(Scomberoides lysan)*	5	6
Surgeonfish (*Acanthurus dussumieri*)	4	1
Surgeonfish *(A. olivaceus)*	4	-
Goatfish (*Parupeneus porphyreus*)	2	1
Unicornfish (*Naso* spp.)	1	1
Threadfin (*Polydactylus sexfilis*)	1	-
Wrasse (*Coris* spp.)	1	3
Flyingfish (*Exocoetus* spp.)	-	1

The deep-slope bottomfish fishery in Hawaii concentrates on species of eteline snappers, carangids, and a single species of grouper concentrated at depths of 30-150 fm. The fishery can be divided into two geographical areas: the inhabited main Hawaiian Islands, with their surrounding reefs and offshore banks, and the NWHI. In the MHI about 80% of the bottomfish habitat lies in state waters. Bottomfish fishing grounds within federal waters include Middle Bank, most of Penguin Bank, and approximately 45 nm of 100-fathom bottomfish habitat in the Maui-Lanai-Molokai complex.

Historically, Penguin Bank has also been one of the most important bottomfish fishing grounds in the MHI, because it is the most extensive shallow shelf area in the MHI, and it is within easy reach of major population centers. Penguin Bank is particularly important for the MHI catch of *uku* (Aprion virescens, or gray snapper), one of the few bottomfish species available in substantial quantities to Hawaii consumers during summer months. Table 3.13 compares bottomfish landings at Penguin Bank during two periods as a percentage of total MHI commercial landings, for five major bottomfish species. It shows that the bank has increased in importance over the years.

For the period 1991 to 1995, 8% of the licensed commercial fishermen who participated in the MHI bottomfish fishery reported catches from Penguin Bank (WPRFMC 1996). Penguin Bank has long been known to support a productive bottom "handline" fishery for snappers and groupers. It is also a popular bottomfish fishing ground for recreational anglers. However, the magnitude and value of the recreational landings, while significant, are poorly documented (Friedlander 1996). However, Holland (1985 in Friedlander 1996) noted that the Kewalo Basin charter fishing fleet uses Penguin Bank as one of its major fishing areas. Offshore and inshore fishing gear are used on Penguin Bank in about equal importance. Table 3.11 lists, in decreasing order of catch, offshore gear and inshore gear. Table 3.12 lists the most common reef/inshore fish species reported in commercial landings from Penguin Bank over the past decade, by five-year periods. Catches for most species are generally comparable for both periods with slightly less taken in the last period (1995-2000). Sharks appear to have been under-reported in the earlier period (1991-1995).

Table 3.13: Average percentage of total MHI commercial catch and average commercial catch of major bottomfish species harvested from Penguin Bank. Sources: WPRFMC (1996) and unpublished data from HDAR.

	Average annual percent of total MHI catch		Average annual catch (lbs)
	1980-1984	1991-1995	1997-1999
Opakapaka	9.63	16.11	20,609
Uku	12.06	44.04	28,785
Onaga	14.87	20.24	9,277
Ehu	12.15	17.60	3,380
Hapuupuu	4.31	6.64	905

Limited information is available on coral reef fish community structure at Penguin Bank. An investigation of deepwater artificial reefs on the bank, using manned submersibles, recorded 62 taxa (25 families), of which 32 were considered resident, 25 transient, and five incidental (Friedlander 1996). Estimates of mean biomass ranged from 3-290 mt/km^2 for resident species to 90-2,460 mt/km^2 for transient species. However, these estimates are considered high for the area, since several studies have shown that artificial reefs tend to support a higher biomass than natural reefs under similar circumstances.

An investigation of the deepwater macroalgal community, using a manned submersible, provides information on algae at Penguin Bank (Agegian and Abbott 1985). The bank consists of a broad carbonate platform (~60m deep) covered with loose carbonate rubble and coarse sediments from the calcareous green alga, *Halimeda.* The algal community, comprising 54 species, is characterized by two deepwater species and many species that occur in shallow water. The deeper areas of the bank (182 m) are dominated by crustose coralline algae.

When reef-associated species that are presently managed under other Council FMPs are excluded from the analysis, almost all of the coral reef fisheries in Hawaii take place in inshore (state) waters in the MHI (Friedlander 1996). For example, in Hawaii less than 12% of the inshore fishes are caught in federal waters, based on reported commercial catch from 1991-1995. Similarly, only 18% of molluscs, 1% of seaweeds, and no echinoderms are harvested in federal waters. Of the crustaceans, less than 50% of the reported commercial catch of kona crab—or 14,191 lbs. valued at $57,436—were taken in federal waters on Penguin Bank. Overall, only 1% of total catch, measured either by weight or value, comes from EEZ waters.

The top species by weight and value in the DAR inshore fish category were soldierfishes (*Myripristis* spp.), parrotfish (*Scarid* spp.), surgeonfishes (including *Acanthurus dussumieri, A. trostegus* and *Naso* spp.) and goatfishes (including *Mulloidichthys* spp.). Inshore fishermen target some of these species (especially the goatfishes *Parupeneus porphyreus* and *P. cyclostomus*), since they can fetch a high price in some seasons (Friedlander 1996). *Tilapia* spp. ranked high in terms of catch, but because it sells for a low price, it does not rank very high in terms of value. In the MHI, 89% of the catch of these species came from state waters.

Crabs are also an important group for commercial, recreational, and subsistence fishermen in Hawaii, with a mean annual commercial value of $182,182 (Friedlander 1996). The dominant species in the catch is kona crab (*Ranina ranina*) with more than 28,000 lbs. caught annually. By weight, 51% of kona crab are caught on Penguin Bank, which has long been an important location for kona crab net harvests of (Onizuka 1972). In contrast, almost all of the other crabs species were caught less than 2 nm from shore in the MHI.

Surveys of the NWHI demonstrate that coral reefs are in good condition with high standing stocks of many reef fish. Nearshore coral reefs receive little human use because of their remoteness, exposure to harsh seasonal ocean conditions, and their protected status as part of a national wildlife refuge. Most of the shallow reefs of the NWHI lie within the boundaries of the State of Hawaii, where access and resource use controlled by special permit.

There is a long history of fishing in the NWHI. Iverson *et al.* (1989) found ample evidence of fishing by the ancient Hawaiians as far northwest as Necker Island. Starting in the 1920's, a handful of commercial boats ventured into the NWHI to fish for shallow and deepwater bottomfish, spiny lobsters, and other reef and inshore species. Black-lipped pearl oysters at Pearl and Hermes Reef in the NWHI were overfished in the late 1920's and recent surveys indicate that stocks have still not recovered, perhaps due to a lack of suitable oyster shell habitat (Green 1997). Efforts to restock this species at this site are under consideration by the USFWS. As discussed in the previous section, from the late 1940s to the late 1950s, there was a fishery for *akule* and reef fish around French Frigate Shoals and Nihoa Island.

During the 1960's, and as recently as 1978, Asian fleets harvested tuna, billfish, precious corals, and groundfish in and around the NWHI using longliners, pole-and-line vessels, draggers, and trawlers. Foreign fleets were not excluded from the 200-mile EEZ surrounding the islands until after the Fishery Conservation and Management Act was signed into law in 1976, and the Council began developing management plans for domestic fisheries in 1978. Even so, over the two decades from 1965 to the late 1980's, dozens of foreign vessels intermittently and illegally harvested precious corals in the waters around the NWHI. Because they used tangle-net bottom dredges, much deepwater habitat was destroyed (Grigg 1993).

As discussed in the previous section, both the deep-slope bottomfish and lobster fisheries grew rapidly, beginning in the early 1980s. Both fisheries have declined from peaks late in that decade. They are now managed by the Council under limited access programs that fix the number of permits. The lobster trap fishery is also subject to a harvest quota, set annually at 13% of MSY, and it is one of the most intensively managed U.S. EEZ fisheries. Conservative management measures reduce the risk of overfishing and help prevent protected species interactions. The lobster fishery is managed for low fishing mortality, which is spread across a wide geographic region. However, the population structure of the lobster population in the region as a whole and the magnitude of oceanographic changes on the recruitment dynamics of the population are not fully understood. Spiny and slipper lobsters are harvested at many banks and on reefs deeper than 10 fathoms. The lobster trap fishery catches octopus and hermit crabs incidentally. But the incidental catch of reef fish is minimal because the lobster traps have escape vents. Bank-by-bank allocation of the 1999 harvest guideline caused permit holders in the lobster trap fishery to distribute effort into new trapping sites, including some areas where retrieval of trap lines may damage live coral.

Currently, there are no other major fisheries in the NWHI. Commercial trolling for *ono* occurs seasonally in some areas of the NWHI. For a short time in 1999, experimental fishing for coastal sharks was permitted. Many of the shallow reefs are in the NWHI are within the National Wildlife Refuge and will likely remain off limits to fishing. Chapter 5 of the EIS discusses documented and potential fisheries interactions with protected species in the NWHI. Occasional visitors, including federal government personnel and contract workers at Midway, sometimes fish recreationally in the NWHI. However, Midway is considered part of the PRIAs and recreational development is discussed in that section.

The most serious problems in the NWHI at present are accumulation of marine debris, vessel groundings, and oil spills. Most of the debris is derelict gear lost from North Pacific fisheries. In addition to the physical damage to coral reefs, the debris entangles protected species, ghost fishes, and may introduce alien marine species (Green 1997). Prior military occupation has resulted in significant impacts at Kure Atoll, Midway Islands, and French Frigate Shoals due to dredging, filling, and contamination by the release of toxins from dumped transformers (Green 1997).

Pacific Remote Island Areas

Socio-economic Overview

During the nineteenth century, the United States and Britain actively mined guano deposits on Howland, Jarvis, and Baker Islands. They became possessions of the U.S. in 1936, and have been under the jurisdiction of the Department of the Interior since that time. From 1935 to 1942, the three islands were occupied by Hawaiians, sent to consolidate U.S. claims. They were used as weather stations and military outposts during World Was II, and debris from that period remains. The three atolls are presently National Wildlife Refuges administered by the U.S. Fish and Wildlife Service. They are uninhabited but visited periodically by scientists, researchers and, occasionally, expeditions of ham radio operators. Entry is controlled by special permit.

Palmyra was claimed by the American Guano Company in 1859. It was annexed to the Kingdom of Hawaii in 1862, but became privately owned in 1911. In 1922, the Fullard-Leo family purchased it. It was later annexed to the United States, but specifically excluded from the Territory and State of Hawaii. In the late 1930's, in preparation for World War II, a seaplane base and other defense facilities were constructed on Palmyra. The U.S. Navy or other federal installations continuously occupied the atoll until 1949. It was also used for nuclear testing programs in 1962. The Navy's attempt to regain control of Palmyra after World War II ended with a U.S. Supreme Court decision to return the atoll to the private owners, the Fullard-Leo family, who also claim ownership of Kingman Reef. In January 2001, The Nature Conservancy negotiated exclusive purchasing rights to Palmyra Island with the Fullard-Leo family. They report that two-thirds of the island will eventually be designated a National Wildlife Refuge, run by the USFWS, and one-third will be used for ecotourism. On January 18, 2001, the Secretary of the Interior, through Secretarial Order 3223, declared Kingman Reef and the surrounding submerged lands and waters as a National Wildlife Refuge out to a distance of 12 nm. Secretarial Order 3224, issued the same day, declared the tidal waters and submerged lands and waters of Palmyra Atoll as a national wildlife refuge out to a distance of 12 nm. The MSFCMA establishes the Council's jurisdiction over EEZ waters surrounding Palmyra to the mean high water mark, including the waters of the lagoon and the area within the 12 nm refuge boundaries.

The written historical record provides no evidence of prehistoric populations on Wake Island, but Marshall Islanders occasionally visited Wake, giving it the name Enenkio. The island was annexed by the United States in 1899. Before the 1930's the only visitors were scientists and

survivors of shipwrecks. The Navy received administrative control of Wake in 1934, and established an air base on the atoll in January 1941. Wake Island figured prominently in World War II. The U.S. re-occupied the atoll after the war, and administrative authority was held by the Federal Aviation Administration until 1962, when it was transferred to the Department of the Interior, which in turn assigned authority to the U.S. Air Force. Since 1994, the Department of the Army has maintained Administrative use of Wake Island.

In 1858, both Hawaii and the U.S. claimed Johnston Atoll. Guano deposits found on the island were exploited for a short period in the nineteenth century. Johnston Atoll is still controlled by the U.S. military. Starting in the late 1940's, Johnston Atoll played an important role in the U.S. nuclear testing program. In 1962, three rockets accidentally exploded on or above Johnston Island. Chemical munitions have been stockpiled on Johnston Atoll for storage and destruction by means of a specially designed chemical munitions incinerator.

A recently established eco-tourism operation in the Midway Atoll National Wildlife Refuge has improved public access to the NWHI. An agreement between Midway Phoenix Corporation and the USFWS allows up to 100 people to visit the atoll each week. These visitors normally get to Midway by air, on charter flights from Honolulu. Typical activities include charter fishing, diving, and wildlife observation. The company emphasizes this last activity in its promotional material, promoting wildlife tours that let visitors "gain first hand knowledge of the albatross, resident seabirds, migrant shorebirds, threatened green turtles and endangered Hawaiian monk seals." The Public Use Plan for the Refuge outlines other outdoor recreational activities—including shoreline fishing, lobstering, night diving, night fishing, kayaking tours, and glass-bottom boat excursions—that could be offered to visitors in the future (USFWS 1997). These activities should result in increased recreational use of NWHI marine resources. Because of their location and history, no genuine community participation in coral reef fisheries can be identified for the PRIAs. The next section discusses coral reef resource use by part-time residents on these islands and atolls.

Historical and Present Coral Reef Uses

Little is known about the present status of coral reefs in most of the remote U.S. island possessions, although anecdotal reports suggest that they are mostly in good condition. Localized impacts on coral reefs have occurred due to coastal construction and pollution on some islands occupied by the U.S. military. Hurricanes and starfish infestations have occasionally affected some areas.

Fishing is light in most areas. Hawaii-based vessels have been reported to make sporadic commercial fishing trips to Palmyra and Kingman Reef for bottom fishing, harvesting coastal sharks for finning,. The past extent of harvesting by passing yachts or poaching by foreign fishing vessels is unknown (Green 1997). Since May 2000, the Nature Conservancy has been conducting small scale experimental ecotourism activities, including, diving, snorkeling, kayaking, fishing, and wildlife photography. The Nature Conservancy has also proposed establishing an inshore/offshore sportfishing operation. It would include a catch-and-release

program for pelagic species, bonefish (*Albula* spp.), and other reef fish, particularly the giant trevally (*Caranx ignoblis*). The proposal also includes monitoring of fish stocks, and conducting biological investigations on the migratory, reproductive, and recruitment patterns of those stocks (Chuck Cook pers. comm. 2001). Data on catch and effort from the recreational fishing will also be recorded. In addition, pursuant to a license agreement with the Nature Conservancy, Palmyra Pacific Seafoods, LLC has established and is currently operating a commercial fishing operation on Palmyra Atoll. Palmyra Pacific Seafoods, LLC is operating under rights granted to it by the Fullard-Leo family, and its existing fishing areas and business interests include the resources in the vicinity of Kingman Reef (F. Sorba, pers. comm 2001).

There are no permanent residents on any of these islands, although on Wake and Johnston there are temporary work forces who have a long history of recreational fishing and shell collecting. The fishery at Johnston Atoll was described over a six-year period (1985–1990), based on the results of a creel census by Irons *et al.* (1990). They found that long-term 'residents' —almost all employees of the prime contractor for Johnston Atoll operations—did most of the fishing and thus produced a large proportion of the catch. These residents fished for enjoyment, to add fresh fish to their diet, and to accumulate fish to take home on leave. The remainder of the catch was harvested by 'transients,' military personnel and contractors stationed on the island for one or two years. However, through cooperative management between the USFWS and the military, the practice of shipping coolers of fish back to Hawaii by workers stationed on the atolls was stopped. Likewise, the collection and shipment of live corals by recreational divers were also stopped.

Irons *et al.* (1990) reported that the soldierfish (*Myrispristis amaenus*) composed the largest proportion of reef fish catch at Johnston (see Table 72 in Green 1997). Other important fish species included bigeyes (*Priacanthus cruentatus*), flagtails (*Kuhlia marginata*), mullet (*Chaenomugil leuciscus*), goatfishes (*Mulloides flavolineatus, Pseudupeneus bifasciatus, P. cyclostomus*, and *P. multifasciatus*), jacks (*Caranx melampygus* and *Carangoides orthogrammus*), parrotfish (*Scarus perspicillatus*), surgeonfishes (*Acanthurus triostegus* and *Ctenochaetus strigosus*), and bigeye scad (*Selar crumenophthalmus*). Gear types varied with the target species and included hook-and-line fishing, spearfishing and throw nets. All of the more heavily fished areas at Johnston are located in nearshore waters. Irons *et al.* (1990) also noted that recreational divers at Johnston collected pieces of coral for souvenirs. *Acropora cytherea* and the hydrocoral *Distichopora violacea* were the two main species collected, although smaller quantities of *Acropora valida, Millepora* and *Fungia* were also collected.

The original Johnston Atoll has been extensively modified by dredging and filling. An estimated 4 million square meters of coral were destroyed by construction, and an additional 25 million square meters were damaged by the resulting sedimentation. By 1964, dredge and fill operations had enlarged the original island by over tenfold and had added two manmade islands. Fishing regulations have changed at Johnston Atoll in recent years because of concerns that fish were being exported and that coral collecting had become excessive and was incompatible with the philosophy of the refuge (Green 1997). Current DOI policy prohibit coral collecting and the export of any reef fish or invertebrates from the island. However, collection of selected

organisms and shells is permitted in restricted areas by recreational divers. Since Johnston is a closed military base, only local residents engage in such activities. No recent fisheries statistics are available for the area.

National Wildlife Refuges have been established at Baker, Howland and Jarvis Islands, Palmyra Atoll Kingman Reef and Johnston Atoll. Natural resources are managed by the USFWS and access is by special use permit only. Wake Atoll is also a candidate for National Wildlife Refuge status.

3.7 Magnuson-Stevens Fishery Conservation and Management Act Definition of Communities

The MSFCMA requires that FMPs take into account the importance of fishery resources to fishing communities, in order to provide for the sustained participation of such communities and to the extent practicable, minimize adverse economic impacts on them. For the purposes of the Coral Reef Ecosystems FMP there are no communities substantially engaged in, or substantially dependent, on the harvesting and processing of coral reef resources from the EEZ, as defined by the MSFCMA.

CHAPTER 4

SPECIFICATION OF MSY, OY AND OVERFISHING, AND DOMESTIC HARVESTING AND PROCESSING CAPACITY

4.1 Introduction

Sections 301, listing National Standards, and 303 of the Magnuson-Stevens Fishery Conservation and Management Act specify required provisions of fishery management plans. First and foremost, an FMP must describe how management measures will prevent overfishing and achieve optimum yield for managed stocks (§301(a)(1) and §303(a)(1)(A)). It must also describe how much of the optimum yield can be harvested by domestic vessels and how much can be processed domestically (§303(a)(4)). Since it is usually impossible to measure stock size directly, managers must identify various indirect measures, or indicators, that they can use to determine stock status, the impact of fishing, and the degree to which the stock is being fished at optimum yield. They must then develop a set of control rules that specify how management action should respond to any given indicator value. Most importantly, if the indicators suggest that a stock is being overfished, managers need to take action to reduce fishing pressure and begin rebuilding stocks. This chapter discusses how measures of stock condition—maximum sustainable yield (MSY), optimum yield (OY), and overfishing—have been developed, and the indicators that will be used to determine these levels. It also specifies how much of the optimum yield domestic fishermen are capable of harvesting and how much can be processed domestically.

As detailed in Chapter 2 of this FMP, the coral reef ecosystem consists of thousands of species; regulation of the enormous number of species with individual harvest control rules would prove unwieldy, and it is unnecessary. One strategy taken in this FMP, described in Section 1.6.2, is to divide the coral reef ecosystem management unit into two groups, Currently Harvested Coral Reef Taxa (CHCRT) and Potentially Harvested Coral-Reef Taxa (PHCRT). This division of the management unit focuses attention on and helps to prevent overfishing of currently harvested taxa. For those taxa for which scientists have limited data, it will make it easier to get the scientific data needed to estimate biological reference points. For CHCRT, available catch and effort data will be used to estimate reference points. If insufficient data exist for a given species, data from similar areas or species will be used instead to estimate reference points. If there is absolutely no information that can be brought to bear, then reference points may be estimated by proxy using data collected from the developing fishery. As fisheries for PHCRT develop, those taxa will be moved to the CHCRT category.

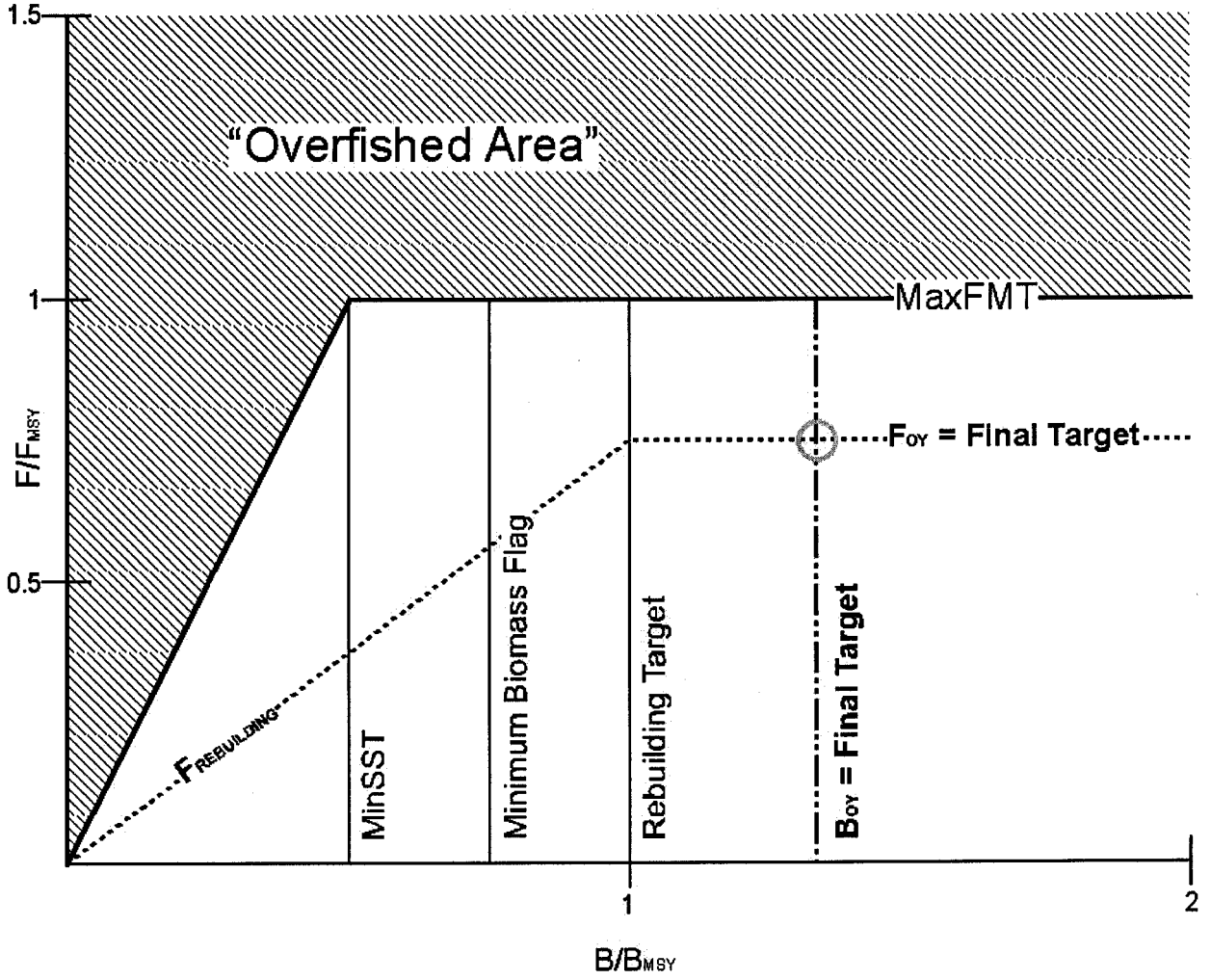


Figure 4.1: Representation of MSY, OY, and overfishing.

4.2 MSY, OY, and Overfishing

The goal of the MSFCMA is to ensure long-term fishery sustainability by halting or preventing overfishing, and by rebuilding any overfished stocks. By definition, overfishing occurs when fishing mortality (F) is higher than the level at which fishing produces maximum sustainable yield (MSY). MSY is the maximum long-term average yield that can be produced by a stock on a continuing basis. A stock is overfished when stock biomass (B) has fallen to a level substantially below what is necessary to produce MSY. So there are two aspects that managers must monitor to determine the status of a fishery: the level of F in relation to F at MSY (F_{MSY}), and the level of B in relation to B at MSY (B_{MSY}).

The technical guidance document for National Standard 1 (Restrepo *et al.* 1998) requires that "control rules" be developed that identify "good" versus "bad" stock conditions. It also requires that control rules describe management action that will influence a control variable (e.g., F) as a

function of some stock size variable (e.g., B), to achieve "good" stock conditions. Each control rule must identify reference points called "status determination criteria": one for F that identifies when overfishing is occurring, and one for B that indicates when the stock is overfished. The status determination criterion for F is the maximum fishing mortality threshold (MaxFMT). Minimum stock size threshold (MinSST) is the status determination criterion for B. When F/F_{MSY} exceeds the MaxFMT, overfishing is occurring, and when B/B_{MSY} falls below MinSST the stock is overfished. When either of these two conditions occur, NMFS must notify Congress that the stock is overfished, and fishery managers must take action to halt overfishing, and rebuild the stock. A reasonable MSY control rule template for application to western Pacific coral reef ecosystems may be derived from the default MSY control rule suggested by Restrepo *et al.* (1998).

Managers must exert some control over F/F_{MSY}, the y-axis labeled in Figure 4.1, which is a function of B/B_{MSY} on the x-axis. The default MaxFMT recommended by the technical guideline document cited above is an upper limit set at F_{MSY}, shown as a horizontal line at 1 = MaxFMT = F/F_{MSY}. In applying the MSY control rule, fishing effort—expressed as the ratio F/F_{MSY}—must not be allowed to exceed the MaxFMT, although a stock with a biomass well above B_{MSY} can support larger F values for a limited time, while B declines towards B_{MSY}. Other types of control rules would allow higher F levels under specified conditions, but such rules require reliable measures of B and a very good understanding of stock dynamics.

The MinSST is shown in Figure 4.1 by a vertical line at a biomass level substantially below B_{MSY}. This allows for some natural fluctuation of biomass around B_{MSY} under an MSY harvest policy. When B falls below MinSST, however, the stock is considered to be overfished and then F must be reduced below the MaxFMT by an amount that depends on the severity of the stock depletion, the stock's capacity to rebuild, and the desired recovery time for the stock. A minimum biomass flag (see Figure 4.1) should also be defined so that if B drops below it, managers are prompted to implement remedial action before biomass reaches the MinSST.

When stock biomass falls below the MinSST, fishery councils are required to develop stock rebuilding plans. Different control rules may be used in rebuilding plans. A precautionary approach dictates that managers follow an "optimal yield" (OY) control rule, as illustrated by the line labeled $F_{REBUILDING}$ in Figure 4.1. OY is MSY as reduced by relevant socioeconomic factors, ecological considerations, and fishery biological constraints to provide the greatest long-term benefits to the nation. Under the suggested OY control rule (adapted from the Restrepo *et al.* 1998 default guidelines), when B is below B_{MSY}, F is controlled as a linear function of B, until a rebuilding target of B_{MSY} is reached at F_{OY}. A final OY target (B_{OY}) somewhat greater than B_{MSY} is achieved by keeping fishing effort at F_{OY} (see Figure 4.1). Simulation results show that when fisheries are managed at F_{OY}, equilibrium biomass will be maintained at about 1.30 B_{MSY} and resulting equilibrium yield (OY) will be at about 95% of MSY (Mace 1994).

4.3 Application of the MSY Control Rule to the Coral Reef Ecosystem

4.3.1 Overfishing Criteria in Coral Reef Ecosystems

It is difficult to determine overfishing criteria for coral reef fisheries because the coral reef ecosystem contains many species and this produces a complex web of ecological interrelationships. Russ (1991) defines four non-mutually-exclusive overfishing categories:

- growth overfishing, which occurs when fishing intensity prevents fish from reaching older age classes;
- recruitment overfishing, which occurs when the spawning stock of a population is reduced below the level at which adequate reproduction can maintain the population;
- economic overfishing, which occurs when a fishery is no longer cost-effective; and,
- ecosystem overfishing, which occurs when fishing pressure causes changes to the species composition in a multi-species setting, often resulting in changes in ecosystem function (DeMartini *et al.* 1996).

The Council manages most other EEZ fisheries through its four implemented FMPs. These FMPs have used either the recruitment overfishing model to identify overfishing criteria—such as spawning potential ratio, or SPR—or the growth overfishing model, using MSY methods. However, the ecosystem overfishing concept, detected by shifts in species composition or trophic web dynamics, may be most appropriate for the CRE-FMP. This approach can guard against single-stock recruitment overfishing, where applicable. Because the coral reef ecosystem is a multi-species community with a long coevolutionary history, removing certain species—if it reduces species diversity—could lead to the unwanted predominance of often less valuable generalist species. Changes in species dominance patterns in coral reefs experiencing fishing pressure have been reported for a number of tropical stocks from various areas around the world. It is also well known that the sensitivity of multi-species systems to environmental fluctuations increases as the level of exploitation increases.

4.3.2 Estimating Reference Points With Limited Data

Available biological and fishery data are poor for all species and island areas covered by the CRE-FMP. Data collection systems are managed by the local island governments, and they vary widely in format and coverage. Data are generally restricted to commercial landings records for a handful of species. Total effort cannot be adequately partitioned between the various management unit species (MUS) for any fishery or area. Biomass, maximum sustainable yield, and fishing mortality estimates are not available for any single MUS. Even though it seems likely that fisheries targeting coral reef ecosystem resources will continue to expand, possibly into the EEZ, there is scant information on the life histories, ecosystem dynamics, fishery impact, community structure changes, yield potential, and management reference points for many coral reef ecosystem species.

Once these data are available, fishery managers will then be able to establish limits and reference points based on the multi-species coral reef ecosystem as a whole. In accordance with the National Standard guidelines cited above, whenever possible, the MSY control rule should be applied to the individual species in a multi-species stock. When this is not possible, MSY may be specified for one or more species; these values can then be used as indicators for the multi-species stock's MSY. Clearly, any given species that is part of a multi-species complex will respond differently to an OY-determined level of fishing effort (F_{OY}). Thus, for a species complex that is fished at F_{OY}, managers still must track individual species' mortality rates in order to prevent species-specific population declines that would lead to strict protection, as required by the Endangered Species Act. For the fisheries encompassed by the CRE-FMP, the multi-species complex as a whole will be used to establish limits and reference points for each area. Where possible, available data for a particular species will be used to evaluate the status of individual MUS stocks in order to prevent recruitment overfishing. When better data and the appropriate multi-species stock assessment methodologies become available, all stocks will be evaluated independently, without proxy. Spatial bounds will initially follow the five island groups that are part of the management area,[1] but will be refined as stock bounds and ecosystem structure become better understood.

Coral reef fishery scientists have used several approaches to model multi-species fisheries with varying levels of success. These have been discussed in Section 2.4. Briefly, the simplest approach has been to consider a community to be the sum of its species. But the coral reef ecosystem is too complex to use these methods. Instead, the system can be divided into separate trophic levels to model energy flow and estimate potential yields. The ECOPATH model, discussed in Section 2.4, is based on this approach (Polovina 1984). When coupled with another computer model, ECOSIM, which uses output from ECOPATH, abundance of both target and non-target species can be estimated when different levels of fishing pressure are applied to the system (Kitchell *et al.* 1999). It may be possible to use these models in the future, but right now there is not enough data on coral reef species and fisheries to use them.

4.3.3 Establishing Reference Point Values

Standardized values of catch per unit effort (CPUE) and effort (E) will be used to establish limit and reference point values, which will act as proxies for relative biomass and fishing mortality, respectively. Limits and reference points will be calculated in terms of $CPUE_{MSY}$ and E_{MSY} included in Table 4.1.

[1]American Samoa, CNMI, Guam, Hawaii, and the PRIAs. See Section 1.6.1 for a description of the management area.

Table 4.1. CPUE-based overfishing limits and reference points for coral reef species.

Value	Proxy	Explanation
MaxFMT (F_{MSY})	E_{MSY}	0.91 $CPUE_{MSY}$
F_{OY}	0.75 E_{MSY}	suggested default scaling for target
B_{MSY}	$CPUE_{MSY}$	operational counterpart
B_{OY}	1.3 $CPUE_{MSY}$	simulation results from Mace (1994)
MinSST	0.7 $CPUE_{MSY}$	suggested default (1-M)B_{MSY} with M=0.3*
B_{FLAG}	0.91 $CPUE_{MSY}$	suggested default (1-M)B_{OY} with M=0.3*

*interim value of M=0.3 is applied.

When reliable estimates of E_{MSY} and $CPUE_{MSY}$ are not available, they will be estimated from the available time series of catch and effort values, standardized for all identifiable biases using the best available analytical tools. $CPUE_{MSY}$ will be calculated as one-half a multi-year moving average reference CPUE ($CPUE_{REF}$). This value has not been finalized yet; however, preliminary values from the types of data presently available for Hawaii are shown in Figures 4.2a-c. These are time series of data from the State of Hawaii commercial catch reports, screened to include only CHCRT from all gear types for the entire area of the MHI. CPUE is estimated as the aggregate weight reported for that year, divided by the number of records for that year. A twenty-year time window is used for the multi-year average. Figure 4.2a presents all CHCRT in aggregate. Figure 4.2b is for *menpachi* (*Myripristis* spp.) while 4.2c is for *weke* (*Mulloidichthys* spp.). These two latter examples were chosen because they are well-represented in the catch report database. $CPUE_{REF}$ and E_{MSY} could be estimated directly from this, as shown in the figures. Alternatively, following Restrepo *et al.* (1998), they could be estimated as $E_{MSY} = E_{AVE}$, where E_{AVE} represents the long-term average effort prior to declines in CPUE. When multiple estimates are available, the more precautionary value will be used. All values will be calculated using the best available data. When new data become available, reference point values will be recalculated.

Figure 4.2a: Time series of aggregate CHCRT CPUE from HDAR data.

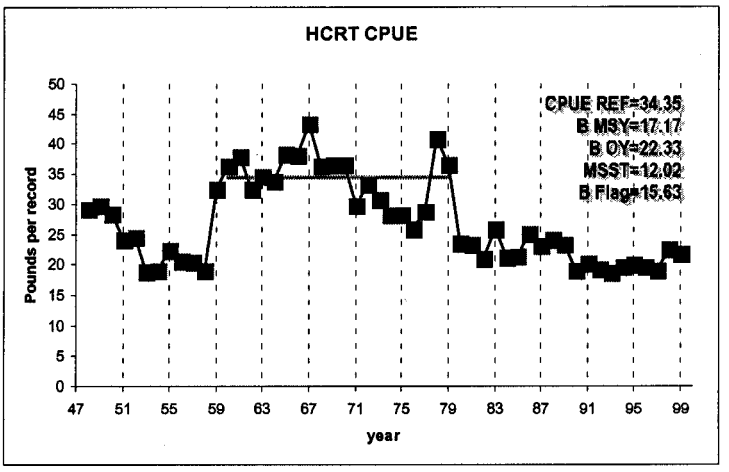


Figure 4.2b: Time series of menpachi (*Myripristis* spp.) CPUE from HDAR data.

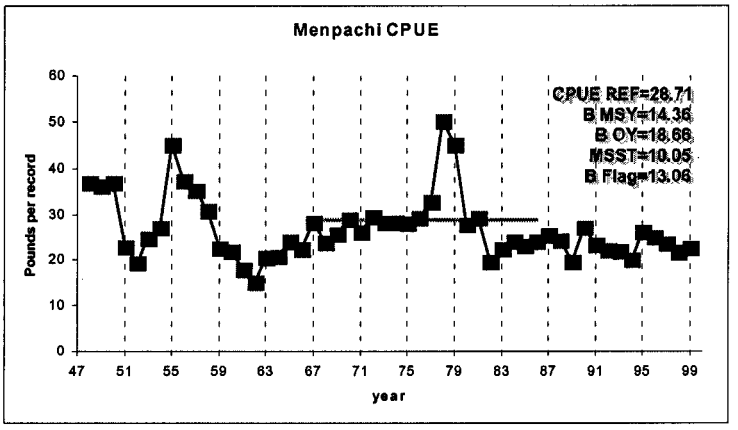
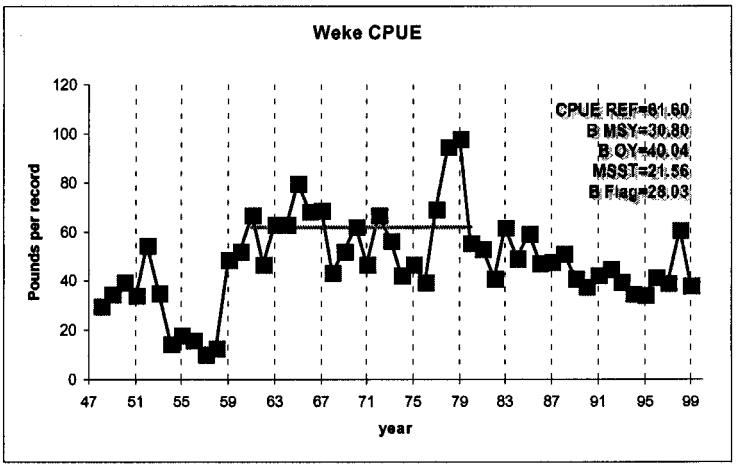


Figure 4.2c: Time series of weke (*Mulloidichthys* spp.) CPUE from HDAR data.



4.3.4 Preventing Recruitment Overfishing

The limits and reference points illustrated in Figure 4.2 can be applied to both multi-species stocks and to individual component species stocks, realizing however, that much of the data in the State of Hawaii commercial catch reports are often at the genus or family level. As stated earlier, while managing the multi-species stock to provide maximum benefit, fishery managers must also ensure that the resulting fishing mortality rate does not reduce any individual species stock to a level requiring protection under the Endangered Species Act. Preventing recruitment overfishing on any component stock will satisfy this need in a precautionary manner. Best available data will be used for each fishery to estimate these values. These reference points will be related primarily to recruitment overfishing and will be expressed in units such as spawning potential ratio or spawning stock biomass. However, no examples can be provided at present. Species for which managers have collected extensive survey data and know their life history parameters, such as growth rate and size at reproduction, will be the best candidates for determining these values.

4.3.5 Preventing Ecosystem Overfishing

Using the best available data, managers will monitor changes in species abundance and/or composition. They will pay special attention to those species they consider important because of their trophic level or other ecological importance to the larger community. For Hawaii, a preliminary approach aggregates HDAR data into two five-year bins for comparison, an early bin comprising 1948-1952 and a recent bin comprising 1995-1999. Table 4.2, which may be found at the end of this chapter, ranks CHCRT based on their proportion of total landings in the 1948-1952 data bin. Although it is difficult to draw conclusions from this exercise, it does show, in a preliminary way, how in an exploited ecosystem species composition has changed over time.

4.4 Specification of Harvesting and Processing Capacity

Section 303(a)(4) of the MSFCMA requires that all FMPs "assess and specify– (A) the capacity and the extent to which fishing vessels of the United States, on an annual basis, will harvest the optimum yield..., (B) the portion of such optimum yield which, on an annual basis, will not be harvested by fishing vessels of the United States and can be made available for foreign fishing, and (C) the capacity and extent to which United States fish processors, on an annual basis, will process that portion of such optimum yield that will be harvested by fishing vessels of the United States."

Information used to compile this FMP, together with information in the other Western Pacific Council's FMPs and related documents, was examined to assess and specify the U.S. fishing and processing capacity in this region. FMPs from other regions and related documents, including *Our Living Oceans* (NMFS 1999) (available online at http://spo.nwr.noaa.gov/olo99.htm) provided additional information on U.S. harvesting and processing capacity. This information clearly indicates that fishing vessels of the U.S. currently have the capacity to harvest the optimum yield on an annual basis. As such, no part of the optimum yield will be made available for foreign fishing. Similarly, the capacity of U.S. fish processors is of sufficient size to process the entire optimum yield.

Table 4.2: Change in landings for selected Hawaii CHCRT, 1948-1952 compared to 1995-1999. Species are ranked based on 1948-1952 landings.

Hawaiian, English & Latin names	1948-1952 aggregate			1995-1999 aggregate		
	Pounds	%	Rank	Pounds	%	Rank
Menpachi, soldierfish (*Myripristis* spp.)	415,252	18.54	1	218,781	15.04	1
Amaama, striped mullet (*Mugil cephalus*)	321,480	14.35	2	27,285	1.88	12
Weke, yellow goatfish (*Mulloidichthys* spp.)	305,108	13.62	3	148,149	10.18	4
Moano, banded goatfish (*Parupeneus spp.*)	172,493	7.70	4	20,656	1.42	19
Wekeula, Pflugers goatfish (*Mulloidichthys* spp.)	101,189	4.52	5	104,909	7.21	5
Moi, threadfin (*Polydactylus sexfilis*)	96,385	4.30	6	5,126	0.35	28
Manini, convict tang (*Acanthurus triostegus*)	88,335	3.94	7	70,448	4.84	7
Kumu, whitesaddle goatfish (*Parupeneus porphyreus*)	86,445	3.86	8	23,620	1.62	13
Kawelea, Hellers barracuda (*Sphyraena helleri*)	84,075	3.75	9	15,589	1.07	21
Kaku, great barracuda (*Sphyraena barracuda*)	82,062	3.66	10	14,847	1.02	22
Tako, octopus (*Octopus* spp.)	80,950	3.61	11	98,016	6.74	6
Uhu, parrotfish (*Scaridae*)	49,795	2.22	12	159,252	10.95	3
Pualu, yellowfin surgeonfish (*Acanthurus xanthopterus, A. blochii*)	46,338	2.07	13	28,020	1.93	11
Palani, eyestriped surgeonfish (*Acanthurus dussumieri*)	43,054	1.92	14	165,164	11.35	2
Aweoweo, bigeye (Priacanthidae)	32,058	1.43	15	22,133	1.52	14

Table 4.2 (cont.)

Hawaiian, English & Latin names	1948-1952 aggregate			1995-1999 aggregate		
	Pounds	%	Rank	Pounds	%	Rank
Aholehole, flagtail (*Kuhlia sandvicensis*)	31,637	1.41	16	21,627	1.49	18
Kala, unicornfish (*Naso* spp.)	27,727	1.24	17	66,686	4.58	8
Nenue, rudderfish (*Kyphosus* spp.)	27,156	1.21	18	56,628	3.89	9
Puhiuha, conger eel (*Conger cinereus*)	20,616	0.92	19	1,378	0.09	33
Aawa, hogfish (*Bodianus bilunulatus*)	20,173	0.90	20	13,576	0.93	25
Nabeta, razorfish (*Xyrichthys* spp., *Cymolutes lecluse*)	17,559	0.78	21	22,014	1.51	15
Mu, porgy (*Monotaxis grandoculis*)	15,937	0.71	22	11,479	0.79	26
Uouoa, false mullet (*Neomyxus leuciscus*)	15,873	0.71	23	2,658	0.18	30
Humuhumu, triggerfish (Balistidae)	14,460	0.65	24	873	0.06	36
Kamanu, rainbow runner (*Elagatis bipinnulatus*)	10,540	0.47	25	21,867	1.50	17
Maiko, bluelined surgeonfish (*Acanthurus nigroris*)	10,067	0.45	26	17,953	1.23	20
Alaihe, squirrelfish (*Neoniphon* spp., *Sargocentron* spp.)	9,718	0.43	27	1,376	0.09	34
Panuhunuhu, parrotfish (*Calotomus* spp.)	8,117	0.36	28	5,316	0.37	27
Kupoupou, cigar wrasse (*Cheilio inermis*)	2,035	0.09	29	227	0.02	39
Kihikhi, Moorish idol (*Zanclus cornutus*)	1,768	0.08	30	0	0.00	43

Table 4.2 (cont.)

Hawaiian, English & Latin names	1948-1952 aggregate			1995-1999 aggregate		
	Pounds	%	Rank	Pounds	%	Rank
Naenae, orangespot surgeonfish (*Acanthurus olivaceus*)	945	0.04	31	28,590	1.97	10
Amaama, summer mullet (*Moolgarda engeli*)	376	0.02	32	421	0.03	38
Pakuikui, Achilles tang (*Acanthurus achilles*)	253	0.01	33	2,233	0.15	32
Kole, goldring surgeonfish (*Ctenochaetus strigosus*)	65	0.00	34	13,882	0.95	23
Maikoiko, whitebar surgeonfish (*Acanthurus leucopareius*)	44	0.00	35	0	0.00	44
Uukanipou, squirrelfish (*Sargocentron spiniferum*)	32	0.00	36	873	0.06	37
Pala, Yellow tang (*Zebrasoma flavescens*)	23	0.00	37	47	0.00	41
Lauwiliwili, longnose butterflyfish (*Forcipiger* spp.)	11	0.00	38	1	0.00	42
Wekepueo, bandtail goatfish (*Upeneus arge*)	8	0.00	39	60	0.00	40
Opelu kala, unicornfish (*Naso hexacanthus*)	0	0.00	40	22,001	1.51	16
Munu, striped goatfish (*Parupeneus bifasciatus*)	0	0.00	41	1072	0.07	35
Moanokea, blue goatfish (*Parupeneus cyclostomus*)	0	0.00	42	13,821	0.95	24
Roi, seabass (*Cephalopholis* argus)	0	0.00	43	2,304	0.16	31
Poopaa, hawkfish (Cirrhitidae)	0	0.00	44	3,744	0.26	29

CHAPTER 5

MANAGEMENT REGIME

5.1 Introduction

The preceding chapters have mainly described the setting for management: what areas and taxa will come under the FMP, the nature of the coral reef ecosystem, the way that resources within that ecosystem are used by people in various communities in the region, and the criteria that will be used to assess the status of managed species. This chapter outlines the actions that the Council is implementing to manage fisheries on coral reefs under Council jurisdiction. The overall goal of this management program is to establish a management regime for the entire Western Pacific Region that will maintain sustainable coral reef fisheries while preventing any adverse impacts to stocks, habitat, protected species, or the ecosystem. Developing management objectives that support this goal was an important starting point in determining the kinds of measures that should be implemented. The reader is encouraged to review Section 1.4, which lists and describes these objectives. Just as this whole plan has been shaped by the ecosystem approach advocated by the Ecosystem Principles Advisory Panel (EPAP 1999), the management regime outlined here has been developed with these principles in mind. Section 1.5, describes how this FMP conforms to the eight actions that the Ecosystem Principles Advisory Panel argues should be included in any "fishery ecosystem plan."

Presently, there is little or no fishing or harvesting of coral reef ecosystem species in federal waters of the Western Pacific Region. This is due partly to access restrictions imposed in some coral reef habitat areas by various federal agencies. Within these areas, certain activities may also be restricted through regulations that in effect serve as a *de facto* management program. The management program described here will not supercede any of the valid restrictions imposed by these federal authorities. However, these areas encompass only a small portion of the total coral reef habitat in the region. Thus, most of the coral reef ecosystem in the region is currently not managed. This FMP management regime will strengthen and extend protection and management of the ecosystem to all areas within the region's EEZ.

The coral reef management area includes all EEZ waters (from the surface to the ocean floor) that are outside of state or territorial waters (0-3 nmi) and within 200 nmi from shore. (See Section 1.6.1 for a detailed description of the management area.) The management area includes some areas where the Council shares jurisdiction with other federal agencies, such as National Wildlife Refuges. State waters have also been considered, although the management measures described here will only apply to waters within federal jurisdiction. CRE-FMP management measures are meant to simplify regulations for coral reef areas by developing consistency between the management regimes of these various state and federal entities.

The remainder of this chapter describes the management measures, which fall in four categories. Section 5.2 describes marine protected areas, which would restrict fishing in certain areas. Section 5.3 outlines permitting regimes. This FMP would implement a special permit and reporting regime for certain activities. A less restrictive general permit may be implemented at a later date. Section 5.4 describes gear restrictions that would be imposed on coral reef fisheries. Section 5.5 enumerates several other components of the management regime that are not regulatory measures. These include measures to adapt the management regime to changing conditions, the enforcement program that will support the regime, and non-regulatory measures to facilitate coordination between the various groups and agencies involved in managing EEZ marine resources.

5.2 Marine Protected Areas

Marine protected areas (MPAs) are an attractive option for ecosystem-based fisheries management. The selection of an MPA does not require detailed knowledge of the management unit species in order to holistically conserve multi-species resources and the functional attributes of marine ecosystems. They can also provide "insurance" against periods of poor recruitment of individual stocks.

MPAs can also vary in scope and extent. They can be areas designated for limited use, seasonal use, or areas that are completely restricted from consumptive use (no-take). Although completely restricted areas are thought to provide the highest degree of protection to marine ecosystems, less restrictive areas also provide some protection with fewer economic and social impacts.

The optimum size of an MPA depends on many factors, including the resources managed, management goals, enforcement capabilities, and social and economic constraints. However, researchers do not yet fully understand the relation between the area covered by an MPA and resulting benefits in the form of ecologically complete coral reef ecosystem protection. To be useful to fisheries and to promote the conservation of coral reef resources on a broader scale, MPAs should serve as sources of reproductive output to replenish larger surrounding or down-current areas. The present approach of establishing small and isolated MPAs is inadequate for this purpose.

Few, if any, studies have sought to verify whether MPAs established in the U.S. Pacific Islands do actually benefit nearby fisheries. It is clear that fish populations that build up in small areas temporarily closed to fishing are quickly reduced when fishing is resumed, as evidenced by studies in Hawaii and the Philippines. Existing MPAs in the U.S. Pacific Islands have been criticized for being either too small and fragmented or for not encompassing sufficient depth range and high quality habitat to provide broad coral reef ecosystem protection or recruitment benefits to fisheries.

It has been suggested that linking the populations in different MPAs over a broad area is necessary to assure long-term sustainability of coral reef fisheries. Some argue for complete

protection from fishing, whereas others believe MPAs are more valuable when they can serve as natural laboratories for fishing experiments and to test adaptive management strategies.

In determining the locations in the CRE-FMP, the Council considered the following criteria:

- Natural resource values- biogeographical representation, biodiversity, ecosystem integrity, ecological significance, species maintenance, habitat structure/features, and other special elements;
- Human use and historical values- renewable resources of importance for sustainable uses, recreational resources, research and monitoring, educational and interpretive opportunity, historical and cultural resources, and aesthetic resources;
- Impacts of human activities- observed environmental impacts and projected impacts; and,
- Management concerns- coordination with other programs, size and boundary considerations, accessibility, surveillance and enforcement, economic considerations, network-wide activities, and urgency of threats.

Two types of MPAs will be used to manage coral reef ecosystem fisheries. The first type is the no-take MPA, where all extractive activities, with a few carefully monitored exceptions, will be prohibited. Certain carefully managed fisheries will be allowed in the second type, the low-use MPA. However, as new information is acquired through resource monitoring, the initial MPA designations could be adjusted and additional MPAs added in the future through the adaptive management process.

5.2.1 No-take Marine Protected Areas

Under this plan, no-take MPAs will encompass federal waters shallower than 10 fathoms in the NWHI and waters shallower than 50 fathoms around Jarvis, Howland, Baker, Kingman, Laysan, French Frigate Shoals, the northern half of Midway Atoll, and Rose Atoll in American Samoa. (The Council recognizes the co-management agreement between the Territory of American Samoa and Department of the Interior for the Rose Atoll National Wildlife Refuge (0-3 nm), together with Department of Commerce's jurisdiction to the shoreline.) Figures 5.1 - 5.13 show the locations of the MPAs implemented by this FMP. Detailed maps of each MPA may be found at the end of this chapter. The Crustacean FMP provides additional protection by prohibiting fishing for lobster within 20 miles around Laysan island. Moreover, other restrictions may also apply inside areas managed and regulated by other federal authorities. The locations of no-take MPAs are described in the draft regulations of this FMP (see Section 8.1).

Amendments to Already-implemented FMPs

The CRE-FMP designates no-take marine protected areas within the management area. Commercial, recreational, subsistence, or cultural take of any marine species within these areas is prohibited. No described or undescribed gear is exempt from this designation. Fisheries

managed under the Council's four already-implemented FMPs[1] are mostly exempt from the regulations outlined in this CRE-FMP, and will observe the management regime of their respective FMPs. No-take marine protected areas are the main exception: they will apply to all Council-managed fisheries. Chapter 5 of the EIS accompanying this plan analyzes the impacts of these area closures on these four already-implemented FMPs. To ensure designated no-take MPAs effectively apply to all of the fisheries managed under Council FMPs, each of the four already-implemented FMPs must be amended to ensure the no-take status of these areas. The following four subsections serve as amendments to those FMPs.

Amendment 7 to the Bottomfish and Seamount Groundfish FMP

It is prohibited to harvest the bottomfish management unit species listed in Table 5.1, and all future additions to the bottomfish MUS list, in no-take marine protected areas designated in the Coral Reef Ecosystem FMP, and in any marine protected areas that may be designated by amendment to the Coral Reef Ecosystem FMP. The locations of the no-take MPAs are:

(1) federal waters shallower than 10 fathoms in the Northwestern Hawaiian Islands; and,

(2) federal waters shallower than 50 fathoms around Jarvis Island (0°23' S, 160°01' W), Howland Island (0°48' N, 176° 38' W), Baker Island (0° 13' N, 176°38' W), Kingman Reef (6°23' N, 162°24' W), Laysan Island (25° 45' N, 171°45' W), French Frigate Shoals (23° 45' N, 166°15' W), the Northern half of Midway Atoll (28° 14' N, 177° 22' W), and Rose Atoll (14° 33' S, 168° 09' W).

Table 5.1: Bottomfish management unit species list.

Scientific Name	English Common Name	Scientific Name	English Common Name
Aphareus rutilans	red snapper/silvermouth	*Pristipomoides auricilla*	yellowtail snapper
Aprion virescens	gray snapper/jobfish	*P. filamentosus*	pink snapper
Caranx ignobilis	giant trevally/jack	*P. flavipinnis*	yelloweye snapper
C. lugubris	black trevally/jack	*P. seiboldi*	pink snapper
Epinephelus fasciatus	blacktip grouper	*P. zonatus*	snapper
E. quernus	sea bass	*Pseudocaranx dentex*	thicklip trevally
Etelis carbunculus	red snapper	*Seriola dumerili*	amberjack
E. coruscans	red snapper	*Variola louti*	lunartail grouper
Lethrinus amboinensis	ambon emperor	*Beryx splendens*	alfonsin
L. rubrioperculatus	redgill emperor	*Hyperoglyphe japonica*	ratfish/butterfish
Lutjanus kasmira	blueline snapper	*Pseudopentaceros richardsoni*	armorhead

[1]The Bottomfish and Seamount Groundfish, Crustaceans, Pelagics, and Precious Corals FMPs. Additionally, the Council is currently developing an amendment to include the CNMI and the PRIA under Council-developed FMPs and to designate 49 additional bottomfish MUS. These FMPs and their fisheries are summarized in Chapter 3 of the EIS that accompanies this CRE-FMP.

Amendment 11 to the Crustaceans FMP

It is prohibited to harvest the crustacean management unit species listed in Table 5.2, and all future additions to the crustacean MUS list, in no-take marine protected areas designated in the Coral Reef Ecosystem FMP, and in any marine protected areas that may be designated by amendment to the Coral Reef Ecosystem FMP. The locations of the no-take MPAs are:

(1) federal waters shallower than 10 fathoms in the Northwestern Hawaiian Islands; and,

(2) federal waters shallower than 50 fathoms around Jarvis Island (0°23' S, 160°01' W), Howland Island (0°48' N, 176° 38' W), Baker Island (0° 13' N, 176°38' W), Kingman Reef (6°23' N, 162°24' W), Laysan Island (25° 45' N, 171°45' W), French Frigate Shoals (23° 45' N, 166°15' W), the Northern half of Midway Atoll (28° 14' N, 177° 22' W), and Rose Atoll (14° 33' S, 168° 09' W).

Table 5.2: Crustacean management unit species list.

Scientific Name	English Common Name
Panulirus marginatus	Spiny lobster
Panulirus penicillatus	Spiny lobster
Family Scyllaridae	Slipper lobster
Ranina ranina	Kona crab

Amendment 10 to the Pelagic FMP

It is prohibited to harvest the pelagic management unit species listed in Table 5.3, and all future additions to the pelagic MUS list, in no-take marine protected areas designated in the Coral Reef Ecosystem FMP, and in any marine protected areas that may be designated by amendment to the Coral Reef Ecosystem FMP. The locations of the no-take MPAs are:

(1) federal waters shallower than 10 fathoms in the Northwestern Hawaiian Islands; and,

(2) federal waters shallower than 50 fathoms around Jarvis Island (0°23' S, 160°01' W), Howland Island (0°48' N, 176° 38' W), Baker Island (0° 13' N, 176°38' W), Kingman Reef (6°23' N, 162°24' W), Laysan Island (25° 45' N, 171°45' W), French Frigate Shoals (23° 45' N, 166°15' W), the Northern half of Midway Atoll (28° 14' N, 177° 22' W), and Rose Atoll (14° 33' S, 168° 09' W).

The Council also recommends that the Pelagic FMP be amended to specifically identify only the nine pelagic shark species that are to remain as Pelagic MUS. In doing so, all other oceanic sharks belonging to the families Alopiidae, Carcharhinidae, Sphyrnidae, and Lamnidae will be removed from the Pelagic MUS list at that time. The Council further recommends that all coastal shark species belonging to these families are to be managed under the CRE-FMP. Therefore, the Pelagic FMP is amended to:

(1) Remove all species of shark belonging to the families Alopiidae, Carcharhinidae, Sphyrnidae, and Lamnidae from the Pelagic MUS list except for the nine shark species listed in Table 5.3.

(2) Remove dogtooth tuna (*Gymnosarda unicolor*) from the Pelagic MUS list. (*Gymnosarda unicolor* is to be managed under the CRE-FMP.)

Table 5.3: Pacific Pelagic management unit species list, as amended.

Scientific Name	English Common Name	Scientific Name	English Common Name
Coryphaena spp.	Mahimahi (dolphinfishes)	*Isurus oxyrinchus*	Shortfin mako shark
Acanthocybium solandri	Wahoo	*Isurus paucus*	Longfin mako shark
Makaira mazara: *M. indica*	Indo-Pacific blue marlin Black marlin	*Lamna ditropis*	salmon shark
Tetrapturus audax	Striped marlin	*Thunnus alalunga*	Albacore
T. angustirostris	Shortbill spearfish	*T. obesus*	Bigeye tuna
Xiphias gladius	Swordfish	*T. albacares*	Yellowfin tuna
Istiophorus platypterus	Sailfish	*T. thynnus*	Northern bluefin tuna
Alapias pelagicus	Pelagic thresher shark	*Katsuwonus pelamis*	Skipjack tuna
Alopias superciliousus	Bigeye thresher shark	*Euthynnus affinis*	Kawakawa
Alopias vulpinus	Common thresher shark	*Lampris* spp	Moonfish
Carcharhinus falciformis	Silky shark	Gempylidae	Oilfish family
Carcharhinus longimanus	Oceanic whitetip shark	family Bramidae	Pomfret
Prionace glauca	Blue shark	*Auxis* spp, *Scomber* spp; *Allothunus* spp	Other tuna relatives

Amendment 5 to the Precious Corals FMP

It is prohibited to harvest the precious corals management unit species listed in Table 5.4, and all future additions to the precious corals MUS list, in no-take marine protected areas designated in the Coral Reef Ecosystem FMP, and in any marine protected areas that may be designated by amendment to the Coral Reef Ecosystem FMP. The locations of the no-take MPAs are:

(1) federal waters shallower than 10 fathoms in the Northwestern Hawaiian Islands; and,

(2) federal waters shallower than 50 fathoms around Jarvis Island (0°23' S, 160°01' W), Howland Island (0°48' N, 176° 38' W), Baker Island (0° 13' N, 176°38' W), Kingman Reef (6°23' N, 162°24' W), Laysan Island (25° 45' N, 171°45' W), French Frigate Shoals (23° 45' N, 166°15' W), the Northern half of Midway Atoll (28° 14' N, 177° 22' W), and Rose Atoll (14° 33' S, 168° 09' W).

Table 5.4: Precious Corals management unit species list.

Scientific Name	English Common Name	Scientific Name	English Common Name
Corallium secundum	Pink coral (also known as red coral)	*Lepidisis olapa*	Bamboo coral
Corallium regale	Pink coral (also known as red coral)	*Acanella* spp.	Bamboo coral
Corallium laauense	Pink coral (also known as red coral)	*Antipathes dichotoma*	Black coral
Gerardia spp.	Gold coral	*Antipathes grandis*	Black coral
Narella spp.	Gold coral	*Antipathes ulex*	Black coral
Calyptrophora spp.	Gold coral		

5.2.2 Low-use Marine Protected Areas

MPAs that allow for limited consumptive activities are becoming a popular tool for conservation of marine resources. Low-use MPAs—while effectively protecting coral reefs—have fewer social and economic impacts than no-take areas. Low-use MPAs may also serve as natural laboratories to conduct research and fishing experiments, and to test adaptive management measures. At the same time, through carefully managed exploitation they can provide for food, medicine, and other benefits.

This FMP establishes low-use MPAs in federal waters between 10 and 50 fathoms deep in the NWHI, and around Palmyra Atoll, Wake Island, Johnston Atoll, and the southern half of Midway Atoll in federal waters shallower than 50 fathoms. The draft regulations of this FMP (see Section 8.1) provide detailed descriptions of the location and extent of these low-use MPAs. Fishing for coral reef ecosystem MUS will be carefully regulated and monitored in the low-use MPAs established under this FMP through a special permit regime described in Section 5.3.

Any vessel operator[2] intending to fish in a low-use MPA must notify the NMFS Regional Administrator (RA) at least 72 hours before the vessel leaves port (not including weekends and federal holidays). The notice must be transmitted directly to the RA's office or via a telephone number designated by the RA. It must provide the official number of the vessel; the name of the vessel; the intended departure date, time, and location of the name of the operator of the vessel; and the name and telephone number of the agent designated by the permit holder that NMFS can contact on any weekday 8:00 a.m. to 5:00 p.m. (Hawaii Standard Time).

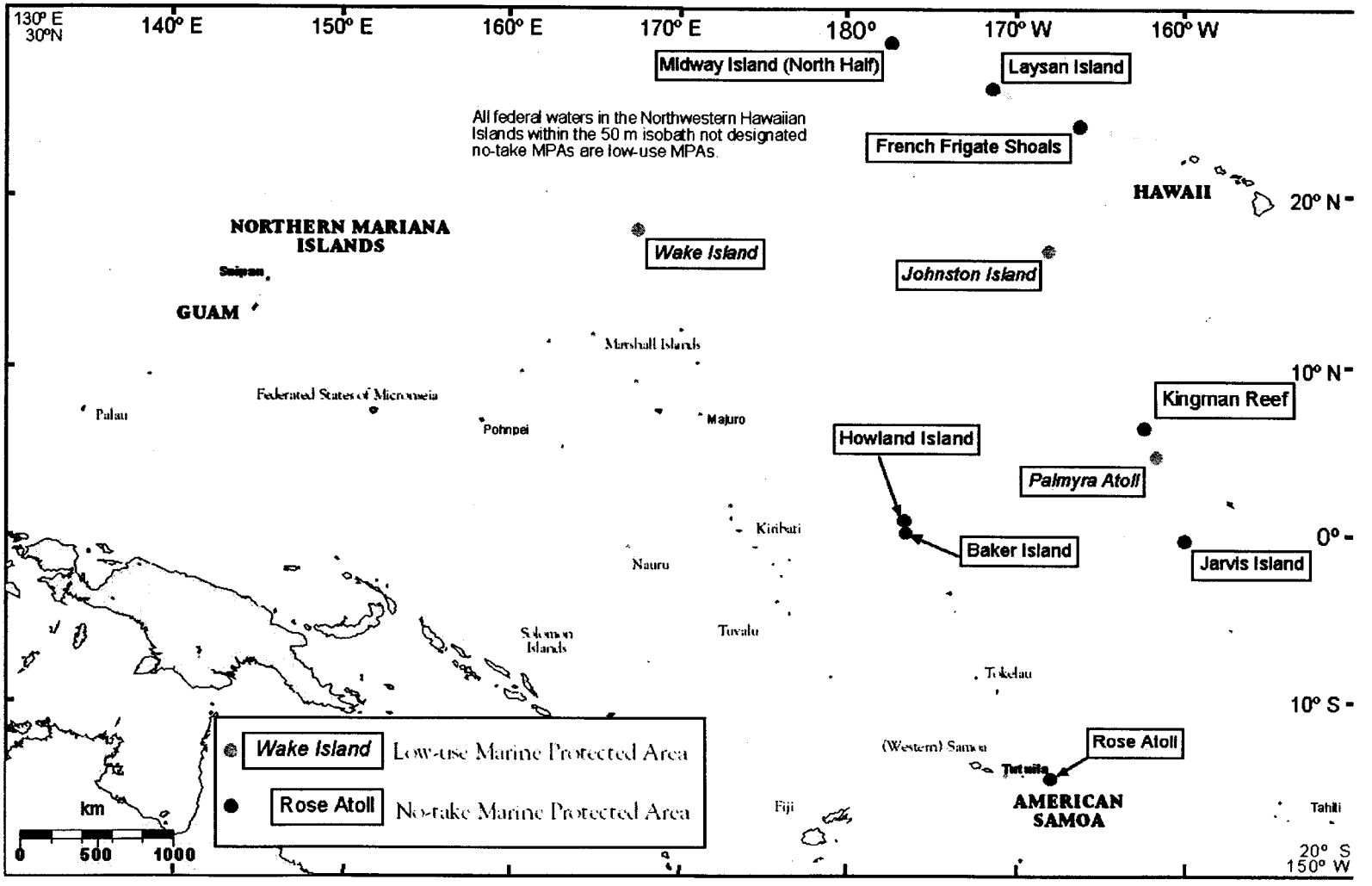
[2]The vessel operator will be presumed to be an agent designated by the permit holder unless the NMFS Regional Administrator is otherwise notified by the permit holder.

5.2.3 Operational Restrictions in MPAs

Most of the operational restrictions are inherent in MPA designation, as is the case with no-take MPAs, or stem from the permit regime described in the next section. (Other restrictions result from the gear restrictions outlined in Section 5.4.) However, there are two more general measures. First, all fishing vessels, including those regulated by existing FMPs, operating in or transiting an MPA must carry insurance to cover the cost of vessel removal and pollution liability in the event of a grounding. The insurance liability so required will be based on vessel category, permit type, and fishing area. Additionally, the Council will work with the relevant authorities to prohibit cruise ships from operating within established no-take and low-use MPAs. The Council will also work with the relevant authorities to authorize other vessels operating within MPAs to carry insurance similar to that which will be required for fishing vessels, as just described. Second, anchoring will not be permitted by vessels larger than 50 feet on Guam's Southern Banks. (It should be noted that the Southern Banks are not designated an MPA under this FMP, so none of the other MPA-related restrictions apply to that area.) In the event of an emergency caused by ocean conditions or vessel malfunction, vessels would be exempted from this prohibition. But they must be able to document the condition or malfunction after the fact.

The Council considered designating sub-zones within low-use MPAs that would be reserved for use by indigenous people on populated islands adjacent to the MPAs. However, the size, location, and specific rights of use have not been determined in any detail. Therefore, indigenous use sub-zones will not be implemented as part of this FMP, but could be a proposed measure for future framework action.

Figure 5.1: Location of MPAs proposed in this FMP.



5.3 Fishing Permits and Reporting Requirements

Permits are a fundamental management tool, and are used as a basis for participation in many U.S. domestic fisheries. Permits establish the legal rights, privileges, and obligations of fishermen. They are thus a vehicle for specifying the conditions under which fishing occurs. For example, performance standards can be set as qualifying criteria for obtaining and renewing permits. Permits can also specify that fishermen provide basic data for fishery monitoring and management. This monitoring can extend to permit holders' success in complying with permit requirements; by evaluating their records, managers can maintain a register of those permit holders in good standing. Permits will be issued only to U.S. citizens or nationals. Permits are not assigned to specific vessels, although the vessel being used during fishing operations will be identified on the permit application.

A permit process that allows managers to monitor participation, effort, and catch contributes to seven of the eight FMP objectives outlined in Section 1.4. Objective 4, which calls for measures to minimize adverse human impacts, is particularly addressed by permitting. More specifically, special permit conditions will allow managers to carefully monitor emerging coral reef fisheries and fisheries in low-use MPAs. Permits focus management attention on the specific reef resources and areas to be exploited and the harvest methods to be used. Periodic analysis of catch/effort data collected through permit reporting facilitates adaptive management. Finally, special permits can encourage applicants to more carefully consider their proposed activities and the potential impacts.

Table 5.5: Summary of CRE reporting requirements.

Fishery Type	Fishery Allowed In:	Permit Type Required	Reporting Requirement
All fisheries (except existing FMP fisheries)	All low-use MPAs	**Special permit** *Framework for general permit*	via special permit
Currently harvested CRE taxa (existing fisheries)	Outside no-take areas	*Framework for general or special permit*	via local monitoring/ coordination
Potentially harvested CRE taxa (new fisheries)	Outside no-take areas	**Special permit** *Framework for general permit*	via special permit
Exemptions to ban on take of wild live rock and coral (bioprospecting, indigenous)	Outside no-take areas	**Special permit**	via special permit
Existing FMP fisheries (bottomfish, crustaceans, precious corals, pelagics)	Outside no-take areas	Follow permit requirements in respective FMP	Report incidental take of CRE taxa via respective FMP requirements

The permit regime adopted through this FMP will regulate the harvest of coral reef ecosystem management unit species (described in Section 1.6.1) under Council jurisdiction. As already noted, the management area covers EEZ coral reef resources in the Council region, including the remote U.S. island possessions directly under federal control, where permits would apply to

fishing from the shoreline to the outer edge of the EEZ. (In no-take MPAs, of course, marine resources harvesting is prohibited).

5.3.1 Permit and Reporting Regimes

Two types of permits will be used to manage coral reef fisheries. First, a special permit will be required to fish in low-use MPAs and to harvest Potentially Harvested Coral Reef Taxa (PHCRT). A second permit type, the general permit, may be implemented at a later date, using the framework process described in Section 5.5. General permits, if implemented, would be required to fish for Currently Harvested Coral Reef Taxa (CHCRT) in the EEZ outside of MPAs. In the meantime, existing permit regimes in the region will be used to manage CHCRT harvests outside MPAs. For the most part, these permit regimes, administered by local agencies in the various jurisdictions in the Council region, effectively manage current coral reef fisheries, to the degree that these fisheries are active. Hawaii and American Samoa have these locally-administered permitting systems. In Hawaii, any person who sells their catch is required to have a commercial fishing licence granted by the Department of Land and Natural Resources. In American Samoa, the Department of Marine and Wildlife Resources issues a variety of fishing permits and commercial licences via a regional general form. Fishing for CHCRT in CNMI and Guam does not require a permit. Nevertheless, information on numbers of vessels fishing, fishing effort, and catch data are collected through standardized sales receipts and creel censuses. If, in the future, these locally-administered permit regimes are deemed inadequate, a federal permit, such as the general permit mentioned above, could be implemented by the framework procedure.

Anyone wishing to fish in the EEZ must contact their local marine fisheries office to confirm if a permit is needed, based on the specific target resources sought and the area to be fished. Local marine fisheries offices will handle requests for participation in all existing fisheries in coordination with the NMFS Pacific Islands Area Office (PIAO), unless by means of a framework measure the Council has specified some other process. If appropriate, the PIAO will explain the proper procedure to the fisherman and make available permit and logbook forms as needed.

The Special Permit and Reporting Regime

Special permits will be required for:

(1) fishing for coral reef taxa in a low-use MPA;

(2) targeting all PHCRT anywhere fishing is allowed in the EEZ; and,

(3) bioprospecting.

The Council thinks that, in general, harvesting significant quantities of wild live rock and live coral should be prohibited because of the harm it could do to the coral reef ecosystem. However, they recognized that limited harvests could be allowed by special permit in two circumstances:

(1) collection of seed stock by aquaculture operations; and, (2) collection by indigenous people for traditional and ceremonial uses.

Once enough data has been acquired from fisheries targeting PHCRT, the framework process could be used to classify the taxon as a CHCRT. A special permit would then no longer be required to harvest the taxon. In addition, in order to use fishing gear that is not one of the allowable gear types listed in Section 5.4, a person will have to apply for a special permit. The applicant must fully describe the gear and its mode of deployment on the permit application. These applications will be reviewed using the same process as would be used for any other special permit application.

Currently, residents on and visitors to Palmyra, Johnston and Wake Islands and Midway Atoll—which under this FMP will be surrounded by low-use MPAs—are allowed to fish recreationally, in some cases using catch-and-release. Although these fisheries are regulated by the USFWS, they are not regulated by any of the Council's already-implemented FMPs. Therefore, under this FMP people who want to take coral reef resources for recreation and personal on-island consumption will have to obtain a special permit for this purpose. They will have to provide an estimate of their total take (in pounds) and this must be approved by the local authority. Any local fishing regulations in effect should also be followed. If these procedures are followed, the NMFS PIAO may allow the on-site resource manager to issue these permits. Since the USFWS already regulates and monitors these activities, their programs will be taken into consideration as part of the permit application process.

Special Permit Application and Review Process

Anyone who wants to fish in the EEZ and meets any of the criteria listed above for the special permit requirement must contact the PIAO in order to obtain an application. They may contact the office directly, or they may be directed to the PIAO by the fishery management agency in their jurisdiction. A completed application must be submitted along with any specified fees at least 60 days prior to the desired date of permit action. The fee will be calculated based on administrative cost, in accordance with procedures in the NOAA Finance Handbook. (A sample application form with directions may be found in Section 8.2.) The applicant must provide the following information:

1. the species or taxa to be targeted by the fishery;
2. the estimated amount of catch (in pounds);
3. the general areas/banks that will be fished; and,
4. the gear that will be used and methods of collection.

Within 10 business days after they receive the application the PIAO will notify applicants if they need to submit additional information in order to process their application. Incomplete applications will not be processed until corrected in writing.

After receiving a completed application, the PIAO Administrator will consult with the Council and the director of the affected state fishery management agency. The Council will then inform PIAO of its decision to approve or deny the application. At the discretion of the Council, it may invite the applicant to appear in support of the application at the next Council meeting. In its review, the Council will consider anticipated cumulative effects of fishing and other activities in the proposed area, environmental factors which could compound effects of fishing pressure, and other relevant scientific information before making recommendations. After reviewing the Council's decision and supporting material, the PIAO Administrator will notify the applicant in writing whether the application has been approved or denied. If the application is denied, reasons for denial will be sent to the applicant in writing within 60 days. Permits can be denied for a number of reasons. Reasons include but are not limited to:

- The applicant has failed to disclose material information required, or has made false statements as to any material fact, in connection with his application;
- According to the best scientific information available, the harvest to be conducted under the permit would be significantly detrimental to the population of any species of fish or fish habitat;
- Activities to be conducted would be inconsistent with the intent of the special permit program or the management objectives of the FMP; and,
- The activity proposed under the special permit would create a significant enforcement problem.

Appeals for denied permits are outlined in Section 5.3.3.

Special Permit Logbooks

Catch reporting is an essential part of the permitting regime. Special permit holders will have to maintain a logbook to record and report their fishing activity. Logbook format and data reporting methods will be determined during the special permit approval process. However, any permit-specific requirements are in addition to the following basic requirements. The permittee must:

1. Report catch, effort and discards by species, location, time, and other factors as specified by the Council;
2. Report protected species observations;
3. Report any lost gear or damage to the coral reef (with no penalty to permittee);
4. Complete a daily logsheet within 24 hours after completion of the fishing day; and,
5. Submit reports within 30 days of returning to port.

For a more complete description, an example special permit daily catch report, and the directions to fill out the form see Section 8.2.

The operator of a vessel harvesting coral reef resources in a low-use marine protected area must contact the USCG, by radio or otherwise, at the 14th District, Honolulu, HI; Pacific Area, San

Francisco, CA; or 17th District, Juneau, AK, at least 24 hours before landing, and report the port and the approximate date and time at which the coral reef resources harvested on the trip will be landed.

As noted above, only recreational and on-island consumption fishing is allowed on Palmyra, Wake and Johnston Islands and Midway Atoll. The USFWS has programs in place to monitor these fisheries. If, after applying for a special permit through PIAO, the Council determines this reporting is adequate for the MSFCMA, and data are properly processed and provided to the appropriate Council advisory bodies, no further data collection will be required.

The General Permit and Reporting Regime

As mentioned above, general permits could be required to harvest CHCRT in any area of the EEZ not designated an MPA. If the Council determines that any extant locally administered permitting and reporting system is inadequate, because it is inconsistent with the objectives of this FMP, the general permit regime could be implemented by means of a framework measure (see Section 5.5.1). This framework procedure can be initiated in one of three ways:

1. If after reviewing the Coral Reef Ecosystem annual report the Council finds that data collection is inadequate, overfishing is occurring or there is the potential for overfishing, or other relevant scientific data show that there is a need for additional management measures;
2. If the Coral Reef Ecosystem Plan Team issues a report to the Council outlining concerns that need to be addressed at the next scheduled Council meeting; and,
3. If at any time regional management authorities bring concerns to the attention of the Council.

General permits can only be issued if the applicant meets certain minimum requirements, such as he or she is at least eighteen years old, a U.S. citizen or national, has no criminal record, and has completed the application form. Applications will be denied if the applicant does not meet any one of the minimum requirements or if in the past the applicant has been cited for not complying with regulations or reporting requirements. A general permit and reporting requirement would allow fishery managers to assess individual fishing effort and methods for a given target species, and associated bycatch. Implementing a general permit would result in more effective and adaptive management because consequent mandatory reporting would allow more specific data to be collected. The general permit application and review process would be administered by the PIAO in a manner similar to that described above for the special permit. Also like the special permit, a denied permit application may be appealed, as described in Section 5.3.3.

General Permit Logbooks

For existing coral reef fisheries that harvest CHCRT outside of MPAs—typically in EEZ waters around the main Hawaiian Islands, Guam, CNMI, and American Samoa—data reporting will be coordinated through the fishery management agencies in local jurisdictions. As with locally administered permitting, these reporting regimes—covering subsistence, recreational, and

commercial fishers—currently provide sufficient information for management. Mechanisms currently in effect include dockside creel surveys, logbooks, and/or sales reports in American Samoa, Guam, and the CNMI. Since these methods are adequate, no changes are recommended. Fishery management agencies in these jurisdictions, and in Hawaii, also collect data through commercial purchases from buyers and wholesalers. The CNMI government has requested all fish buyers to fill out data forms since 1983. While commercial fish catch reporting is also still voluntary in Guam, a relatively high percent coverage has been maintained since 1982 through cooperation of the major fish dealers there. In American Samoa, the Department of Marine and Wildlife Resources requires fish buyers to fill out a form that includes the date, species, weight of fish purchased, and additional economic information. Fishermen who land their catch in Hawaii are required to fill out a fish catch report; it includes area fished, type of gear, and weight and numbers of fish caught by species.

If the Council determines data collection to be inadequate for the given fishery, the general permit could be implemented through the framework process. In addition to the permit, this regime would also require a "general coral reef taxa daily catch report," which will be provided by NMFS. NMFS can coordinate with local fisheries agencies to facilitate the collection, distribution, and processing of data via established WPacFIN protocols. Section 8.2 contains an example of this form and associated directions. Catch report or general permit logbook format and data reporting methods will be determined during the framework implementation process. However, any permit-specific requirements are in addition to the same five basic requirements listed below for the special permit logbook. The permittee must:

1. Report catch, effort and discards by species, location, time and other factors as specified by the Council;
2. Report protected species observations;
3. Report any lost gear or damage to the coral reef (with no penalty to permittee);
4. Complete daily logsheet within 24 hours after completion of the fishing day; and,
5. Submit reports within 30 days of returning to port.

It should be noted that the PIAO Administrator may, after consultation with the Council, initiate rule-making to modify these or any fishing record forms.

5.3.2 Federal Permit Exemptions

Two activities are exempted from the special permit and any future general permit requirement:

Scientific Research: Scientific research is permitted in all areas of the EEZ, including both no-take and low-use MPAs, if approved by the NMFS-Southwest Regional Administrator (RA), Science Center Director, or designee. The RA will, upon a formal request for a scientific permit for a given project in a designated area, contact the regional authority and consult with both the Council and the regional management agency at a subsequent Council meeting and prior to issuing a scientific permit. Foreign scientists who want to conduct research in the EEZ of the

Western Pacific Region must also contact the RA with a formal request. The RA will also contact the appropriate regional authority and then consult with the Council in the same manner as for domestic scientific permits.

Fishing permitted by other Council FMPs: Fishing for species managed under one of the Council's implemented FMPs already requires a permit, as specified by the relevant FMP. Therefore, participants in those fisheries will not be required to get a second CRE permit to fish in the CRE management area. They are already required to report any incidental catch of coral reef taxa under the relevant FMP permit and reporting regime. This information will be shared among managers through formal and informal coordination (see Section 5.5.3).

5.3.3 Appealing a Denied Permit

Within 30 days of receiving reasons for denial of a special or general permit from the PIAO Administrator, the applicant must submit in writing to the NMFS Southwest Regional Administrator an explanation of why he or she is appealing the decision, including supporting material for the appeal, and copies of the original application and reasons for denial. The applicant may also request an informal hearing.

Appeals to decisions will be heard by the RA, who will consult with the Council prior to making a determination. The RA has the discretion to grant the informal hearing. If no hearing is granted, the RA will notify the applicant and other interested parties in writing of the decision within 30 days.

If the RA determines that a hearing is necessary, a notice of the time, place, and subject will be published in the Federal Register. The hearing shall be held before a hearing officer within 30 days of the FR notice. The appellant and all interested parties are invited to give testimony. Within 30 days of the close of the hearing, the hearing officer will make a written recommendation to the RA on his decision. Within 30 days of receiving this recommendation, the RA will notify the appellant and other interested parties about the final action. Time limits may be extended for a period no longer than 30 days by either the RA or through a request from the appellant, based upon a written request stating good cause.

5.3.4 Data Processing and Annual Reports

For other FMP fisheries, data processing procedures have been established for Hawaii, Guam, CNMI, and American Samoa. The CRE-FMP will follow these established procedures. Creel survey, logbook, and/or commercial buyer's data will be collected and processed by the relevant local agencies in each jurisdiction. A cooperative program, funded in part by NMFS, augments existing fisheries monitoring efforts so that they more effectively support FMP objectives. As part of this cooperative agreement, NMFS staff make regular visits to the insular areas to coordinate data programs and to help produce the other FMPs' annual report modules. This cooperative program can support CRE data analysis in the same fashion, including NMFS staff visits. Island-specific annual report modules will be produced by CRE Plan Team members from

each respective island jurisdiction. Additional data come from federal logbooks, which are submitted directly to the NMFS-Honolulu Laboratory. Once all this information is given to the Council, it will be combined with other required material to produce the CRE-FMP Annual Report, which must be published by July 31 of each year. Annual reports are divided into six regions: MHI, NWHI, PRIAs, American Samoa, Guam, and CNMI. They include summaries of the status of the fisheries, the health of the ecosystem, status of current research, economics of the fisheries, and potential or emerging issues. They also include a section detailing fishing and non-fishing impacts to Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC) for both nearshore and EEZ waters throughout the Council region. Finally, these reports include actions taken in the past year by the Council; recommendations from the Plan Team, Advisory Panels, and the Scientific and Statistical Committee; reports from enforcement; and a report on the status of protected species.

5.3.5 Other Permit-related Matters

Fishing Regulations

Upon receipt of a special permit (or general permit if implemented), the user must affix the permit to the vessel for which the permit was issued in the manner outlined in regulations pursuant to this FMP. Regulations that will affect fishing operations include, among others, gear and area restrictions.

Transshipment Logbooks

Any vessel engaged in transshipment of coral reef ecosystem resources in the EEZ must have a permit issued for such activity as outlined in regulations pursuant to this FMP. These vessels must have an accurate and complete NMFS transshipment logbook. Section 8.2 contains an example form and directions. All required information must be recorded on the form within 24 hours after transshipment is completed. This information must be submitted to NMFS within seven days of landing transshipped coral reef ecosystem resources in port.

State Reporting

Vessels required to complete a federal logbook must still follow any state laws and regulations regarding reporting and submit those forms to the appropriate state agency. These records shall be made available for federal inspection and copying if an authorized officer so requests.

5.4 Fishing Gears and Methods

Pacific Islanders have fished on coral reefs for several thousand years. Sustainability resulted in part from the inefficiency and selectivity of the gear that they used. Many of these traditional methods are still used in contemporary fisheries, although the introduction of manufactured gear and population growth have increased the impacts. Today's fishermen employ a wide variety of gear and methods to harvest extremely diverse resources numbering hundreds of species. Most of these methods are very inefficient when compared to industrial fishing technology, such as

bottom trawls, all-terrain trawls, bottom dredges, or industrial netting—used in U.S. continental shelf fisheries but prohibited in many benthic fisheries around the Pacific. However, several potential threats to coral reef resources in the EEZ around U.S. Pacific Islands remain, due to the use of destructive fishing methods.

Unregulated live reef fish harvests for food and ornamental markets are already a problem in Southeast Asia, and could find their way to U.S. EEZ waters, especially in remote, difficult to monitor areas. Controls are needed to prevent the possession or use of destructive gear such as poisons, explosives, and intoxicating substances. Gillnets also need to be controlled because they can be very unselective, if left unattended. Along with other non-selective gears and methods, they result in substantial incidental catch or bycatch. Scuba-assisted spearfishing at night can be very efficient because highly-prized fish, which sleep among coral heads and in reef crevices, can be sought out and easily speared. Bioprospecters may also wish to harvest reef resources. Despite the potential benefits to society, any harvesting must be carried out in a controlled manner. The collection of these organisms, many of which are still unknown, will utilize novel techniques that are difficult to anticipate.

Because certain gear types can damage habitat and result in high levels of bycatch, FMPs are required to list allowable gear types. In addition to meeting this requirement, specifying allowable gear types addresses several FMP objectives including Objective 1- sustainable use of resources, Objective 4- minimizing adverse human impacts, and Objective 7- effective surveillance and enforcement.

Three criteria have been used to rate fishing gear that has been or may be used in the coral reef ecosystem environment. First, how selective is the gear, or how well does it catch the target species and not other organisms? Second, does the gear damage essential fish habitat? And third, to what degree does the gear or method of use allow species to find refuge from capture?

5.4.1 Restricted Gear

The use of poisons, explosives and intoxicating substances are specifically banned in all areas of the EEZ. Scuba-assisted spearfishing at night is prohibited in the PRIAs and NWHI, and in other areas, scuba-assisted spearfishing could be prohibited via future framework action so as to be consistent with local regulations.

5.4.2 Allowable Gear

Existing FMP fisheries shall follow the allowable gear and methods outlined in their respective plans. For coral reef fisheries, only the following 11 selective, non-destructive fishing gears are allowed: (1) hand harvest; (2) spear; (3) slurp gun; (4) hand net/dip; (5) hoop net (for kona crab) net; (6) throw net; (7) barrier net (for aquarium fish); (8) surround/purse nets for targeted schools (e.g., *akule*, baitfish, *weke*) with a minimum of bycatch; (9) hook-and-line (includes powered and unpowered handlines, rod-and-reel, and trolling); (10) traps (with conditions); and (11) remote-operating vehicles/submersibles.

Anyone who wants to fish with gear that is not on this list must describe the gear and its method of deployment in the special permit application. The PIAO Administrator will rule on the acceptability of a proposed gear type after consulting with the Council and the director of the affected state fishery management agency. While fishing for coral reef resources in the EEZ, it is prohibited to possess any gear not approved under 50 CFR 660.108 (a) or not approved by the PIAO Administrator as part of the permit approval process.

5.4.3 Unattended Gear and Gear Identification

Because any allowable gear type, if improperly used, has the potential to cause damage, specific conditions of operation are outlined in the gear catalogue (Appendix B). In summary, nets must be tended at all times (except hoop nets for Kona crabs) and traps must only be used in appropriate areas and only operated under appropriate conditions. These conditions are meant to minimize bycatch mortality, produce negligible habitat impact, and minimize the possibility of ghost fishing. In addition, all traps on board a vessel possessing a CRE-FMP permit or deployed by this vessel in the EEZ must be permanently and legibly marked to identify the owner. NMFS personnel, or an authorized officer, may seize and dispose of traps found that do not comply with CRE-FMP regulations and are unattended in EEZ waters. By the same token, they may dispose of unattended surround nets or bait seine nets. The U.S. Coast Guard has authority to board any vessel in the EEZ to check for violations, including gear compliance.

5.5 Other Components of the Management Regime

This section describes three parts of the management regime that are not immediately implemented as regulatory measures. Section 5.5.1 describes procedures to adapt the management regime to changing environmental and fishery conditions. These are the framework and amendment processes for implementing new management measures. Section 5.5.2 outlines how management measures will be enforced. Finally, Section 5.5.3 list non-regulatory measures that will improve inter-agency coordination, and highlights education programs to raise public awareness.

5.5.1 Adapting the Management Regime to Changes in the Environment and Fishery

Since the status of coral resources and their exploitation can change over time, any management regime must be able to adapt to those changing conditions. Flexibility is also needed to change management measures in response to new information on ecosystem function, including how it responds to alteration, and on productivity limits. Implementation is also a learning process and regulations sometimes need to be changed if, for example, they do not work as intended. Generally, the process of changing the management regime begins with recommendations made in the annual report and/or at Council or other advisory body meetings. There are two ways to implement new management measures, by the framework procedure, for established measures, and by FMP amendment, for new measures.

Framework Actions for Established Measures

Established management measures can be changed in an administratively simpler and more timely fashion through the framework process. Framework measures are measures that have been evaluated in this FMP or one of its amendments. These changes, or "adjustments," must be consistent with the original intent of the measure and within the scope of analysis in any previous documents supporting the existing measures. All adjustments must address the objectives of this FMP, which taken together promote sustainable resource management of coral reef ecosystems. Provided that a proposed adjustment meets these criteria, a draft document is prepared. It outlines the need for action, analyzes alternatives, provides supporting material, and describes how other federal laws may be applicable. A notice is then placed in the Federal Register and the document is made available for public comment. A public hearing may also be required. After receiving and addressing all public comments, the document is revised prior to the next Council meeting, when the Council votes on it. If the measure is approved, the RA is asked to begin rule-making.

This section identifies five such measures, which could be implemented at a later date using this procedure. These are: (1) mooring buoy installation and an anchoring prohibition, (2) a vessel monitoring system (VMS) requirement for vessels operating in specific coral reef areas, (3) implementation of the general permit and reporting regime, (4) moving MUS on the PHCRT list to the CHRCT list, and (5) designating indigenous sub-zones within low-use MPAs. Additional measures could be implemented through the framework process too, if their impacts are evaluated in a subsequent amendment to this FMP; otherwise a full FMP amendment is required.

These five measures are not slated for immediate implementation for several reasons. Details for actions 1, 2 and 5 still need to be worked out. For action 1, mooring buoy locations have not yet been determined, although all parties agree on their importance. For action 2, a closer look at the needs of vessels operating in MPAs and a better understanding of EFH and HAPC will be required. It has not yet been determined whether the federal government will pay for the installation and operation of VMS in this fishery. For action 5, the size and location of indigenous sub-zones have not been decided and legal issues were not fully explored. Although the management aspects of framework measures 3 and 4 have been explored in this FMP, their implementation depends on the availability of new information on the fishery and its environment.

1. **Designate zones in the EEZ where mooring buoys will be installed in order to protect EFH from anchor damage. In areas with approved mooring buoys, prohibit anchoring of fishing vessels within a radius indicated on the buoy.**

Rationale: "No anchor zones" in specific habitat areas would protect coral reefs from devastating anchor damage. Mooring buoys have been used successfully in Hawaii and elsewhere in the Pacific as an alternative to anchoring, particularly in high use areas. The buoys would be used on a first-come-first-served basis and allowed time limits would be specified so that no one boat monopolizes a buoy. This process would ensure that the use of these buoys and the concomitant

access to the resources would be fair and equitable to all fishermen, consistent with National Standard 4. Only one boat would be allowed to moor at a time at each buoy. The prohibition of anchoring would limit the number of secured boats fishing an area to the number of mooring buoys at the site. While this may concentrate fishing effort around the buoys, it would also limit the number of vessels fishing at one time, increasing vessel safety and minimizing fishing pressure on coral reef resources.

Beneficial Impacts:

- Prevents anchor damage to reef habitats and allows anchoring for safety reasons in EFH and/or HAPC.
- Limits number of vessels fishing on the banks at one time, increasing vessel safety and minimizing fishing pressure on coral reef resources.
- Increases safety of fishermen by making anchoring (and its hazards) unnecessary and reducing risk of anchor dragging.
- Is consistent with requirements of the Sustainable Fisheries Act by minimizing degradation of coral reef habitats.

Adverse Impacts:

- Limits number of vessels able to fish in a designated mooring zone at one time.
- Mooring buoy maintenance may be difficult.
- May concentrate fishing effort in areas with buoys.
- Includes a cost for installation and maintenance of buoys.
- May encourage "rafting" of vessels at each mooring buoy (even though it would be prohibited under the measure), which is a safety concern.

2. Require fishing vessels to carry remote electronic vessel monitoring systems (VMS) as part of an effective monitoring and enforcement system for state and federal agencies. This requirement could be applied to coral reef fisheries in specific geographical areas (e.g., the NWHI). This measure will only be enacted if the cost of such a system is fully subsidized with federal funding.

Rationale: VMS is an effective system for managing vessels operating in areas with different use zones, such as the MPAs, and with different licenses/permits, and for encouraging and documenting compliance with permit conditions. The vessel's precise location would be transmitted via satellite to a Land Earth Station and from there to a computerized monitoring station where the information would be kept in a secure and confidential database. If the vessel enters a designated buffer zone or MPA, an automatic signal is sent to both the ship's captain and the appropriate management agency. Such a system may prove to be a cost-effective compliance tool for real time and accurate positioning of vessels and instant recognition of a breach of permitted activities, as well as a tool to locate vessels in distress. VMS also has been shown to be an effective tool for monitoring vessels' locations in relation to navigational hazards and,

when used in conjunction with automated buffer zones, may serve as an additional warning mechanism to prevent vessel groundings.

Beneficial Impacts:

- Protects coral reef resources by providing early warning of a vessel approaching too close to a reef slope, thereby protecting both the reef and the vessel from grounding damage.
- Protects coral reef resources by providing a tool that can dramatically improve compliance with FMPs.
- Is consistent with the requirements of the Sustainable Fisheries Act.
- Provides precise location information to assist in emergencies and rescues.
- Provides documentation on vessel movements, which can be used to clear up misunderstandings regarding liability or accusations of responsibility for environmental damage.
- Requires no input by captain or crew to run the automatic system.
- Can make enforcement easier and potentially much less costly.

Adverse Impacts:

- Cost of implementation may be burdensome to federal government.
- Implementation will require fiscal and personnel resources.
- Fishermen are concerned over the use of VMS information (security and confidentiality of data).

3. Require general permits to fish for CHCRT MUS outside of MPAs in the EEZ, in the event that regional management is determined inadequate to protect the species and/or ecosystem.

Rationale: This framework measure is described in Section 5.3.1 in the subsection outlining the general permit and reporting regime. Initially, general permits will not be required for existing CRE fisheries. This option to implement a general permit requirement would allow fishery managers to assess individual fishing effort and methods for a given target species and associated bycatch before any vessel begins fishing. This more detailed data collection and mandatory reporting would facilitate more effective and adaptive management. This framework measure can be enacted if the Council determines that a locally administered permit and reporting regime does not adequately address CRE-FMP objectives. A general permit, issued by NMFS-PIAO, would then be required to harvest CHCRT MUS in the EEZ outside of MPAs.

A number of methods could be used to instigate this framework procedure: (1) as a result of the Council reviewing the Coral Reef Ecosystem Annual Report for adequate data collection, overfishing or potential for overfishing, and other relevant scientific data which reflect the need for additional management measures, (2) the Coral Reef Plan Team issuing a report outlining concerns to the Council to be addressed at the following scheduled Council meeting, or (3)

regional management authorities bringing their concerns to the attention of the Council at any time.

American Samoa can be used as an example of how a general permit and reporting regime could be implemented and applied, using framework procedures. This example is particularly apposite because reef fisheries occur both in territorial and federal waters. The American Samoa Department of Aquatic and Wildlife Resources issues permits to fish for coral reef species and collects data through both creel surveys and commercial purchases. These reef fisheries are small-scale operations, with individuals catching a few to a couple hundred pounds of fish on a given day. If one or more large-scale operations began efficiently targeting these species in the EEZ, increasing the total catch substantially, regional management might not be sufficient to address this development. The Council could then initiate the framework process to require a general permit for reef fisheries in the EEZ of American Samoa.

While details about who would be affected and how the measure would affect fishing are unique and unforeseeable, general procedures can be outlined here. Federal regulation 50 CFR 660.13 details current permitting procedures, which would also apply to this CRE general permit. Permits would be valid only for the fishery management subarea specified on the permit and remain valid for the period specified unless transferred, revoked, suspended, or modified. A permittee first requests an official Southwest Region Federal Fisheries permit application form. After filling out all required information and attaching necessary documents (see example form in Section 8.2), the permittee returns the application along with any fees, as specified. The PIAO will review and process all completed applications within 15 business days. Permittees will be notified of incomplete or incorrect applications. If deficiencies are not corrected within 30 days following notification, the application will be considered abandoned. Within 15 business days after receiving a completed application, the administrator of the PIAO will issue a permit to the applicant under the CRE-FMP or send a written notification of denial, which will include the reasons for the denied application.

Beneficial Impacts:

- Requires specific data reporting of catch, effort, area, and method of fishing.
- Allows for a thorough understanding of the total fishing effort for given areas and given target species.
- Provides information on bycatch and protected species.
- Allows for standardization of reporting, assisting fishery managers assessment of impacts
- Makes fishermen more aware of concerns of impacts from fishing through completing both permit form and logbooks.
- Assists adaptive management with crucial data on fishery.

Adverse Impacts:

- Increases administrative burdens (time and costs) due to the permit process.
- Increases burdens to fishermen not used to completing this type of paperwork.

- Removes management from regional authority which had traditionally managed these fisheries.

4. Allow particular MUS on the PHCRT list to be moved to the CHCRT list when sufficient information has been gathered for less restrictive management.

Rationale: If a market develops for potentially-harvested species, fishermen will request to fish those species under a special permit. The special permit embodies the precautionary approach. Permit approval requires a thorough description and evaluation of all aspects of the fishing method for each applicant. Additionally, permittees will be subject to strict reporting requirements, including submittal of bycatch and discards information. The data gathered from the vessels will help managers determine MSY, OY, and potential for overfishing. When enough data has been gathered for a given species or species complex and its associated bycatch to understand cumulative impacts on the species and the ecosystem, the Council can determine whether to lessen the stringent requirements by moving such species to the currently harvested list. This reduces administrative and regulatory burdens at the appropriate time without causing risk to the resource.

Beneficial Impacts:

- Relieves unnecessary administrative burdens associated with fishing for species for which management is better understood.
- Reduces burden to the Council and the PIAO Administrator for permit approval.
- Eases burdens on fishermen who have complied with regulations, allowing for given species to be re-listed as CHCRT.
- Procedure to re-list MUS prompts fishery managers to better understand species and the ecosystem to facilitate effective management.

Adverse Impacts

- Has the potential to put species at risk, which could require more stringent management measures.
- Could facilitate additional fishing pressure for given species due to less stringent permit requirements for allowed harvesting.

5. Designate a set percentage of the area within low-use MPAs for sole use by indigenous people, with the percentage based upon the percentage of indigenous population in the area around the low-use MPA.

Rationale: Discussions during the planning process centered around access for Native Hawaiians to the NWHI for traditional and ceremonial purposes. Later on, other island cultures were included in these discussions, with details to be worked out in the future as new MPAs were designated in their EEZs. At this time, however, details are lacking even for the NWHI. Details include where the areas would be, the exact percentage of low-use MPA that would be set aside,

and also the legal issues surrounding the proposal. Nevertheless, the CRE Plan Team and other groups strongly believe in the premise. As discussed in Section 1.3.5, the indigenous people of the Samoan, Hawaiian and Mariana islands have close historical and cultural relationships with the marine environment and coral reef resources. Increasing restrictions on customary and traditional uses of marine resources are jeopardizing cultural continuity in many areas of the U.S. Pacific. The designation of no-take zones in the NWHI could result in some negative impact on the Hawaii fishing community by causing a loss of earning potential, investment value, and lifestyle for some bottomfish and lobster fisheries participants.

A 1993 survey of participants in the NWHI bottomfish fishery found that half of the respondents who fish in the Ho'omalu Zone were motivated to fish by a long-term family tradition (Hamilton 1994). This sense of continuity is also reflected in the importance placed on the process of learning about fishing from "old timers" and transmitting that knowledge to the next generation. Hawaii's commercial fishing industry dates back nearly 200 years and closure of some fishing grounds in the NWHI would also likely have a negative impact on those who value the continued existence of Hawaii's maritime tradition and culture. In view of the historic and cultural importance of fishing over the last 2,000 years for Native Hawaiians, this deprivation of the right to make a living at *koa* (see Kahaulelio 1902, pp. 22, 24), which they have been accustomed to frequent in the NWHI, is an especially onerous penalty. Two events have exacerbated this situation. First, annexation of Hawaii by the U.S. opened access to fishery resources to any U.S. citizen (Kosaki 1954). Second, this action increased fishing pressure on resources customarily used by Native Hawaiians and weakened cultural norms that controlled the proper conduct of fishing.

Beneficial Impacts

- Helps preserve and reestablish island cultures and families whose history of traditional and ceremonial use of coral reef resources dates back thousands of years.
- Adds additional protection within low-use MPAs, by effectively limiting the amount of users in the area.
- Will make the permitting process for certain activities simpler because usage in these areas can be expected to be uniform across these select user groups.
- Potentially supports subsistence fishing.

Adverse Impacts

- Could be challenged legally on grounds of discrimination.
- Locations and size of the sub-zones could cause contention between user groups.
- Concerns have been expressed regarding what constitutes cultural take. For example, modern gear and techniques could alter the purpose of the sub-zone.

Procedure for New Measures (Amendments)

These procedures apply to regulatory measures that have not been included in previous regulations and/or whose impacts have not been analyzed previously in the FMP. These new measures include, but are not limited to, catch limits, resource size limits, closures, and effort limitations. New regulatory measures will follow the procedure outlined for amendments in NMFS' *Operational Guidelines, Fishery Management Plans* (May 1, 1997 revision).

A Federal Register notice will be published describing any proposed new management measure. The notice will solicit public comment. At the subsequent Council meeting, the Council will formally address the specific measure for which they will consider recommendations. A Federal Register notice will be prepared summarizing the Council's deliberations, rationale, and analysis for the preferred action, and include the time and place for any other Council meetings to consider the measure. At subsequent meetings, the Council will consider public comments and other information received and will draft a document with a recommendation to the Regional Administrator.

Within two weeks of the decision, the RA will propose regulations to carry out the action or offer a written explanation supporting the denial of the recommendation. The Council may appeal a denial by writing to the Assistant Administrator. The Assistant Administrator must respond to the Council within 30 days. If the RA agrees with the recommendation, the RA and the Assistant Administrator will make their decision in accordance with the MSFCMA and other applicable laws. Finally, NMFS may implement any recommendation made by the Council by rule-making, if approved by the Regional Administrator.

5.5.2 Enforcement

Enforcement burdens and costs have been analyzed in the draft Regulatory Impact Review (RIR) and Initial Regulatory Flexibility Act (IRFA) analysis found in Appendix B. Enforcement can occur either at sea with use of air and/or boat patrols or dockside through vessel and logbook inspection.

At-Sea Enforcement

The major additional enforcement burden required by this FMP is directly related to the designation of no-take and low-use MPAs. In the NWHI, these areas follow the 10 or 50 fathom depth contour in the EEZ. Due to the irregular shape of the bathymetric contours that define MPAs, it may be difficult for enforcement officials to determine whether a vessel is inside or outside an MPA. Large-scale maps of the MPA with boundary coordinates will help determine whether a vessel is in violation of MPA provisions. Improving the accuracy and detail of maps of coral reef ecosystems and associated habitat is a priority for both the Council and NOAA.

Prior to implementation of framework action 2, mandating VMS for every vessel operating in any MPA, the only method to enforce MPA regulations is through direct at-sea monitoring with either aerial or vessel patrols. The cost and time needed to patrol the coral reef ecosystem of the

NWHI, the PRIAs, and the other insular areas is analyzed in the associated RIR and EIS. Mandatory installation and use of VMS for every vessel operating in MPAs would greatly reduce the need for at-sea patrols, simplify the process of determining whether vessels are operating within or outside an MPA, and greatly reduce the cost while increasing overall coverage.

Enforcement agencies may, if deemed necessary, board any vessel and request to conduct an at-sea inspection of the catch, gear, and logbooks. Retained catch should be recorded in the logbook entries. Fishing data forms should be filled out within 24 hours of completing fishing. If on-board gear should be specifically identified (e.g., traps), compliance can be checked.

Unattended surround nets or bait seine nets or traps without owner identification, as described in the CRE-FMP regulations, and found deployed in the EEZ, will be considered unclaimed or abandoned property. Enforcement officers may dispose of these in any manner considered appropriate.

Dockside Inspection

While many of the activities stated above could occur at sea, it is much more effective to inspect gear compliance, validity of permits, and logbooks and reporting of catch when a boat returns from a fishing trip. Vessels that have fished in low-use MPAs are supposed to notify the Coast Guard at least 24 hours prior to returning to port. This makes dockside inspection much easier than at-sea inspection.

5.5.3 Non-regulatory Actions

Strengthen Inter-agency Cooperation

Coherent management of coral reefs and better enforcement of island government fishing regulations, which presupposes regulatory consistency in state and federal waters, can be achieved through cooperative agreements between federal and island government natural resource management and enforcement agencies. The enforcement agreements between NMFS Southwest Law Enforcement and enforcement agencies in American Samoa, Guam, and Hawaii are good examples of such cooperation. Such agreements may vary from area to area. They are manpower intensive and require a substantial commitment to training. With joint enforcement by island government and federal agencies, local regulations might be enforced as landing laws to control the harvest of coral reef resources in areas outside state waters. Coral reef areas where fishing is prohibited or restricted and which function as *de facto* MPAs could be expanded by island governments and federal agency designations.

Process to Facilitate Interagency Coordination to Assess Non-fishing Impacts and Threats to Coral Reef Habitat

This document identifies and describes MPAs, Essential Fish Habitat (EFH), and Habitat Areas of Particular Concern (HAPC). Many of these areas fall under state or territorial jurisdiction

(i.e., within 3 nm from shore), while others are under partial jurisdiction of the Department of Interior and the Department of Defense (e.g., National Wildlife Refuges or Defensive Seas around some parts of the NWHI and the PRIAs). Under the EFH provision of the MSFMCA, federal agencies are required to consult with NMFS for any action that may affect EFH. The EFH provision also allows for NMFS and the Council to comment on any federal or state agency action that may impact EFH. Therefore, designation of these specific areas within the whole management area will help to provide additional focus for conservation and management efforts.

In the populated areas, much of the non-fishing impacts are land-derived and the potential impacts from these activities will not initially affect the EEZ waters under Council jurisdiction. But these spillover effects may eventually impact resources under the Council's jurisdiction. Therefore, efficient inter-agency coordination is vital to effective conservation and resource management.

In order to facilitate interagency coordination to assess the impacts of non-fishing activities on the marine environment, specific concerns that would initiate inter-agency coordination must be identified. These issues include, but are not limited to the following:

- Significant damage to habitat or high likelihood of significant damage;
- Size of a coastal construction project (dredging, likelihood of erosion);
- Large-scale agricultural activity (pesticides, herbicides, nutrient loading);
- Increased marine tourism (anchoring, shell collecting, cruise ships);
- Military activities (bombing and training operations, construction);
- Boat activity (oil / fuel spills, vessel grounding);
- Offshore mining (sand, coral, manganese);
- Power plant and water treatment plant discharge;
- Scientific projects;
- Marine debris (fishing gear); and,
- Introduction of exotic species (ballast/bilge waters, aquaculture).

The National Environmental Policy Act requires that an environmental impact statement be prepared for any major federal action that significantly affects the environment. Similarly, the EFH provisions require that any federal agency must consult with NMFS and the Council if the action they propose is conducted or may impact an area designated as EFH or HAPC. After this consultation, the permitting agency must make an initial assessment of how the proposed activity may affect EFH and must respond to any recommendations provided by NMFS or the Council. This consultation merges the requirements of other environmental laws (e.g., Clean Water Act, Endangered Species Act) so as not to cause undue burden on the permittee, the permitting agency, NMFS, or the Council. If an action or project is proposed by any state or territorial agency that may impact an area designated as EFH or HAPC, NMFS and the Council may provide recommendations to minimize or eliminate the impacts to those areas.

Formal Process for Coordination among Plan Teams to Identify and Address Impacts to Coral Reef Ecosystems

A formal process will be established (under the Council's Standard Operating Procedures and Practices) to ensure coordination of the CRE-FMP with the existing Bottomfish, Crustaceans, Pelagics and Precious Corals FMPs. The plan team coordination procedure is described here. The CRE Plan Team (CRE-PT) identifies an ecosystem issue pertinent to the activities of another Council FMP. Conversely, ecosystem issues may also be brought to the attention of the CRE-PT by other plan teams, the Scientific and Statistical Committee, the Council, fishermen, government agencies, NGOs, or the public. The CRE-PT then prepares a written description of the issue, together with various options or measures to minimize the identified fishery-related impacts to the coral reef ecosystem, and submits it to the respective FMP plan teams for review. The other FMP plan teams then prepare a summary of proposed alternatives to mitigate the impacts, including pros and cons, in consultation with the CRE-PT. The plan teams, at their next regularly scheduled meeting, then formalize their proposed mitigation measures in their meeting reports and recommend a preferred alternative to the Council. The Council reviews these alternatives at its next regularly scheduled meeting and directs an appropriate course of action. The Council's program planning "milestones" document, which is regularly updated, also describes cross-FMP activities and needs, including research.

Education

The Council has established an education and public outreach program for FMP-managed fisheries. The program will be expanded to include a strong educational outreach component to raise public awareness of coral reef ecosystems and to improve compliance with regulations controlling the harvest of coral reef resources.

Figure 5.2: NWHI Marine Protected Area (MPA) Map legend.

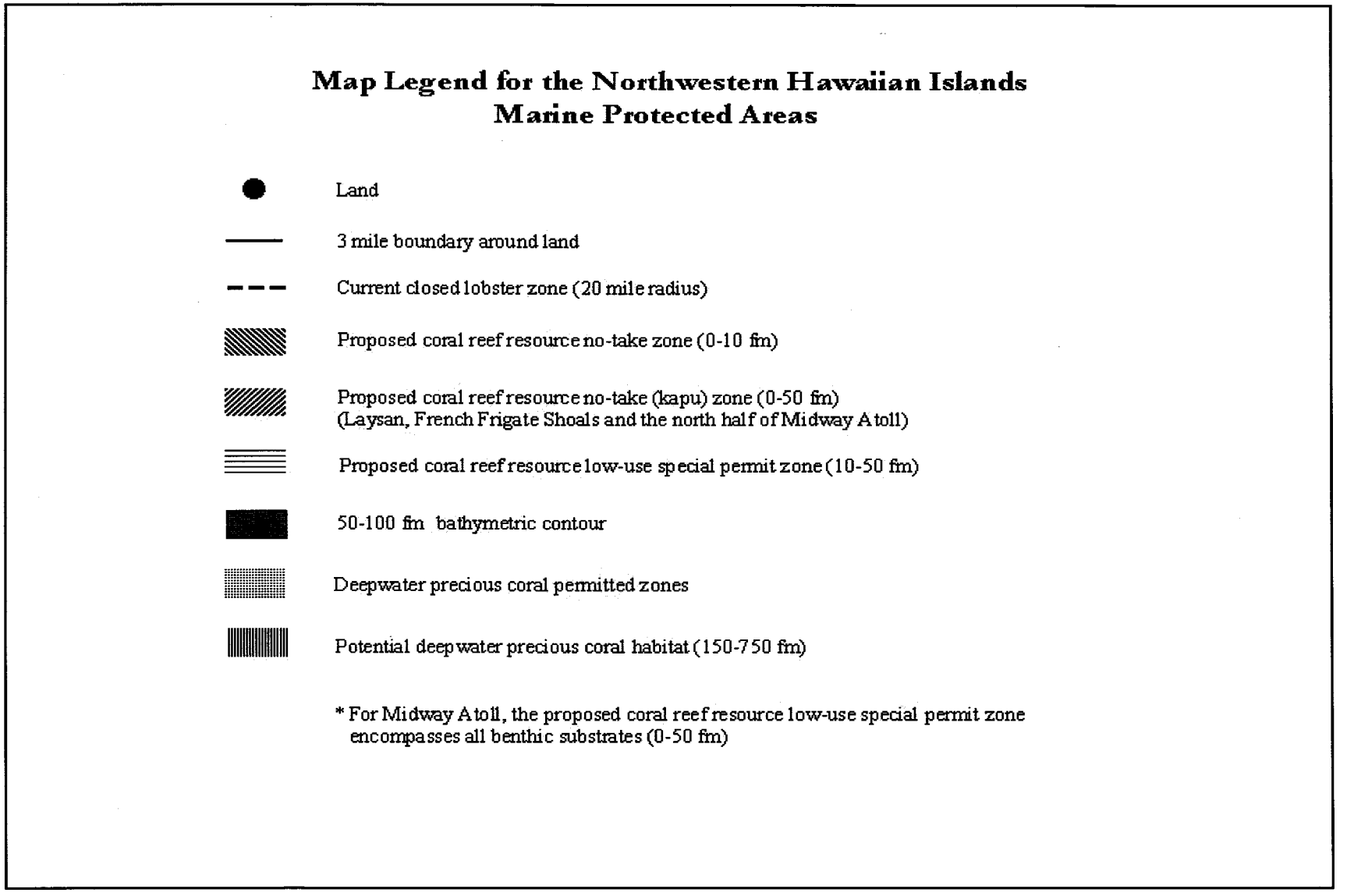


Figure 5.3 : Nihoa to Necker Island Marine Protected Area.

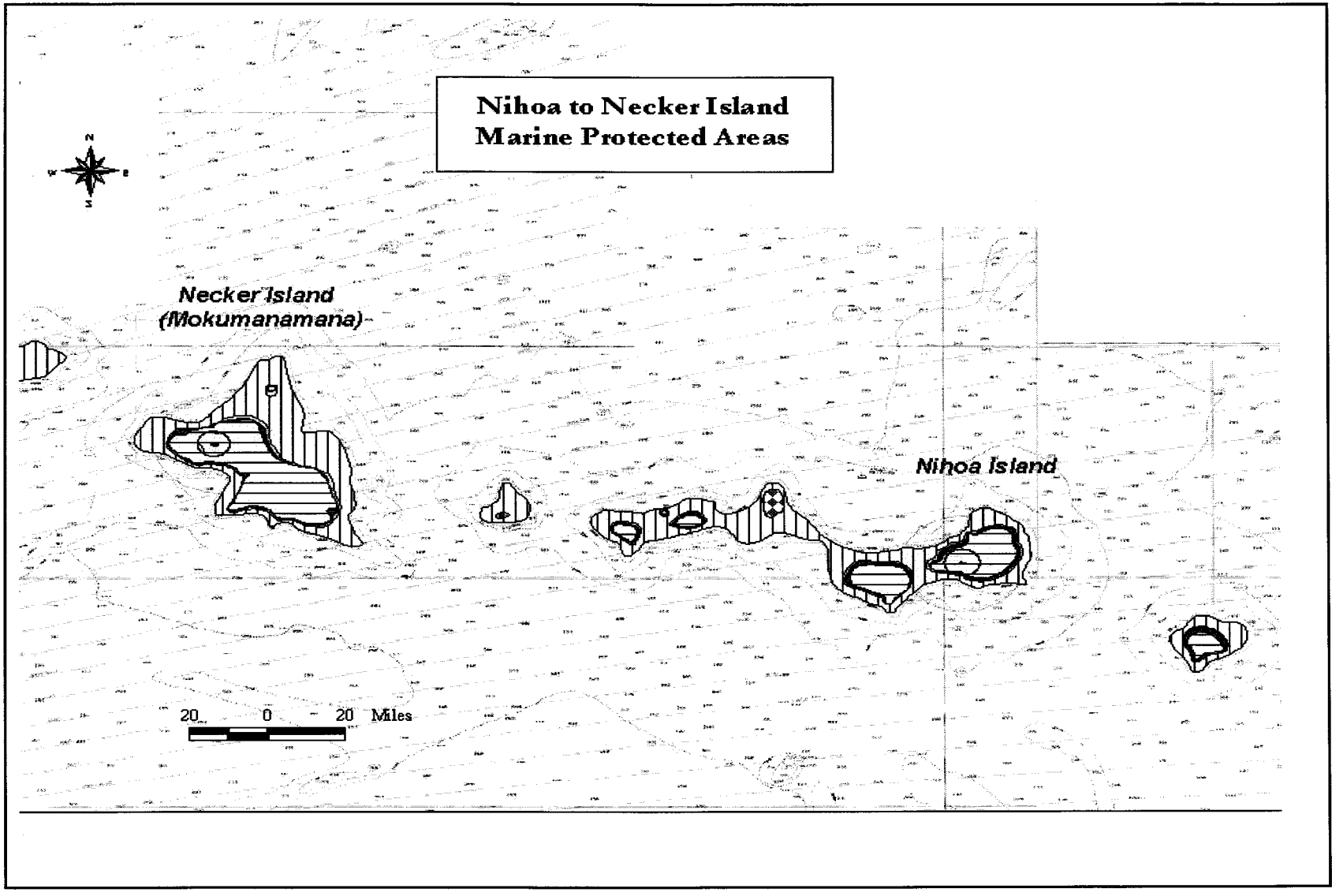


Figure 5.4: French Frigate Shoals to Raita Bank Marine Protected Area.

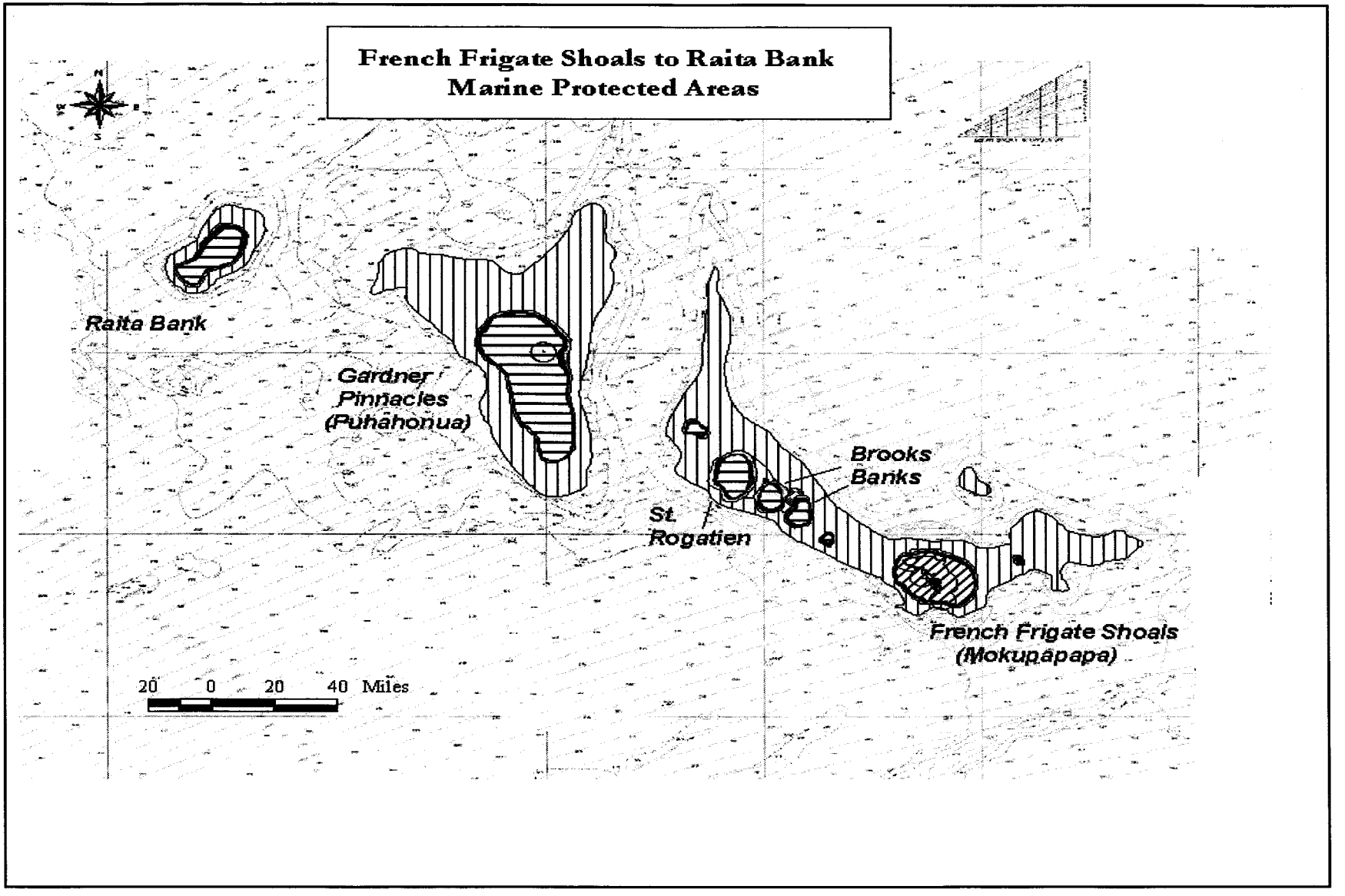


Figure 5.5: Maro Reef to Lisianski Island Marine Protected Area.

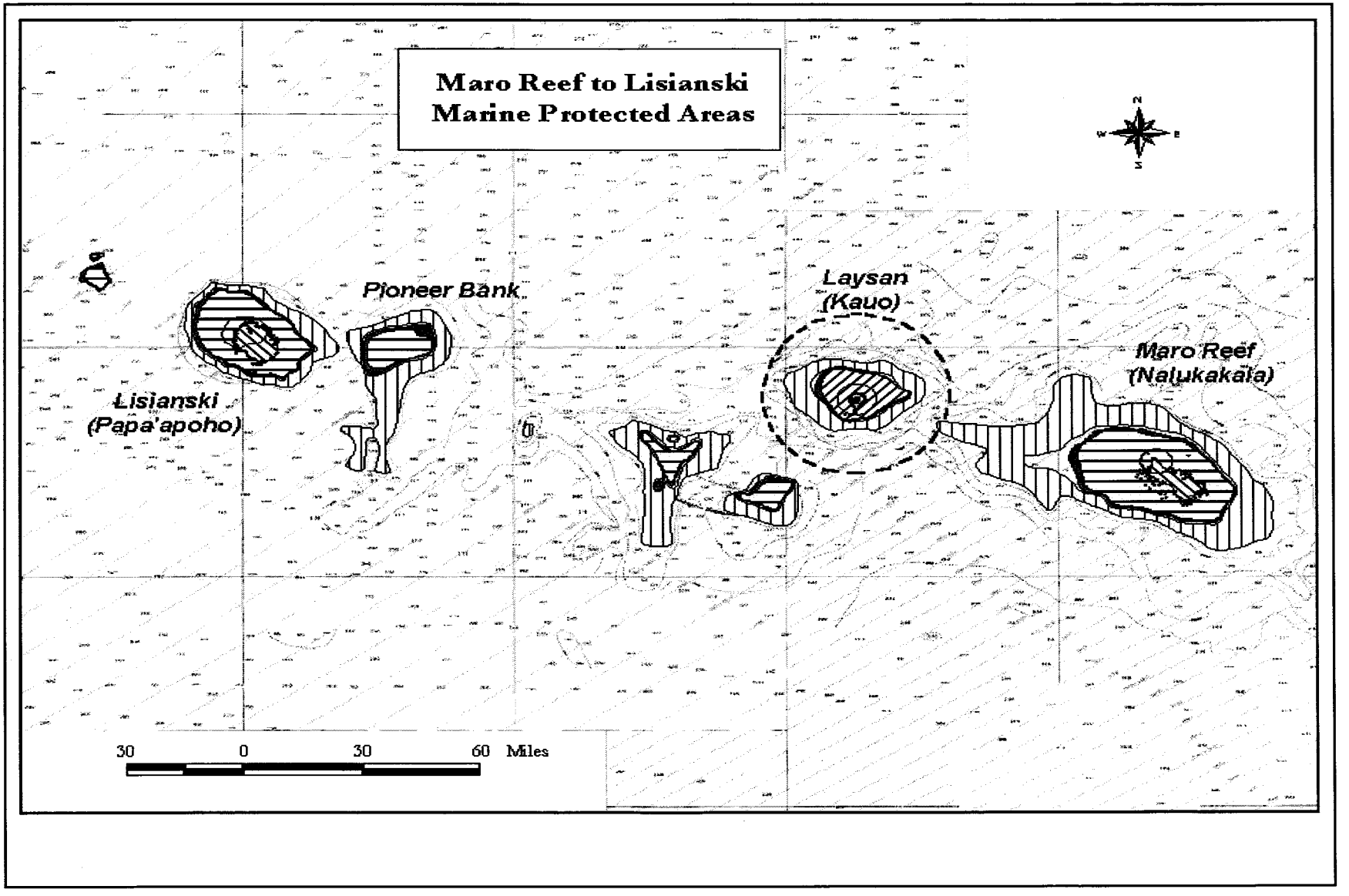


Figure 5.6: Pearl and Hermes Reef to Midway Atoll Marine Protected Area.

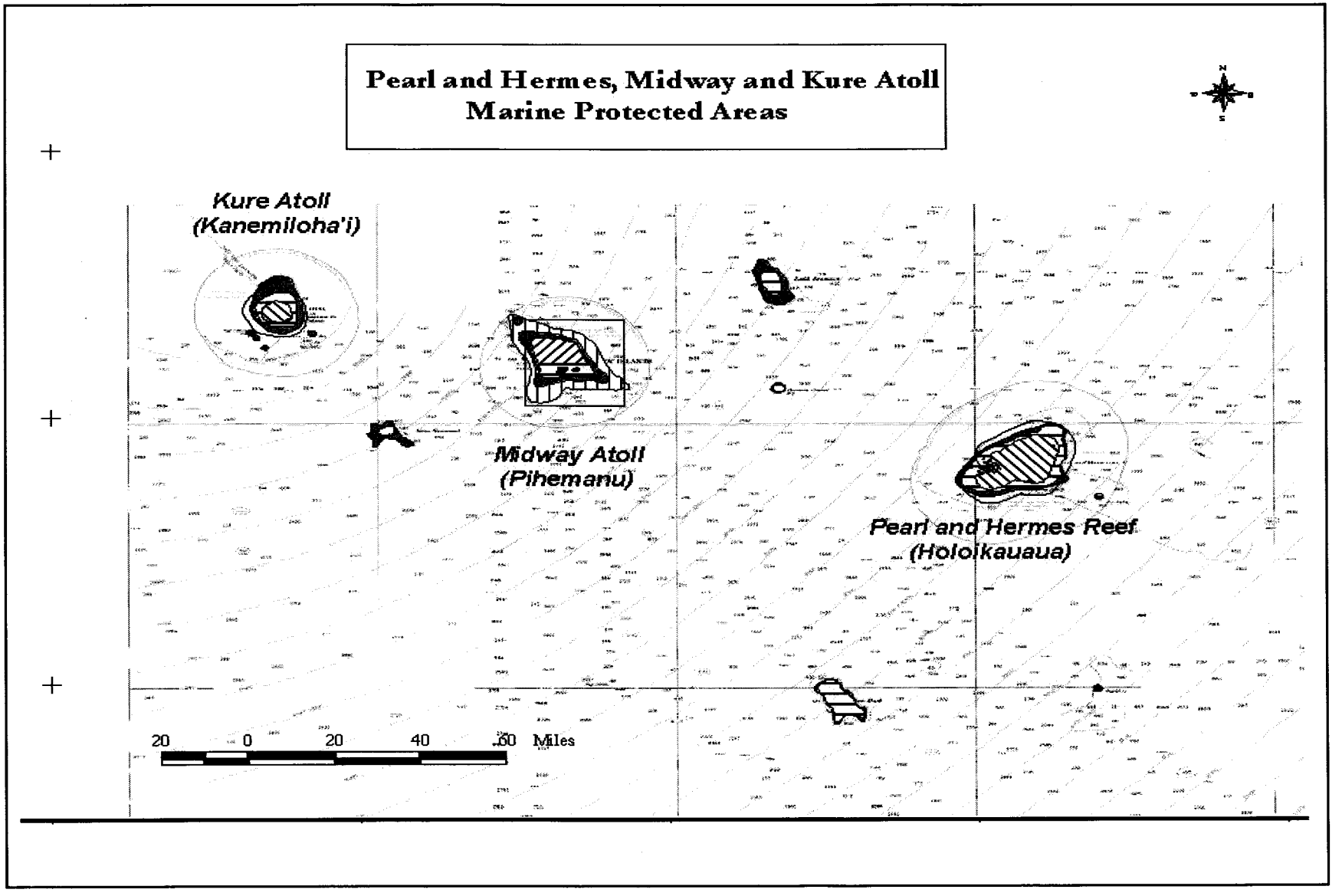


Figure 5.7: Rose Atoll Marine Protected Area.

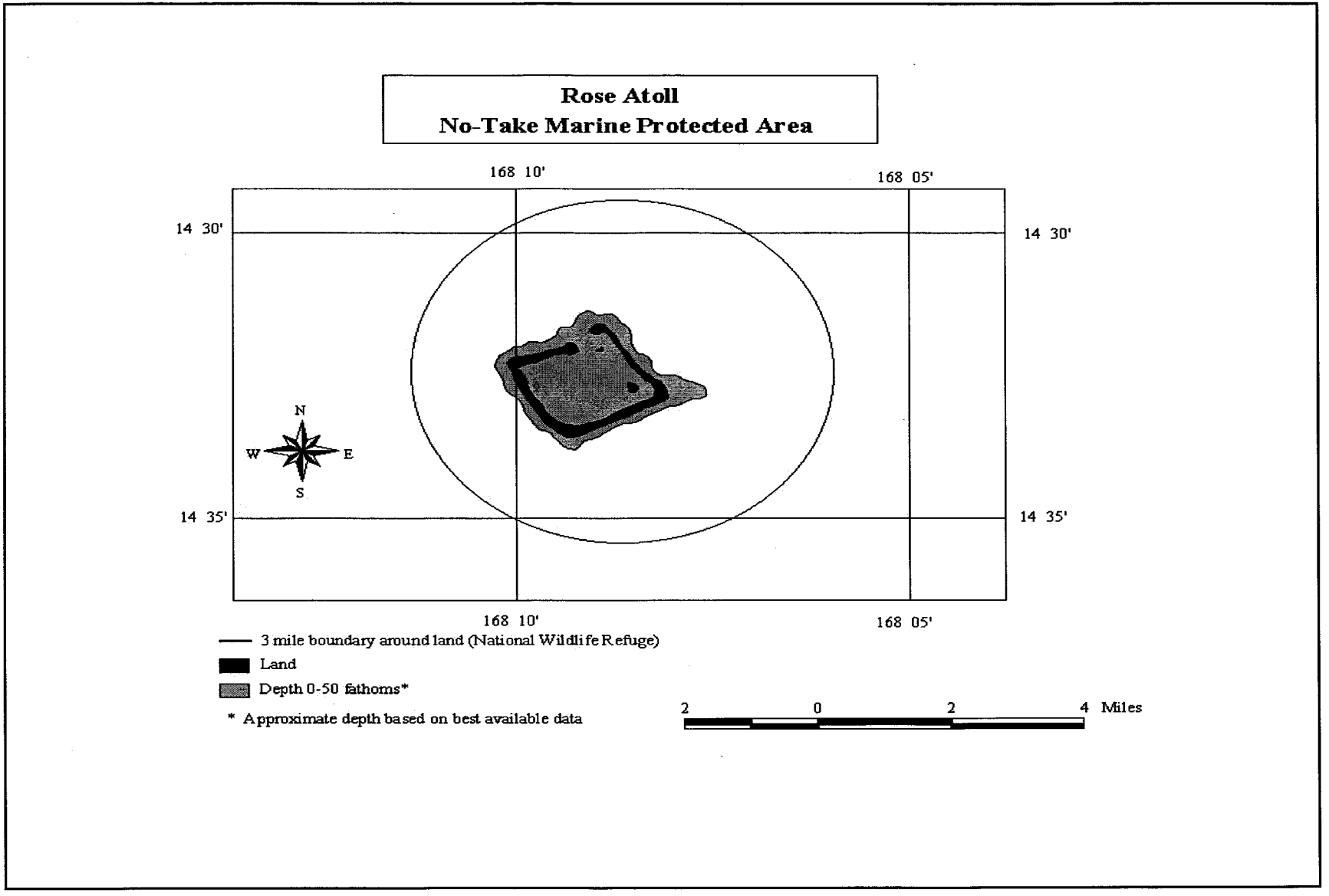


Figure 5.8: Howland Island Marine Protected Area.

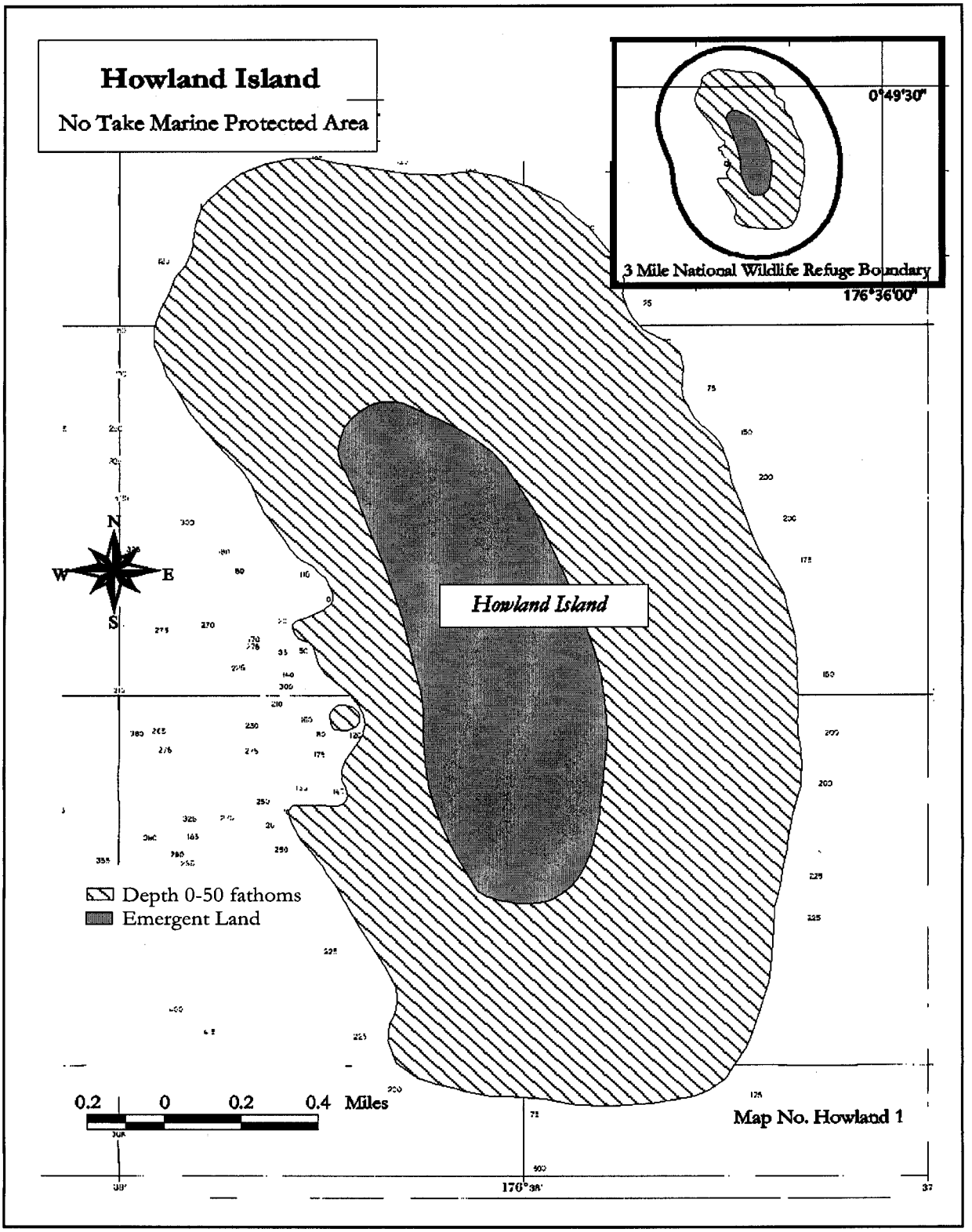


Figure 5.9: Baker Island Marine Protected Area.

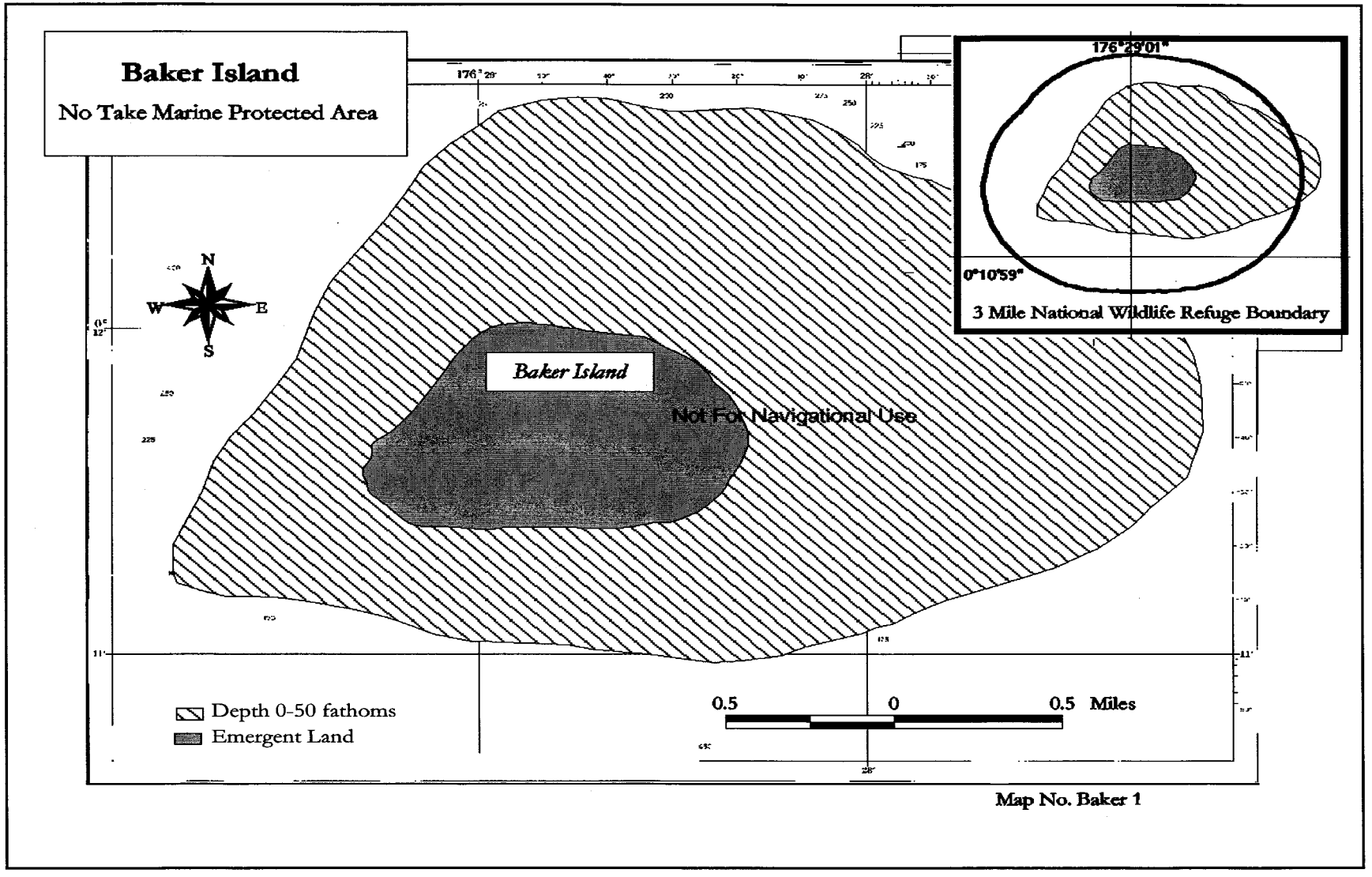


Figure 5.10: Jarvis Island Marine Protected Area.

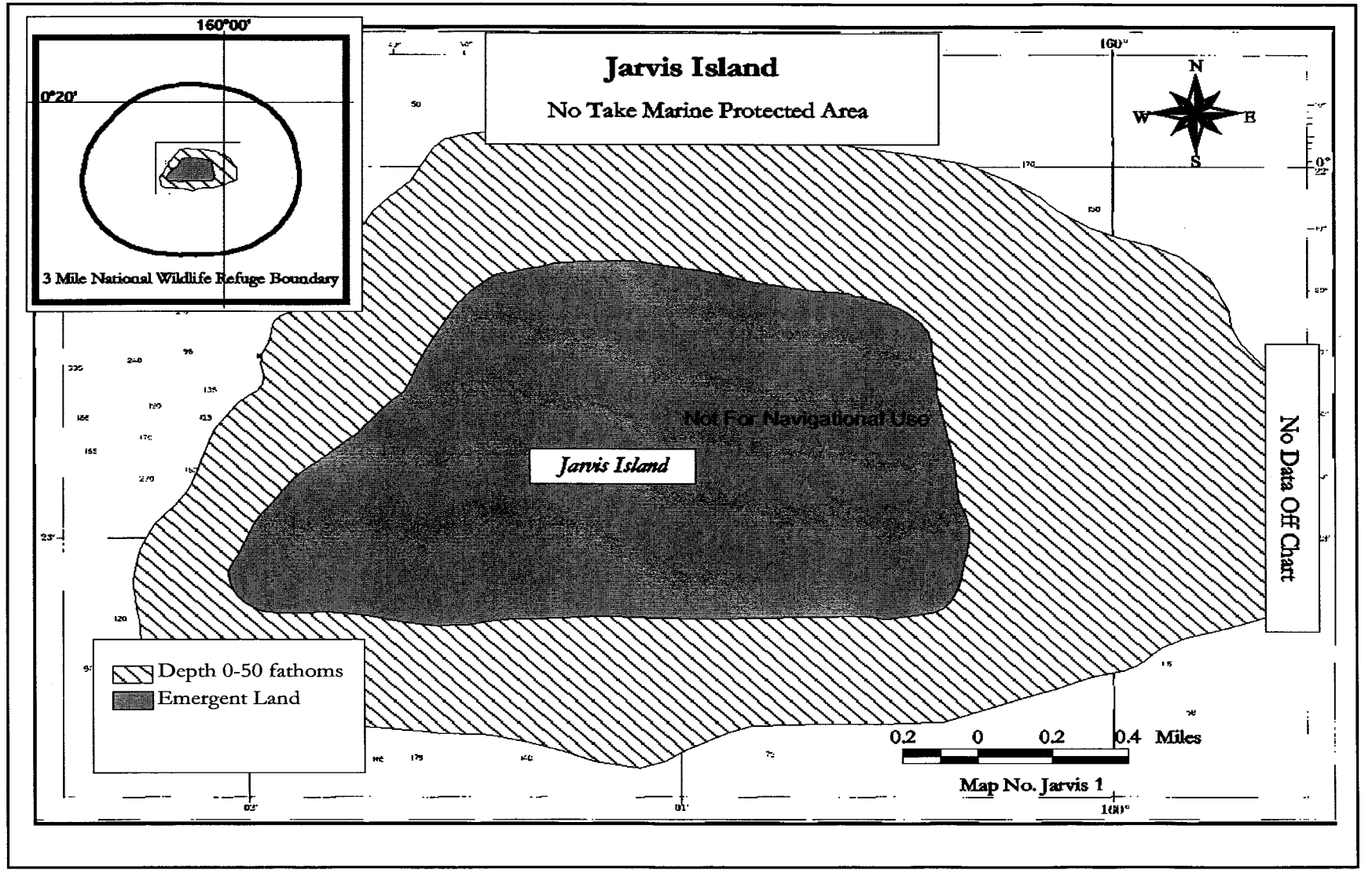


Figure 5.11: Kingman Reef Marine Protected Area.

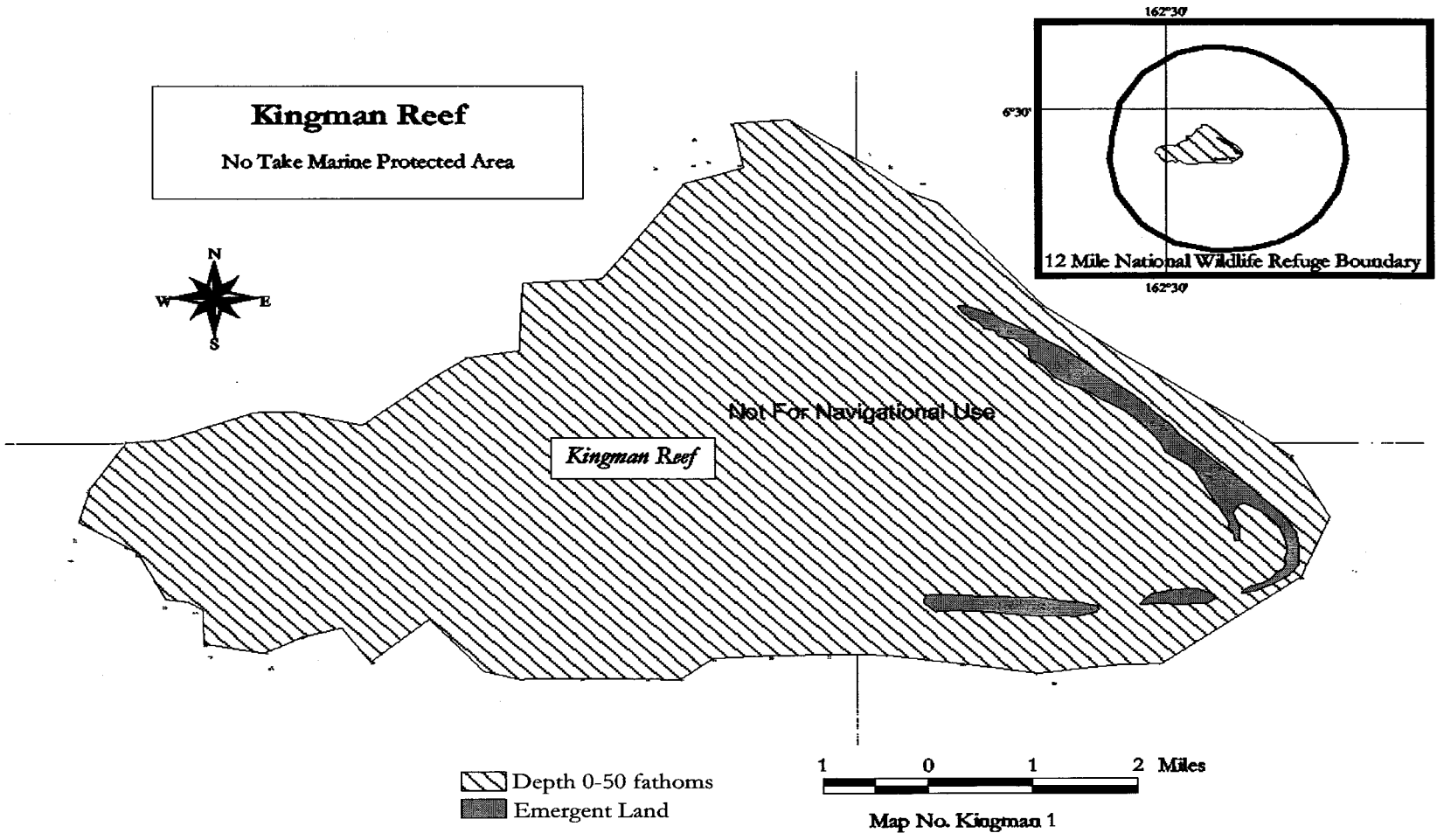


Figure 5.12: Palmyra Atoll Marine Protected Area.

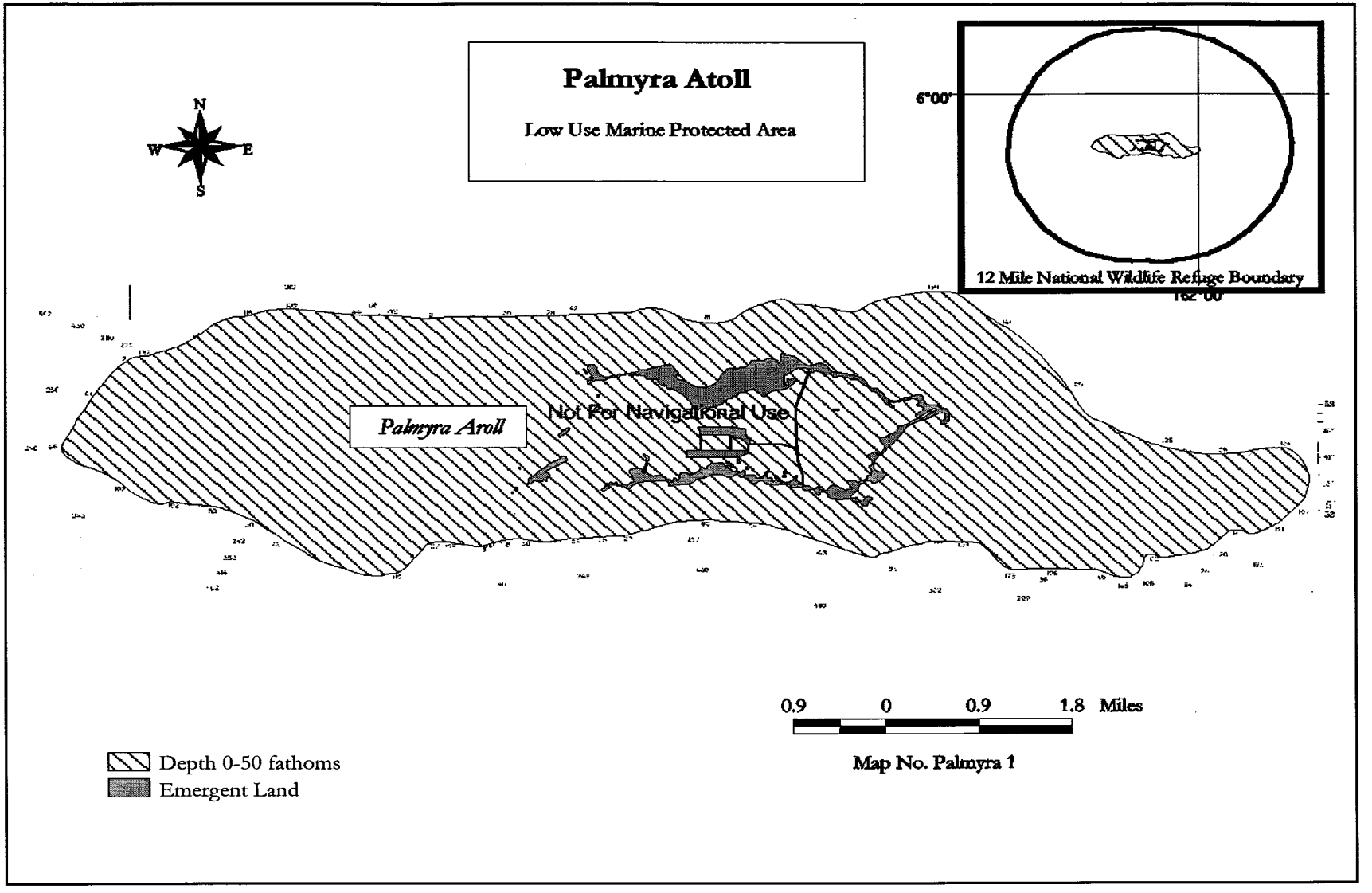


Figure 5.13: Wake Island Marine Protected Area.

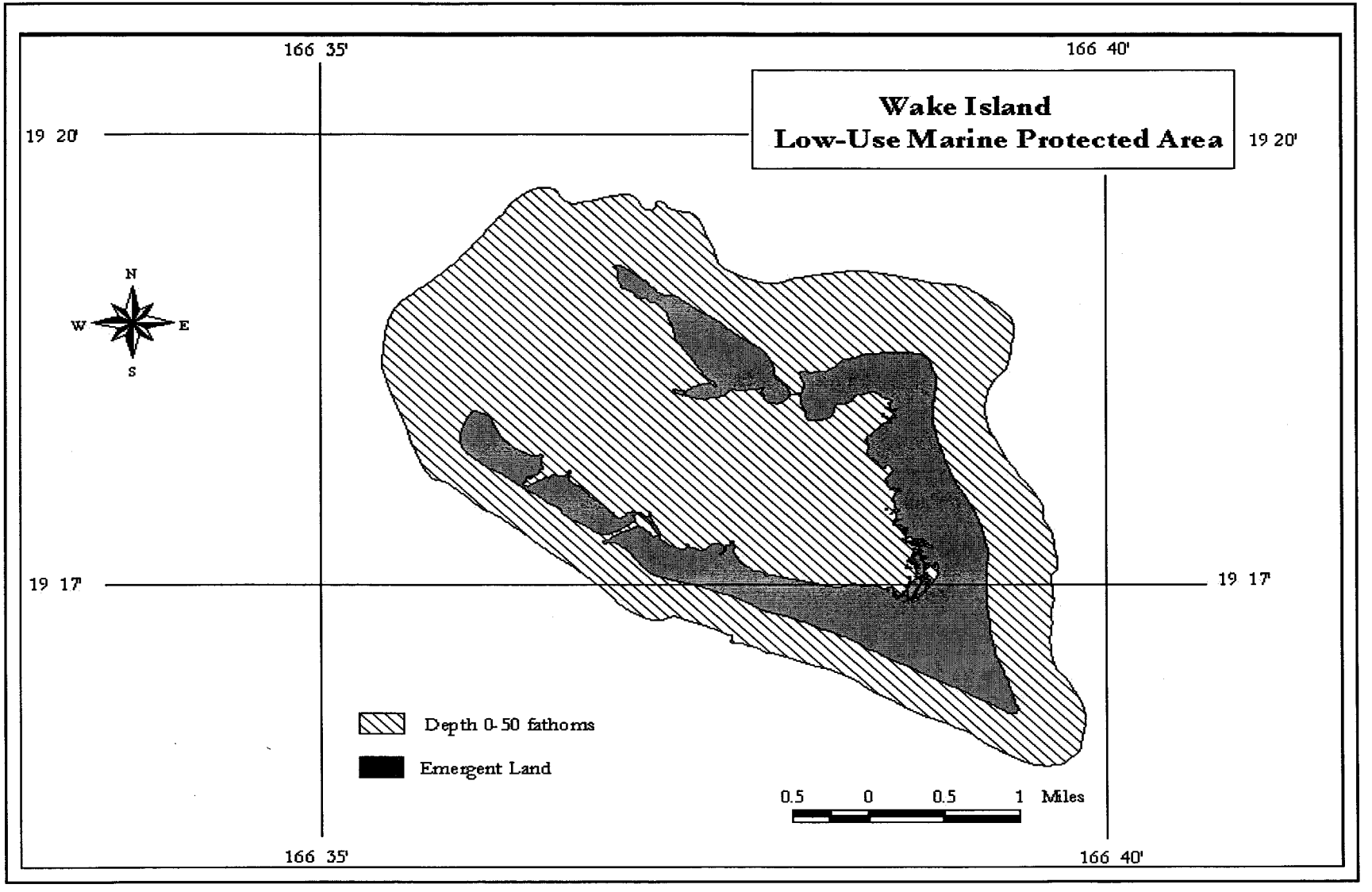
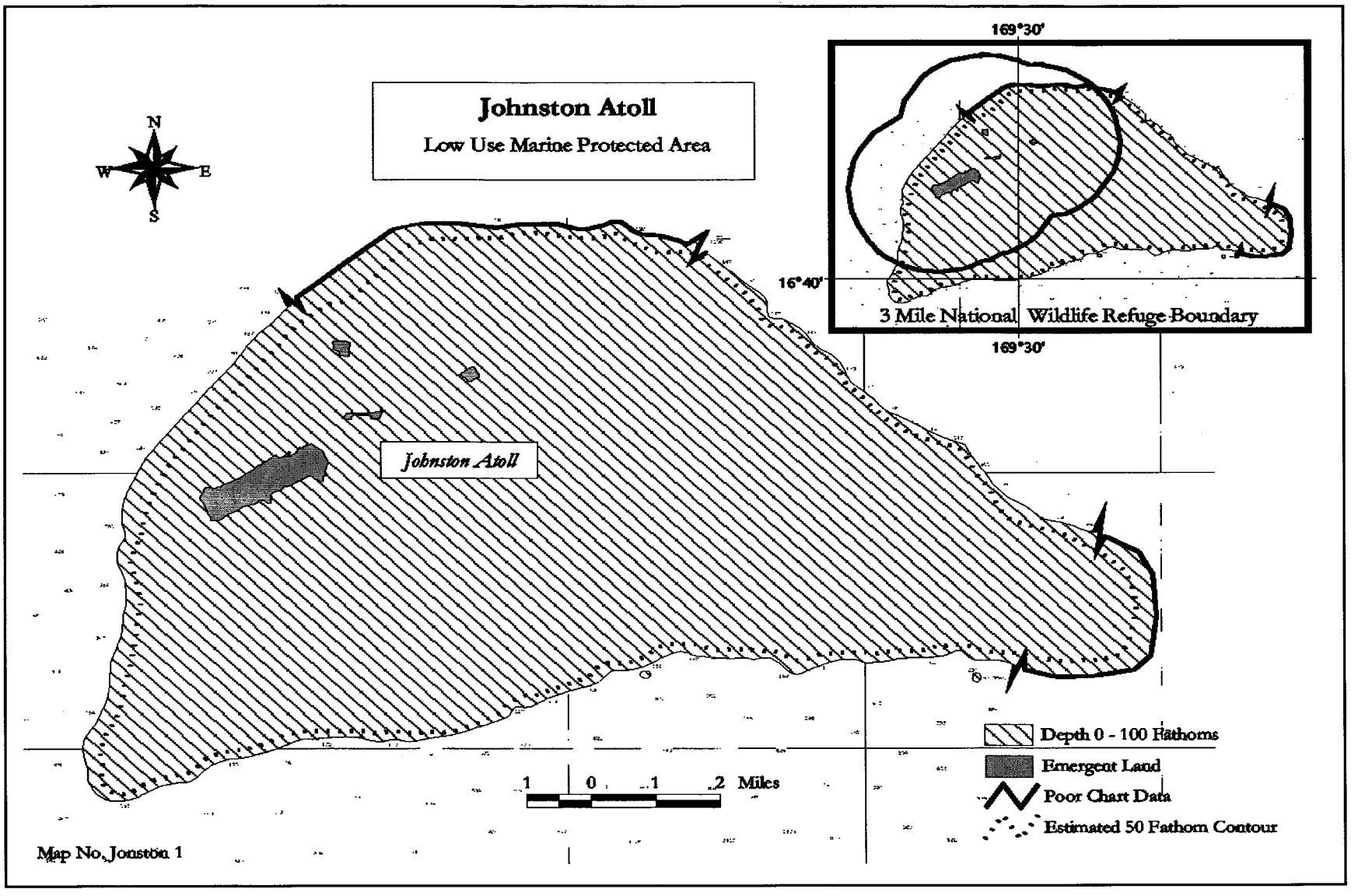


Figure 5.14 : Johnston Atoll Marine Protected Area.



CHAPTER 6

IDENTIFICATION AND DESCRIPTION OF ESSENTIAL FISH HABITAT

6.1 EFH Background

The Sustainable Fisheries Act—which amended the MSFCMA in 1996—requires several new FMP provisions. The identification and description of essential fish habitat (EFH) for all managed species[1] is among the most important of these additions. According to the MSFCMA, EFH is "those waters and substrate necessary to fish for spawning, breeding or growth to maturity." This new mandate represents a significant shift in fishery management policy. Because councils must now consider management unit species' ecological role, they must move beyond traditional single- or multi-species management to a broader ecosystem-based approach. This fits well with the objectives of this fishery ecosystem plan, and more generally, the principals set forth by the Ecosystem Principles Advisory Panel (EPAP 1999), which have guided this plan's development. As their report pointed out, many existing MSFCMA requirements—EFH in particular—contribute to the ecosystem approach, if effectively implemented.

The EFH provisions are especially important because of the procedural requirements they impose on both councils and federal agencies. First, in their FMPs, councils must identify adverse impacts to EFH resulting from both fishing and non-fishing activities, and describe measures to minimize these impacts. Second, councils can provide comments and make recommendations to federal or state agencies that propose actions that may affect the habitat, including EFH, of a managed species. Based on these comments, and comments from other agencies, the Secretary of Commerce makes recommendations to the action agency on how to minimize the adverse impacts of their actions. Within 30 days, the action agency must provide a written response, describing how they intend to minimize or mitigate identified adverse impacts.

EFH designations in this FMP are based on the best available scientific information, including both environmental and fisheries data. This information was obtained through a series of public meetings of the Council, Scientific and Statistical Committee, FMP plan teams, and fishing industry advisory panels. In addition, the Council worked in close cooperation with NMFS scientists.

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[1]Subsequent guidance allows either individual species or species assemblages to be described.

6.1.1 Description of EFH

NMFS guidelines for EFH implementation require that in their FMPs councils:

- Identify and describe EFH for all species managed under an FMP;
- Describe adverse impacts to EFH from fishing activities;
- Describe adverse impacts to EFH from non-fishing activities; and,
- Recommend conservation and enhancement measures to minimize and mitigate the adverse impacts to EFH resulting from fishing- and non-fishing-related activities.

The guidelines recommend that each Council prepare a preliminary inventory of available environmental and fisheries information on managed species. Such an inventory is useful in describing and identifying EFH, and helps to identify missing information about the habitat of a particular species. A wide range of basic information is needed to identify EFH, including data on current and historic stock size, the geographic range of the managed species, the habitat requirements by life history stage, and the distribution and characteristics of those habitats. Since EFH has to be identified for each major life history stage, information about a species' distribution, density, growth, mortality, and production within all the habitats it occupies, or formerly occupied, is also necessary. The inventory should classify these data according to their quality, using these four categories:

Level 1: All that is known is where a species occurs based on distribution data for all or part of the geographic range of the species;

Level 2: Data on habitat-related densities or relative abundance of the species are available;

Level 3: Data on growth, reproduction or survival rates within habitats are available; and,

Level 4: Production rates by habitat are available.

With higher quality data, those habitats most highly valued by a species can be identified, allowing a more precise designation of EFH. Habitats of intermediate and low value also may be essential, depending on the health of the fish population and the ecosystem. For example, if a species is overfished, and habitat loss or degradation is thought to contribute to its overfished condition, all habitats currently used by the species may be essential. However, no Level 3 or Level 4 data are yet available for CRE MUS.

Despite these data limitations, this FMP describes EFH in text and tables that provide information on the biological requirements for the egg, larvae, juvenile, and adult life stages of all MUS. Because of these limitations, the Council adopted a precautionary approach to EFH designation. As result, the Council's EFH designation for CRE MUS covers all the waters and habitat at depths from the sea surface to 50 fathoms extending from the shoreline (including state and territorial lands and waters) to the outer boundary of the EEZ. This broad EFH designation will ensure that enough habitat is protected to sustain managed species.

In addition to text and tabular descriptions, the distribution and geographic limits of CRE MUS EFH were mapped, using a computer-based geographic information system. This facilitates analysis and presentation. More detailed and informative maps will be produced as more complete information about population responses (e.g., growth, survival, or reproductive rates) to habitat characteristics becomes available.

The Western Pacific Region comprises a range of marine ecosystems used as habitat by coral reef organisms, and each constituent state differs in the type of reef habitat that they contain (Green 1997). (Table 6.1 summarizes their distribution.) Most of the reefs in the Main Hawaiian Islands are large non-structural or fringing reefs. There are also a few barrier reefs and banks or shoals. In contrast, most of the reefs in the NWHI are banks/shoals, although there are also a few atolls, and non-structured and fringing reefs. Similarly, the reefs in the CNMI tend to be mostly banks/shoals or non-structural reefs, although there are some fringing and barrier/lagoon reefs. American Samoa has mostly fringing reefs, with two remote atolls and two non-structural reefs. Most of the reefs on Guam are a mixture of banks/shoals, barrier/lagoon and fringing or non-structural reefs. Other U.S. Pacific Islands are either atolls or have fringing reefs.

Table 6.1: Occurrence of habitat types in the Western Pacific Region.

	AS	CNMI	Guam	HI	Other
Estuaries	x	x	x	x	
Fringing Reefs	x	x	x	x	x
Atolls	x			x	x
Barrier/Lagoon	x	x	x	x	
Non-structural Reef	x	x	x	x	
Banks and Shoals	x	x	x	x	x
Seagrass Beds		x	x	x	x
Mangroves	x	x	x	x	x
Pelagic/Open Ocean	x	x	x	x	x
Deep Slope Terraces	x	x	x	x	x
Patch Reefs	x	x	x	x	x
Reef Communities/ Apron Reefs	x	x	x	x	x

Habitat protection is an essential component of a coral reef ecosystem management regime. Clearly, healthy and intact habitats are fundamental to the health and survival of coral reef species. At the same time, very little data are available to adequately document the extent of these habitats, to identify those that may be particularly critical to various life phases of significant commercial and recreational species, or to best locate appropriate areas for marine reserves.

6.1.2 EFH Designation for MUS

Ten alternatives for EFH designation were considered: (1) no action/status quo; (2) species-by-species; (3) family-by-family; (4) habitat/behavioral group; (5) reef obligate species/reef-associated species; (6) designate MUS at a higher taxonomic order; (7) representative species; (8) indicator species; (9) habitat composites; and (10) designate the sessile benthos MUS (e.g., reef-building corals) as EFH for those organisms themselves and for associated species.

This FMP uses an approach similar to one used by both the South Atlantic and the Pacific Fishery Management Councils. Using this approach, MUS are linked to specific habitat "composites" (e.g., sand, live coral, seagrass beds, mangrove, open ocean) for each life history stage, consistent with the depth of the ecosystem to 50 fathoms and to the limit of the EEZ. These designations could also protect species managed under other Council FMPs to the degree that they share these habitats.

Except for several of the major coral reef associated species, very little is known about the life histories, habitat utilization patterns, food habits, or spawning behavior of most coral reef associated species. For this reason, the Council has designated EFH using a two-tiered approach based on the division of MUS into the Currently Harvested Coral Reef Taxa (CHCRT) and Potentially Harvested Coral Reef Taxa (PHCRT) categories (see Section 1.6.2). This is also consistent with the use of habitat composites.

Currently Harvested Coral Reef Taxa MUS

In the first tier, EFH has been identified for species which are: (1) currently being harvested in state and federal waters and for which some fishery information is available, and (2) are likely to be targeted in the near future based on historical catch data. Table 6.2 summarizes the habitat types used by CHCRT species, grouped into higher taxonomic orders. (Tables 6.2-6.6 may be found after Section 6.2.) The designations of EFH for these MUS are summarized in Table 6.3.

To reduce the complexity and the number of EFH identifications required for individual species and life stages, the Council has designated EFH for species assemblages pursuant to 50 CFR 600.815 (a)(2)(ii)(E). The designation of these "complexes" is based on the ecological relationships among species and their preferred habitat. These species complexes are grouped by the known depth distributions of individual MUS. For a broader description of the life history and habitat utilization patterns of CHCRT, see Volume III.

Potentially Harvested MUS

EFH has also been designated for the second tier, Potentially Harvested Coral Reef Taxa. These taxa include literally thousands of species encompassing almost all coral reef fauna and flora. However, there is very little scientific knowledge about the life histories and habitat requirements of the thousands of species of organisms that compose these taxa. In fact, a large percentage of these biota have not been described by science. Therefore, the Council has used the

precautionary approach in designating EFH for PHCRT so that enough habitat is protected to sustain managed species. Table 6.4 summarizes the habitat types used by PHCRT species, grouped into higher taxonomic orders. The designation of EFH for these MUS is summarized in Table 6.5. As with CHCRT, the Council has designated EFH for species assemblages pursuant to the federal regulations cited above, and Volume III also contains more detailed descriptions of PHCRT.

6.2 Habitat Areas of Particular Concern

In addition to EFH, the Council also identified habitat areas of particular concern (HPAC) for Coral Reef Ecosystem MUS. HAPCs are specific areas within EFH that are essential to the life cycle of important coral reef species. In determining whether a type or area of EFH should be designated as an HAPC, one or more of the following criteria established by NMFS must be met: (1) the ecological function provided by the habitat is important; (2) the habitat is sensitive to human-induced environmental degradation; (3) development activities are, or will be, stressing the habitat type; or (4) the habitat type is rare. However, it is important to note that if an area meets only one of the HAPC criteria, it will not necessarily be designated an HAPC.

Because of the already-noted lack of scientific data, the Council considered locations that are known to support populations of Coral Reef Ecosystem MUS and meet NMFS criteria for HAPC. Although not one of the criteria established by NMFS, the Council considered designating areas that are already protected—for example, wildlife refuges—as HAPC. The HAPCs identified in Table 6.6 have met at least one of the four criteria listed above, or the fifth criterion just identified. However, a great deal of life history work needs to be done in order to adequately identify the extent of HAPCs and link them to particular species or life stages.

Table 6.2a: Occurrence of Currently Harvested Management Unit Species.

Habitats: Mangrove (Ma) Lagoon (La) Estuarine (Es) Seagrass Beds (SB) Soft substrate (Ss) Coral Reef/Hard Substrate (Cr/Hr) Patch Reefs (Pr) Surge Zone (Sz) Deep-slope Terraces (DST) Pelagic/Open Ocean (Pe)

Life-history stages: Egg (E) Larvae (L) Juvenile (J) Adult (A) Spawners (S)

	Ma	La	Es	SB	Ss	Cr/Hs	Pr	Sz	DST	Pe
Acanthuridae (surgeonfishes) Subfamily Acanthurinae (surgeonfishes) Orange-spot surgeonfish (*Acanthurus olivaceus*) Yellowfin surgeonfish (*Acanthurus xanthopterus*) Convict tang (*Acanthurus triostegus*) Eye-striped surgeonfish (*Acanthurus dussumieri*) Blue-lined surgeon (*Acanthurus nigroris*) Whitebar surgeonfish (*Acanthurus leucopareius*) Blue-banded surgeonfish (*Acanthurus lineatus*) Blackstreak surgeonfish (*Acanthurus nigricauda*) Whitecheek surgeonfish (*Acanthurus nigricans*) White-spotted surgeonfish (*Acanthurus guttatus*) Ringtail surgeonfish (*Acanthurus blochii*) Brown surgeonfish (*Acanthurus nigrofuscus*) Elongate surgeonfish (*Acanthurus mata*) Mimic surgeonfish (*Acanthurus pyroferus*) Yellow-eyed surgeonfish (*Ctenochaetus strigousus*) Striped bristletooth (*Ctenochaetus striatus*) Twospot bristletooth (*Ctenochaetus binotatus*)	J	A, J, S	A, J, S	J	A, J, S	A, J, S	A, J, S		A, J	E, L
Subfamily Nasianae (Unicornfishes) Bluespine unicornfish (*Naso unicornus*) Orangespine unicornfish (*Naso lituratus*) Humpnose unicornfish (*Naso tuberosus*) Blacktounge unicornfish (*Naso hexacanthus*) Bignose unicornfish (*Naso vlamingii*) Whitemargin unicornfish (*Naso annulatus*) Spotted unicornfish(*Naso brevirostris*) Humpback unicornfish(*Naso brachycentron*) Barred unincornfish (*Naso thynnoides*) Gray unicornfish (*Naso caesius*)	J	A, J, S	J		A, S	A, J, S	A, J, S		A, S	All

	Ma	La	Es	SB	Ss	Cr/Hs	Pr	Sz	DST	Pe
Balistidae (Trigger Fish) Titan triggerfish (*Balistoides viridescens*) Clown triggerfish (*B. conspicillum*) Orangstriped trigger (*Balistapus undulatus*) Pinktail triggerfish (*Melichthys vidua*) Black triggerfish (*M. niger*) Blue Triggerfish (*Pseudobalistesfucus*) Picassofish (*Rhinecanthus aculeatus*) Wedged Picassofish (*B. rectangulus*) Bridled triggerfish (*Sufflamen fraenatus*)	J	A, J, S	J	J		A, J, S	A, J, S	A	A, S	E, L
Carangidae (jacks) Bigeye scad (Selar crumenophthalmus) Mackerel scad (Decapterus macarellus)	A, J, S	A, J, S	A, J, S	J	A, J, S	A, J, S	A, J, S	A, J, S	All	
Carcharhinidae Grey reef shark (*Carcharhinus amblyrhynchos*) Silvertip shark (Carcharhinus albimarginatus) Galapagos shark (*Carcharhinus galapagenis*) Blacktip reef shark (*Carcharhinus melanopterus*) Whitetip reef shark (*Triaenodon obesus*)	A, J	A, J	A, J	J	A, J	A, J	A, J		A, J	A, J

	Ma	La	Es	SB	Ss	Cr/Hs	Pr	Sz	DST	Pe
Holocentridae (soldierfish/squirrelfish) Bigscale soldierfish (*Myripristis berndti*) Bronze soldierfish (*Myripristis adusta*) Blotcheye soldierfish (*Myripristis murdjan*) Bricksoldierfish (*Myripristis amaena*) Scarlet soldierfish (*Myripristis pralinia*) Violet soldierfish (*Myripristis violacea*) Whitetip soldierfish (*Myripristis vittata*) Yellowfin soldierfish (*Myripristis chryseres*) Pearly soldierfish(*Myripristis kuntee*) (*Myripristis hexagona*) Tailspot squirrelfish (*Sargocentron caudimaculatum*) Blackspot squirrelfish (*Sargocentron melanospilos*) File-lined squirrelfish(*Sargocentron microstoma*) Pink squirrelfish(*Sargocentron tieroides*) Crown squirrelfish (*Sargocentron diadema*) Peppered squirrelfish (*Sargocentron punctatissimum*) Blue-lined squirrelfish (*Sargocentron tiere*) Ala'ihi (*Sargocentron xantherythrum*) (*Sargocentron furcatum*) (*Sargocentron spiniferum*) Spotfin squirrelfish(*Neoniphon spp.*)		A, J, S	A, J, S	J		A, J, S	A, J, S		A, S	E, L
Kuhliidae (flagtails) Hawaiian flag-tail (*Kuhlia sandvicensis*) Barred flag-tail (*Kuhlia mugil*)	A, J	A, J	A, J	A, J				A		E, L
Kyphosidae (rudderfishes) Rudderfish (*Kyphosus bigibbus*) (*K. Cinerascens*) (*K. Vaigiensis*)	J	A, J, S	A, J, S		A, J	A, J, S	A, J, S	A, J		All

	Ma	La	Es	SB	Ss	Cr/Hs	Pr	Sz	DST	Pe
Labridae (wrasses) Saddleback hogfish (*Bodianus bilunulatus*) Razor wrasse (Xyricthys pavo) Whitepatch wrasse (*Xyrichtes aneitensis*)		J	J	J	A, J, S	A, J, S	A, J, S		A, J, S	E, L
Triple-tail wrasse (*Cheilinus trilobatus*) Floral wrasse (*Cheilinus chlorourus*) Harlequin tuskfish (*Cheilinus fasciatus*)		A, J	J		A, J, S	A, J, S	A, J, S		A, J, S	E, L
Ring-tailed wrasse (*Oxycheilinus unifasciatus*) Bandcheek wrasse (*Oxycheilinus diagrammus*) Arenatus wrasse (*Oxycheilinus arenatus*)		A, J			A, J, S	A, J, S	A, J, S		A, J, S	E, L
Blackeye thicklip (*Hemigymnus melapterus*) Barred thicklip (*Hemigymnus fasciatus*)		A, J		J	A, J, S	J	J, S		A, J, S	E, L
Cigar wrass (*Cheilio inermis*)										
Threespot wrasse (*Halichoeres trimaculatus*) Checkerboard wrasse (*Halichoeres hortulanus*) Weedy surge wrasse (*Halichoeres margaritacous*) (*Halichoeres zeylonicus*)		A, J	J		A, J, S	A, J, S		A, J		E, L
Surge wrasse (*Thalassoma purpureum*) Redribbon wrasse (*Thalassoma quinquevittatum*) Sunset wrasse (*Thalassoma lutescens*)		A, J		J	A, J, S	A, J, S	A, J, S			E, L
Longface wrasse (*Hologynmosus doliatus*) Rockmover wrasse (*Novaculichthys taeniourus*)		A, J			A, J, S	A, J, S		A, J		
Napoleon wrasse (*Cheilinus undulatus*)	J	J		J		A, J, S	A, J, S		A, S	E, L

	Ma	La	Es	SB	Ss	Cr/Hs	Pr	Sz	DST	Pe
Mullidae (goatfish) Yellow goatfish (*Mulloidichthys spp.*) (*Mulloidichthys* Pfleugeri) (*Mulloidichthys* vanicolensis) (*Mulloidichthys flaviolineatus*) Banded goatfish (*Parupeneus spp.*) (*Parupeneus barberinus*) (*Parupeneus bifasciatus*) (*Parupeneus heptacanthus*) (*Parupeneus ciliatus*) (*Parupeneus ciliatus*) (*Parupeneus cyclostomas*) (*Parupeneus pleurostigma*) (*Parupeneus indicus*) (*Parupeneus multifaciatus*) Bantail goatfish (*Upeneus arge)*		A, J	A	A, J	A, J	A, J	A, J			E, L
Octopodidae (octopuses) *Octopus cyanea* *O. ornatus*	A, J, S	All	A, J, S	All	All	All	All		All	L
Mugilidae (Mullets) Stripped mullet (*Mulgil cephalus)* Engel's mullet (*Moolgarda engeli*) False mullet (*Neomyxus leuciscus*) Fringelip mullet (*Crenimugil crenilabis*)	J	A,J,S	A,J,S	J		A, J		A		E,L
Muraenidae (moray eels) Yellowmargin moray (*Gymnothorax flavimarginatus*) Giant moray (*Gymnothorax javanicus*) Undulated moray (Gymnothorax undulatus)	A, J, S	A, J, S	A, J, S	A, J	A, J, S	A, J, S	A, J, S	A, J, S	E, L	
Polynemidae (threadfins) Threadfin (*Polydactylus sexfilis*) -Moi	A, J	A, J, S	A, J, S		A, J, S			A, J		E, L

	Ma	La	Es	SB	Ss	Cr/Hs	Pr	Sz	DST	Pe
Priacanthidae (bigeyes) Glasseye (*Heteropriacanthus cruentatus*) Bigeye (*Priacanthus hamrur*)						A, J	A, J		A, J	E, L
Siganidae (rabbitfish) Forktail rabbitfish (*Siganus aregentus*) Golden rabbitfish (*Siganus guttatus*) Gold-spot rabbitfish (*Siganus punctatissimus*) Randall's rabbitfish (*Siganus randalli*) Scribbled rabbitfish (*Siganus spinus*) Vermiculate rabbitfish (*Signaus vermiculatus*)	A, J, S	A, J, S	A, J, S	J		A, J, S	A, J, S		E, L	
Scaridae (parrotfishes) Parrotfishes (*Scarus spp.*) Pacific longnose parrotfish (Hipposcarus longiceps) Stareye parrotfish (Catolomus carolinus)	J	A, J, S		A, J		A, J, S	A, J, S			E, L
Bumphead parrotfish (*Bolbometopon muricatum*)	J	J		J		A, J, S	A, J, S		A, J	E, L
Scombridae (tuna/mackerel) Dogtooth tuna (*Gymnosarda unicolor*)		A, J, S			A, J	A, J, S	A, J,		A, J	E, L
Sphyraenidae (barracudas) Heller's barracuda (*Sphyraena helleri*) Great Barracuda (*Sphyraena barracuda*)	A, J	A, J, S	A, J, S	J		A, J, S	A, J, S		A, S	All
Turbinidae (turban shells) Turbo sp.		A, J, S				A, J, S	A, J, S		A	E, L

Table 6.2b: Occurrence of Currently Harvested Management Unit Species: Aquarium Taxa/Species.

	Ma	La	Es	SB	Ss	Cr/Hs	PR	Sz	DST	Pe
Acanthuridae (surgeonfishes) Yellow tang (*Zebrasoma flavescens*) Yellow-eyed surgeonfish (*Ctenochaetus strigosus*) Achilles tang (*Acanthurus achilles*)	J	A, J, S	A, J, S	J	A, J, S	A, J, S	A, J, S		A, J	E, L
Zanclidae Moorish Idol (*Zanclus cornutus*)	J	A, J, S	J	J		A, J, S	A, J, S			E, L
Pomacanthidae (angelfishes) *Centropyge shepardi* *C. flavissimus*		A, J				A, J	A, J	A	J	E, L
Muraenidae Dragon moray (*Enchelycore pardalis*,)	A, J, S	A, J, S	A, J, S	A, J	A, J, S	A, J, S	A, J, S	A	A, J, S	E, L
Cirrhitidae (hawkfishes) Longnose hawkfish (*Oxycirrhites typus*) Flame hawkfish (*Neocirrhitus armatus*)		A, J, S				A, J, S	A, J, S	A	A, J, S	All
Chaetodontidae (butterflyfishes) Threadfin butterflyfish (*Chaetodon auriga*) Raccoon butterflyfish (*Chaetodon lunula*) Black-backed butterflyfish (*Chaetodon melannotus*) Saddled butterflyfish (*Chaetodon ephippium*)		A, J				A, J	A, J			E, L
Pomacentridae (damselfishes) Blue-green chromis (*Chromis viridis*) Humbug dascyllus (*Dascyllus aruanus*) Threespot dascyllus (*Dascyllus trimaculatus*)		A, J				A, J	A, J	A	A, J	E, L
Sabellidae (feather-duster worms)	A, J, S	A, J, S	A, J, S		A, J, S	A, J, S	A, J, S	A	A, J, S	E, L

Table 6.3: Summary of EFH designations for Currently Harvested Coral Reef Taxa.

Species Assemblage/Complex	EFH (Egg and Larvae)	EFH (Adult and Juvenile)
Acanthuridae	The water column from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All bottom habitat and the adjacent water column from 0 to 50 fm.
Balistidae	The water column from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All bottom habitat and the adjacent water column from 0 to 50 fm.
Carangidae	The water column from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All bottom habitat and the adjacent water column from 0 to 50 fm.
Carcharhinidae	N/A	All bottom habitat and the adjacent water column from 0 to 50 fm to the outer extent of the EEZ.
Holocentridae	The water column from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All rocky and coral areas and the adjacent water column from 0 to 50 fm.
Kuhliidae	The water column from the shoreline to the outer limits of the EEZ to a depth of 50 fm.	All bottom habitat and the adjacent water column from 0 to 25 fm.
Kyphosidae	Egg, Larvae and Juvenile: the water column from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All rocky and coral bottom habitat and the adjacent water column from 0 to 15 fm.
Labridae	The water column and all bottom habitat extending from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	
Mullidae	The water column extending from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All rocky/coral and sand-bottom habitat and adjacent water column from 0 to 50 fm.
Mugilidae	The water column from the shoreline to the outer limits of the EEZ to a depth of 50 fm.	All sand and mud bottoms and the adjacent water column from 0 to 25 fm.
Muraenidae	The water column from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All rocky and coral areas and the adjacent water column from 0 to 50 fm.
Octopodidae	Larvae: The water column from the shoreline to the outer limits of the EEZ to a depth of 50 fm.	EFH for the adult, juvenile phase and demersal eggs is defined as all coral, rocky and sand-bottom areas from 0 to 50 fm.

Species Assemblage/Complex	EFH (Egg and Larvae)	EFH (Adult and Juvenile)
Polynemidae	The water column extending from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All rocky/coral and sand-bottom habitat and the adjacent water column from 0 to 50 fm.
Priacanthidae	The water column extending from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All rocky/coral and sand-bottom habitat and the adjacent water column from 0 to 50 fm.
Scaridae	The water column from the shoreline to the outer limit of the EEZ to a depth of 50 fm.	All bottom habitat and the adjacent water column from 0 to 50 fm
Siganidae	The water column from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All bottom habitat and the adjacent water column from 0 to 50 fm.
Scombridae	EFH for all life stages of dogtooth tuna is designated as the water column from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	
Sphyraenidae	EFH for all life stages in the family Sphyraenidae is designated as the water column from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	
Turbinidae	The water column from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All bottom habitat and the adjacent water column from 0 to 50 fm.
Aquarium Species/Taxa	All waters from 0-50 fm from the shoreline to the limits of the EEZ.	All coral, rubble, or other hard-bottom features and the adjacent water column from 0-50 fm.

Table 6.4: Occurrence of Potentially Harvested Coral Reef Taxa.

Habitat: Mangrove (Ma) Lagoon (La) Estuarine (Es) Seagrass Beds (SB) Soft substrate (Ss) Coral Reef/Hard Substrate (Cr/Hr) Patch Reefs (Pr) Deep-slope Terraces (DST) Pelagic/Open Ocean (Pe).

Life History Stage: Egg (E) Larvae (L) Juvenile (J) Adult (A) Spawners (S).

Management Unit Species/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	DST	Pe
Labridae spp. (wrasses)	J	A, J, E	J	J	A, J	A, J, S	A, J, S	A, J	E, L
Kuhliidae	A, J	A, J	All	A, J		A, S	A, S		E, L
Carcharhinidae*, Sphyrnidae, (sharks)	A, J	A, J	A, J		A, J	A, J	A, J	A, J	A, J
Dasyatididae, Myliobatidae, Mobulidae (rays)	A, J	A, J	A, J		A, J	A, J	A, J	A, J	A, J
Serranidae spp.* (groupers)	J	A, J		J	A, J, S	A, J, S	A J, S	A, S	E, L
Carangidae* (jacks/trevallies)	A, J, S	A, J, S	A, J, S	J	A, J, S	A, J, S	A, J, S	A, J, S	All
Holocentridae spp. (soldierfish/squirrelfish)		A, J, S	A, J, S	J		A, J, S	A, J, S	A, S	E, L
Scaridae spp. (parrotfishes)	J	A, J, S		A, J		A, J, S	A, J, S		E, L
Bumphead parrotfish (*Bolbometopon muricatum*)	J	J		J		A, J, S	A, J, S		E, L
Mullidae spp. (goatfish)	A, J, S	A, J, S	A, J, S	A, J	A, J, S	A, J, S	A, J, S	A, J	E, L
Acanthuridae spp. (surgeonfish/unicornfish)	J	A, J, S	A, J, S	J	A, J, S	A, J, S	A, J, S	A, J	E, L
Lethrinidae spp. (emperors), *	J	A, J, S	J	J	A, J, S	A, J, S	A, J, S	A, S	E, L
Chlopsidae, Congridae, Moringuidae, Ophichthidae, Muraenidae (eels)	A, J, S	A, J, S	A, J, S	A, J	A, J, S	A, J, S	A, J, S	A, J, S	E, L
Apogonidae (cardinalfish)	A, J, S	A, J, S	A, J, S	A, J, S		A, J, S	A, J, S	A, J, S	E, L
Zanclidae spp. (moorish idols)		A, J				A, J	A, J		E, L
Chaetodontidae spp. (butterflyfish)	J	A, J, S	J	J		A, J, S	A, J, S	A, S	E, L
Pomacanthidae spp. (angelfish)	J	A, J, S	J	J		A, J, S	A, J, S	A, S	E, L
Pomacentridae spp. (damselfish)	J	A, J, S	J	J		A, J, S	A, J, S	A, S	E, L

Management Unit Species/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	DST	Pe
Scorpaenidae (scorpionfish)	J	A, J, S	A, J, S	J		A, J, S	A, J, S		E, L
Blenniidae (blennies)		A, J, S	A, J, S		A, J, S	A, J, S	A, J, S	A, J, S	E, L
Ephippidae (batfish)	J	A, J, S	J		A, S	A, J, S	A, J, S	A, S	All
Monodactylidae (mono)	A, J, S	A, J, S	A, J, S			A, J, S	A, J, S		E, L
Haemulidae (sweetlips)	J	A, J, S	A, J, S	J		A, J, S	A, J, S		E, L
Echineididae (remoras)						A, J, S	A, J, S	A, J, S	E, L
Malacanthidae (tilefish)		A, J, S			A, J, S	A, J, S	A, J, S		E, L
Acanthoclinidae (spiny basslets)						A, J		A, J	E, L
Pseudochromidae (dottybacks)	J	J		J		A, J, S	A, J, S		E, L
Plesiopidae (prettyfins)	J	A, J, S				A, J, S	A, J, S		E, L
Tetrarogidae (waspfish)	J	A, J, S				A, J, S	A, J, S		E, L
Caracanthidae (coral crouchers)						A, J, S	A, J, S		E, L
Grammistidae (soapfish)						A, J, S	A, J, S		E, L
Aulostomus chinensis (trumpetfish)	J	A, J, S		A, J	A	A, J, S	A, J, S		E, L
Fistularia commersoni (coronetfish)	J	A, J, S		A, J		A, J, S	A, J, S		E, L
Anomalopidae (flashlightfish)						J	J	A, J, S	E, L
Clupeidae (herrings)	A, J, S	A, J, S	A, J, S			A, J, S	A, J, S	A, S	All
Engraulidae (anchovies)	A, J, S	A, J, S	A, J, S			A, J, S	A, J, S	A, S	All
Gobiidae (gobies)	All	All	All	All	All	All	All	All	All
Lutjanids (snappers)*	A, J, S	A, J, S	A, J, S	J		A, J, S	A, J, S	A, S	E, L
Ballistidae/Monocanthidae spp.	J	A, J, S	J	J		A, J, S	A, J, S	A, S	L
Siganidae spp. (rabbitfishes)	A, J, S	A, J, S	A, J, S	J		A, J, S	A, J, S		E, L

Management Unit Species/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	DST	Pe
Kyphosidae	J	A, J, S	A, J, S			A, J, S	A, J, S		All
Caesionidae	J	A, J, S			A, S	A, J, S	A, J, S	A, S	All
Cirrhitidae		A, J, S				A, J, S	A, J, S	A, J, S	All
Antennariidae (frogfishes)		All		All		All	All		L
Syngnathidae (pipefishes/seahorses)	All	All		All		All	All		L
Sphyraenidae spp. (barracudas)	A, J	A, J, S	A, J, S	J		A, J, S	A, J, S	A, S	All
Priacanthidae	J	A, J, S	J			A, J, S	A, J, S	A, S	E, L
Stony corals		A, J, S	A, J, S			A, J, S	A, J, S	A, J, S	E, L
Heliopora (blue)		A, J, S	A, J, S			A, J, S	A, J, S	A, J, S	E, L
Tubipora (organpipe)						A J	A, J		
Azooxanthellates (non-reefbuilders)		A, J, S	A, J, S		A, J, S	A, J, S	A, J, S	A, J, S	E, L
Fungiidae (mushroom corals)		A, J, S	A, J, S			A, J, S	A, J, S	A, J, S	E, L
Sm/Lg Polyped Corals (endemic spp.)		A, J				A, J	A, J	A, J	
Millepora (firecorals)		A, J, S				A, J, S	A, J, S	A, J, S	E, L
Soft corals and Gorgonians		A, J, S			A, J, S	A, J, S	A, J, S	A, J, S	E, L
Anemones (non-epifaunal)	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	E, L
Zooanthids	A, J, S	A, J, S	A, J, S		A, J, S	A, J, S	A, J, S	A, J, S	E, L
Sponges	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	E, L
Hydrozoans	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	E, L
Stylasteridae (lace corals)	A, J, S	A, J, S	A, J, S			A, J, S	A, J, S	A, J, S	E, L
Solanderidae (hydroid fans)	A, J, S	A, J, S	A, J, S			A, J, S	A, J, S	A, J, S	E, L
Bryozoans	A, J, S	A, J, S	A, J, S	A, J		A, J, S	A, J, S	A, J, S	E, L

Management Unit Species/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	DST	Pe
Tunicates (solitary/colonial)	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	E, L
Feather duster worms (Sabellidae)	A, J, S	A, J, S	A, J, S		A, J, S	A, J, S	A, J, S	A, J, S	E, L
Echinoderms (e.g., sea cucumbers, sea urchins)	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	E, L
Mollusca	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	E, L
Sea Snails (gastropods)	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	E, L
Trochus spp.		A, J, S				A, J, S	A, J, S		E, L
Opistobranchs (sea slugs)	A, J	A, J, S		A, J, S	A, J, S	A, J, S	A, J, S	A, J	E, L
Pinctada margaritifera (black lipped pearl oyster)	A, J	A, J, S				A, J, S	A, J, S	A, J, S	E, L
Tridacnidae		A, J, S			A, J, S	A, J, S	A, J, S		E, L
Other Bivalves	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	E, L
Cephalopods		All	A, J, S	All	All	All	All	All	E, L
Octopodidae	A, J, S	All	A, J, S	All	All	All	All	All	L
Crustaceans*	A, J	All	A, J	A, J	A, J	All	All	All	L
Lobsters*		All			A, J	All	All	All	L
Shrimp/Mantis		All	A, J	A, J	A, J	All	All	All	L
Crabs*	A, J	All	A, J	A, J	A, J	All	All	All	L
Annelids	A, J, S	A J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	E, L
Algae	All	All	All	All	All	All	All	All	
Live rock		A, J	A, J			A, J, A	A, J, A	A J, A	E, L

*Some species belonging to this taxa will be managed under other FMPs, but ecosystem effects will be addressed by this FMP.

Table 6.5: Summary of EFH designations for Potentially Harvested Coral Reef Taxa.

Species Assemblage/Complex	**EFH (Egg and larvae)**	**EFH (Adult and Juvenile)**
All Potentially Harvested Coral Reef Taxa	EFH for all life stages of Potentially Harvested Coral Reef Taxa is designated as the water column and bottom habitat from the shoreline to the outer boundary of the EEZ to a depth of 50 fm	

Table 6.6: Habitat Areas of Particular Concern for CRE MUS.

	Rarity of Habitat	Ecological function	Susceptibility to Human Impact	Likelihood of Developmental Impacts	Existing Protective Status
NWHI					
All substrate 0-10 fm	x	x	x		x
Laysan: All substrate 0-50 fm	x	x			
Midway: All substrate 0-50 fm	x	x	x		x
FFS: All substrate 0-50 fm	x	x	x	x	
Main Hawaiian Islands					
Kaula Rock (entire bank)		x	x		x
Niihau (Lehua Island)	x	x	x		
Kauai (Kaliu Point)		x	x		
Oahu					
Pupukea (MLCD)		x	x	x	x
Shark's Cove (MLCD)			x	x	x
Waikiki (MLCD)			x	x	x
Makapuu Head/Tide Pool Reef Area		x	x	x	
Kaneohe Bay	x	x	x	x	
Kaena Point		x	x		
Kahe Reef		x	x		
Maui					
Molokini	x	x	x	x	x
Olowalo Reef Area		x	x	x	
Honolua-Mokuleia Bay (MLCD)		x	x		x
Ahihiki Kinau Natural Area Reserve	x	x	x		x
Molokai (south shore reefs)		x	x		

Table 6.6 (cont.).

	Rarity of Habitat	Ecological function	Susceptibility to Human Impact	Likelihood of Developmental Impacts	Existing Protective Status
Main Hawaiian Is. (cont.)					
Lanai					
Halope Bay		x	x		
Manele Bay		x	x	x	
Five Needles		x	x		
Hawaii					
Lapakahi Bay State Park (MLCD)		x	x		x
Pauko Bay and Reef (MLCD)		x	x		x
Kealakekua		x	x		x
Waialea Bay (MLCD)	x	x	x		x
Kawaihae Harbor-Old Kona Airport (MLCD)		x	x		x
Additional Areas					
All long-term research sites		x	x		
All CRAMP sites		x	x		
American Samoa					
Fagatele Bay	x	x			x
Larsen Bay		x	x	x	
Steps Point		x	x		
Pago Pago (North Coast of Tutuila), National Park of American Samoa	x	x	x		x
Aunuu Island	x	x	x	x	
Rose Atoll	x	x			x
South coast Ofu (marine areas)	x	x	x	x	
Aua Transect- Pago Pago harbor, oldest coral reef transect	x	x	x	x	
Tau Island	x	x	x		

Table 6.6 (cont.)

	Rarity of Habitat	Ecological function	Susceptibility to Human Impact	Likelihood of Developmental Impacts	Existing Protective Status
Guam					
Cocos Lagoon	x	x	x		
Orote Point Ecological Reserve Area	x	x	x	x	x
Haputo Point Ecological Reserve Area	x	x			x
Ritidian Point	x	x			x
Jade Shoals	x	x	x		
CMNI					
Saipan (Saipan Lagoon)	x	x	x	x	
US Pacific Remote Islands					
Wake Atoll	x	x			x
Johnston Atoll	x	x		x	x
Palmyra Atoll	x	x	x		x
Kingman Reef	x	x	x		x
Howland Island	x	x			x
Baker Island	x	x			x
Jarvis Island	x	x			x

6.3 Fishing Activities That May Adversely Affect EFH

The Council is required to act to prevent, mitigate, or minimize adverse effects from fishing upon evidence that a fishing practice has identifiable adverse effects on EFH for any management unit species (MUS) covered by an FMP. Table 6.7 summarizes EFH for species managed by other FMPs. Adverse fishing impacts may include physical, chemical, or biological alterations of the substrate and loss of, or injury to, benthic organisms, prey species, and their habitat or other components of the ecosystem. FMPs must also contain an assessment of the potential adverse effects of all fishing equipment types used in waters described as EFH. This assessment should consider the relative impacts of all fishing equipment types used in EFH on different types of habitat found within EFH.

The predominant fishing gear types—hook-and-line, longline, troll, traps—used in the fisheries managed by the Council cause few fishing-related impacts to the benthic habitat utilized by coral reef species, bottomfish, crustaceans, or precious corals. The current management regime prohibits the use of bottom trawls, bottom-set nets, explosives, and poisons. The use of non-selective gear to harvest precious corals in the MHI is prohibited. Under this FMP, only selective and non-destructive gear may be allowed to fish for CRE-MUS. Additionally, any gear type not listed in Section 5.4.2 must first be evaluated by the PIAO Administrator in consultation with the Council and the director of the affected state fishery management agency before any such gear may be used. The Council has determined that current management measures to protect fishery habitat are adequate and no additional measures are necessary at this time. However, the Council has identified the following potential sources of fishery-related impacts to benthic habitat that may occur during normal fishing operations:

- Anchor damage from vessels attempting to maintain position over productive fishing habitat.
- Heavy weights and line entanglement occurring during normal hook-and-line fishing operations.
- Lost gear from lobster fishing operations.
- Remotely operated vehicle (ROV) tether damage to precious coral during harvesting operations.

Trash discarded and lost gear (leaders, hooks, and weights) by fishing vessels operating in the EEZ, are a Council concern. A report on the first phase of a submersible-supported research project conducted in 2001 preliminarily determined that bottomfish gear exhibited minimal to no impact on the coral reef habitat (C. Kelley, pers. comm.). A November 2001 cruise in the MHI determined that precious corals harvesting has "negligible" impact on the habitat (R. Grigg, pers. comm.). The Council is concerned with habitat impacts of marine debris originating from fishing operations outside the WPR. NMFS is currently investigating the source and impacts of this debris. International cooperation will be necessary to find solutions to this broader problem.

Because the habitat of pelagic species is the open ocean, and managed fisheries employ variants of hook-and-line gear, there are no direct impacts to EFH. Lost gear may be a hazard to some species due to entanglement, but it has no direct effect on habitat. A possible impact would be caused by fisheries that target and deplete key prey species, but currently there is no such fishery.

Table 6.7: Essential Fish Habitat for Management Unit Species Managed Under Other Fishery Management Plans.

FMP	Species Complex	EFH	HAPC
Pelagic	**Temperate species** Striped Marlin (*Tetrapurus audax*); Bluefin Tuna (*Thunnus thynnus*); Swordfish (*Xiphias gladius*); Albacore (*Thunnus alalunga*); Mackeral (*Scomber* spp); Bigeye (*Thunnus obesus*); Pomfret (family Bramidae	**Eggs and larvae:** the (epipelagic zone) water column down to a depth of 200 m (100 fathoms) from the shoreline to the outer limit of the EEZ. **Juvenile/adults:** the water column down to a depth of 1,000 m (500 fathoms) from the shoreline to the outer limit of the EEZ	The water column from the surface down to a depth of 1,000 m (500 fathoms) above all seamounts and banks with summits shallower than 2,000 m (1,000 fathoms) within the EEZ.
Pelagic	**Tropical species** Yellowfin (*Thunnus albacares*); Kawakawa (*Euthynnus affinis*); Skipjack (*Katsuwonus pelamis*); Frigate and bullet tunas (*Auxis thazard, A. rochei*); Blue marlin (*Makaira nigricans*); Slender tunas (*Allothunnus fallai*); Black marlin (*Makaira indica*); Dogtooth tuna (*Gymnosarda unicolor*); Spearfish (*Tetrapturus spp*); Sailfish (*Istiophorus platypterus*); Mahimahi (*Coryphaena hippurus, C. equiselas*); Ono (*Acanthocybium solandri*); Opah (*Lampris* sp)	**Eggs and larvae:** the (epipelagic zone) water column down to a depth of 200 m (100 fathoms) from the shoreline to the outer limit of the EEZ. **Juvenile/adults:** the water column down to a depth of 1,000 m (500 fathoms) from the shoreline to the outer limit of the EEZ	The water column from the surface down to a depth of 1,000 m (500 fathoms) above all seamounts and banks with summits shallower than 2,000 m (1,000 fathoms) within the EEZ.
Pelagic	**Sharks** Requiem sharks (family Carcharinidae); Thresher sharks (family Alopiidae); Mackeral sharks (family Lamnidae); Hammerheads sharks (family Sphyrnidae)	**Eggs and larvae:** the (epipelagic zone) water column down to a depth of 200 m (100 fathoms) from the shoreline to the outer limit of the EEZ. **Juvenile/adults:** the water column down to a depth of 1,000 m (500 fathoms) from the shoreline to the outer limit of the EEZ	The water column from the surface down to a depth of 1,000 m (500 fathoms) above all seamounts and banks with summits shallower than 2,000 m (1,000 fathoms) within the EEZ.
Bottomfish and Seamount Groundfish	**Shallow water species (0-50 fm):** Uku (*Aprion virescens*), Thicklip trevally (*Pseudocaranx dentex*), Lunartail grouper (*Variola louti*), Blacktip grouper (*Epinephelus fasciatus*), Ambon emperor (*Lethrinus amboinensis*), Redgill emperor (*Lethrinus rubrioperculatus*), Giant trevally (*Caranx ignoblis*), Black trevally (*Caranx lugubris*), Amberjack (*Seriola dumerili*), Taape (*Lutjanus kasmira*)	**Eggs and larvae:** the water column extending from the shoreline to the outer limit of the EEZ down to a depth of 400 m (200 fathoms). **Juvenile/adults:** the water column and all bottom habitat extending from the shoreline to a depth of 400 m (200 fathoms)	All slopes and escarpments between 40-280 m (20 and 140 fathoms). Three known areas of juvenile opakapaka habitat: Two off Oahu and one off Molokai

FMP	Species Complex	EFH	HAPC
Bottomfish and Seamount Groundfish	**Deep water species 50-200 fm):** Ehu (*Etelis carbunculus*), Onaga (*Etelis coruscans*), Opakapaka (*Pristipomoides filamentosus*), Yellowtail Kalekale (*P. auricilla*), Yelloweye opakapaka (*P. flavipinnis*), Kalekale (*P. sieboldii*), Gindai (*P. zonatus*), Hapupuu (*Epinephelus quernus*), Lehi (*Aphareus rutilans*)	**Eggs and larvae:** the water column extending from the shoreline to the outer limit of the EEZ down to a depth of 400 m (200 fathoms). **Juvenile/adults:** the water column and all bottom habitat extending from the shoreline to a depth of 400 m (200 fathoms)	All slopes and escarpments between 40-280 m (20 and 140 fathoms). Three known areas of juvenile opakapaka habitat: Two off Oahu and one off Molokai
Bottomfish and Seamount Groundfish	**Seamount Groundfish species (50-200 fm):** Armorhead (*Pseudopentaceros richardsoni*), Ratfish/butterfish (*Hyperoglyphe japonica*), Alfonsin (*Beryx splendens*)	**Eggs and larvae:** the (epipelagic zone) water column down to a depth of 200 m (100 fathoms) of all EEZ waters bounded by lattitude 29°-35° **Juvenile/adults:** all EEZ waters and bottom habitat bounded by latitude 29°-35° N and longitude 171° E-179° W between 200 and 600 m (100 and 300 fathoms	No HAPC designated for Seamount Groundfish
Crustaceans	**Spiny and Slipper Lobster Complex** Hawaiian spiny lobster (*Panulirus marginatus*), Spiny lobster (*P. penicillatus, P.* sp.), Ridgeback slipper lobster (*Scyllarides haanii*), Chinese slipper lobster (*Parribacus antarticus*) **Kona Crab** Kona crab (*Ranina ranina*)	**Eggs and larvae:** the water column from the shoreline to the outer limit of the EEZ down to a depth of 150 m (75 fathoms) **Juvenile/adults:** the all bottom habitat from the shoreline to a depth of 100 m (50 fathoms)	All banks in the NWHI with summits less than or equal to 30 m (15 fathoms) from the surface.
Precious Corals	**Deep-water Precious Corals (150-750 fm)** Pink coral (*Corallium secundum*), Red coral (*C. regale*), Pink coral (*C. laauense*), Midway deepsea coral (*C.* sp nov.), Gold coral (*Gerardia* sp), Gold coral (*Callogorgia gilberti*), Gold coral (*Narella* spp.), Gold coral (*Calyptrophora* spp.), Bamboo coral (*Lepidisis olapa*), Bamboo coral (*Acanella* spp.) **Shallow-water Precious Corals (10-50 fm)** Black coral (*Antipathes dichotoma*), Black coral (*Antipathis grandis*), Black coral (*Antipathes ulex*)	EFH for Precious Corals is confined to six known precious coral beds located off Keahole Point, Makapuu, Kaena Point, Wespac bed, Brooks Bank and 180 Fathom Bank. EFH has also been designated for three beds known for black corals in the Main Hawaiian Islands between Milolii and South Point on the Big Island, the Auau Channel and the southern border of Kauai	Includes the Makapuu bed, Wespac bed, Brooks Banks bed. For Black Corals, the Auau Channel has been identified as a HAPC.

There is also a concern that invasive marine and terrestrial species may be introduced into sensitive environments by fishing vessels transiting from populated islands and grounding on shallow reef areas. Of most concern is the potential for unintentional introduction of rats (*Ratus spp.)* to the remote islands in the NWHI and PRIA that harbor endemic landbirds. Although there are no restrictions that prohibit fishing vessels from transiting near these remote islands areas, no invasive species introductions due to this activity have been documented. However, the Council is concerned that this could occur as fisheries expand and emerging fisheries develop in the future. Establishing no-take MPAs—which are mostly contiguous around these remote islands—will deter fishing vessels from transiting near the islands, thus reducing the potential for unintentional groundings and introductions of invasive species.

While the Council has determined that current management measures to protect fishery habitat are adequate, should future research demonstrate a need, the Council will act accordingly to protect habitat necessary to maintain a sustainable and productive fishery in the Western Pacific Region. For a full assessment of potential adverse impacts to EFH from fishing gear currently used in areas designated as EFH see Appendix A- Catalogue of Fishing Gear.

In modern times, some reefs have been degraded by a range of human activities. Comprehensive lists of human threats to coral reefs in the U.S. Pacific Islands are provided by Maragos *et al.* (1996), Birkeland (1997b), Grigg 1997, and Clark and Gulko (1999). (These findings are summarized in Table 6.8.) In general, reefs closest to human population centers are more heavily used and are in worse condition than those in remote locations (Green 1997). Nonetheless, it is difficult to generalize about the present condition of coral reefs in the U.S. Pacific Islands because of their broad geographic distribution and the lack of long-term monitoring to document environmental and biological baselines. Coral reef conditions and use patterns vary throughout the U.S. Pacific Islands.

A useful distinction is between coral reefs near inhabited islands of American Samoa, CNMI, Guam, and the main Hawaiian islands and coral reefs in the remote NWHI, PRIAs, and northern islands of the CNMI. Reefs near the inhabited islands are heavily used for small-scale artisanal, recreational, and subsistence fisheries, and those in Hawaii, Saipan (CNMI), and Guam are also the focus for extensive non-consumptive marine recreation. Rather than a relatively few large-scale mechanized operations, many fishermen each deploy more limited gear. The more accessible banks in the main Hawaiian Islands (Penguin Bank, Kaula Rock), Guam (southern banks), and the CNMI (Esmeralda Bank, Farallon de Medinilla) are the most heavily fished offshore reefs in the FMP management area.

The vast majority of the reefs in the CRE-FMP management area are remote and, in some areas, they have protected status. Most of these are believed to be in good condition. (Table 6.9 summarizes coral reef conditions in the region.) Existing fisheries are limited. The major exception is in the NWHI, where there are commercial fisheries for spiny lobster and deep-slope bottomfish (Green 1997). Poaching by foreign fishing fleets is suspected at Guam's southern banks, in the PRIA, and possibly in other areas. Poachers usually target high-value, and often rare or overfished, coral reef resources. These activities are already illegal but difficult to detect.

Table 6.8: Threats to Coral Reef in the U.S. Pacific Islands (after Maragos *et al.* 1996; Grigg 1997; Birkeland 1997; Jokiel 1999; Clark and Gulko 1999).

Activity	American Samoa	Guam	Hawaii		CNMI	Remote U.S. island possessions
			MHI	NWHI		
Coastal construction	X	X	X		X	X
Destructive fishing	X		X		X	
Flooding	X	X	X			
Industrial pollution	X				X	
Overuse/over harvesting	X	X	X		X	
Nutrient loading (sewage/eutrophication)	X	X	X		X	
Poaching/depletion of rare species	X				X	X
Soil erosion/sedimentation	X	X			X	
Vessel groundings/oil spills	X	X		X	X	
Military activity		X	X	X	X	X
Hazardous waste		X		X		X
Tourist impacts		X	X		X	
Urbanization		X	X			
Thermal pollution			X			
Marine debris			X	X		
Introduced species			X			

Table 6.9: Summary of coral reef condition in nearshore areas (0-3 nmi from shore) and offshore areas (3-200 nm from shore) in sub-areas of the U.S. Pacific Islands (after Green, 1997).

Location	0-3 nmi	3-200 nmi
American Samoa	Poor-Excellent	Good-Excellent
CNMI	Poor-Excellent	Good-Excellent
Guam	Poor-Good	Good-Excellent
Hawaii		
Main Hawaiian Islands	Poor-Good	Good-Excellent
Northwestern Hawaiian Islands	Excellent	Excellent
Remote Islands	Poor-Excellent	Excellent
Overall	**Poor-Excellent**	**Good-Excellent**

6.4 Non-fishing Related Activities That May Adversely Affect EFH

Based on the guidelines established by the Secretary under Section 305 (b)(1)(A) of the MSFCMA, NMFS has developed a set of guidelines to assist councils meet the requirement to describe adverse impacts to EFH from non-fishing activities in their FMPs. A wide range of non-fishing activities throughout the U.S. Pacific Islands contribute to EFH degradation. FMP implementation will not directly mitigate these activities. However, as already noted, it will allow NMFS and the Council to make recommendations to any federal or state agency about actions that may impact EFH. Not only could this be a mechanism to minimize the environmental impacts of agency action, it will help them focus their conservation and management efforts.

The Council is required to identify non-fishing activities that have the potential to adversely affect EFH quality and, for each activity, describe its known potential adverse impacts and the EFH most likely to be adversely affected. The descriptions should explain the mechanisms or processes that may cause the adverse effects and how these may affect habitat function. The Council considered a wide range of non-fishing activities that may threaten important properties of the habitat used by managed species and their prey, including dredging, dredge material disposal, mineral exploration, water diversion, aquaculture, wastewater discharge, oil and hazardous substance discharge, construction of fish enhancement structures, coastal development, introduction of exotic species, and agricultural practices. These activities and impacts, along with mitigation measures are detailed in the next section.

6.4.1 Habitat Conservation and Enhancement Recommendations

Background

According to NMFS guidelines, this FMP must describe ways to avoid, minimize, or compensate for the adverse effects to EFH. It must also promote the conservation and enhancement of EFH. Generally, non-water dependent actions that may have adverse impacts should not be located in EFH. Activities that may result in significant adverse effects on EFH should be avoided where less environmentally harmful alternatives are available. If there are no alternatives, the impacts of these actions should be minimized. Environmentally sound engineering and management practices should be employed for all actions that may adversely affect EFH. Disposal or spillage of any material (dredge material, sludge, industrial waste, or other potentially harmful materials) that would destroy or degrade EFH should be avoided. If avoidance or minimization is not possible, or will not adequately protect EFH, compensatory mitigation to conserve and enhance EFH should be recommended. FMPs may recommend proactive measures to conserve or enhance EFH. When developing proactive measures, councils may develop a priority ranking of the recommendations to assist federal and state agencies undertaking such measures. FMPs should describe a variety of options to conserve or enhance EFH, which may include, but are not limited to:

Enhancing of rivers, streams, and coastal areas through new federal, state, or local government planning efforts to restore river, stream, or coastal area watersheds.

Improve water quality and quantity through the use of best land management practices to ensure that water quality standards at state and federal levels are met. The practices include improved sewage treatment, disposing of waste materials properly, and maintaining sufficient in-stream flow to prevent adverse effects to estuarine areas.

Restore or create habitat, or convert non-EFH to EFH, to replace lost or degraded EFH, if conditions merit. However, habitat conversion at the expense of other naturally functioning systems must be justified within an ecosystem context.

6.4.2 Description of Mitigation Measures for Identified Activities and Impacts

Established policies and procedures of the Council and NMFS provide the framework for conserving and enhancing EFH. Components of this framework include adverse impact avoidance and minimization, provision of compensatory mitigation whenever the impact is significant and unavoidable, and incorporation of enhancement. New and expanded responsibilities contained in the MSFCMA will be met through appropriate application of these policies and principles. In assessing the potential impacts of proposed projects, the Council and the NMFS are guided by the following general considerations:

- The extent to which the activity would directly and indirectly affect the occurrence, abundance, health and continued existence of fishery resources.
- The extent to which the potential for cumulative impacts exists.
- The extent to which adverse impacts can be avoided through project modification, alternative site selection or other safeguards.
- The extent to which the activity is water dependent if loss or degradation of EFH is involved.
- The extent to which mitigation may be used to offset unavoidable loss of habitat functions and values.

Seven non-fishing activities have been identified that directly or indirectly affect habitat used by management unit species. Impacts and conservation measures are summarized below for each of these activities. Although not all-inclusive, what follows is a good example of the kinds of measures that can help to minimize or avoid the adverse effects of identified non-fishing activities on EFH.

Habitat Loss and Degradation

Impacts

- Infaunal and bottom-dwelling organisms.
- Turbidity plumes.
- Biological availability of toxic substances.
- Damage to sensitive habitats.
- Current patterns/ water circulation modification.
- Loss of habitat function.
- Contaminant runoff.
- Sediment runoff.
- Shoreline stabilization projects.

Conservation Measures

1. To the extent possible, fill materials resulting from dredging operations should be placed on an upland site. Fills should not be allowed in areas with subaquatic vegetation, coral reefs or other areas of high productivity.

2. The cumulative impacts of past and current fill operations on EFH should be addressed by federal, state and local resource management and permitting agencies and considered in the permitting process.

3. The disposal of contaminated dredge material should not be allowed in EFH.

4. When reviewing open-water disposal permits for dredged material, state and federal agencies should identify the direct and indirect impacts such projects may have on EFH. When practicable, benthic productivity should be determined by sampling prior to any discharge of fill material. Sampling design should be developed with input from state and federal resource agencies.

5. The areal extent of the disposal site should be minimized. However, in some cases, thin layer disposal may be less deleterious. All non-avoidable impacts should be mitigated.

6. All spoil disposal permits should reference latitude-longitude coordinates of the site so information can be incorporated into GIS systems. Inclusion of aerial photos may also be required to help geo-reference the site and evaluate impacts over time.

7. Further fills in estuaries and bays for development of commercial enterprises should be curtailed.

8. Prior to installation of any piers or docks, the presence or absence of coral reefs and submerged aquatic vegetation should be determined. These areas should be avoided. Benthic productivity should also be determined, and areas with high productivity avoided. Sampling design should be developed with input from state and federal resource agencies.

9. The use of dry stack storage is preferable to wet mooring of boats. If that method is not feasible, construction of piers, docks and marinas should be designed to minimize impacts to the coral reef substrate and subaquatic vegetation.

10. Bioengineering should be used to protect altered shorelines. The alteration of natural, stable shorelines should be avoided.

Pollution and Contamination

Impacts

- Introduction of chemicals.
- Introduction of animal wastes.
- Increased sedimentation.
- Wastewater effluent with high contaminant levels.
- High nutrient levels down-current of outfalls.
- Biocides to prevent biofouling.
- Thermal effects.
- Turbidity plumes.
- Affected submerged aquatic vegetation sites.
- Stormwater runoff.
- Direct physical contact.
- Indirect exposure
- Cleanup.

Conservation Measures

1. Outfall structures should be placed sufficiently far offshore to prevent discharge water from affecting areas designated as EFH. Discharges should be treated using the best available technology, including implementation of up-to-date methodologies for reducing discharges of biocides (*e.g.*, chlorine) and other toxic substances.

2. Benthic productivity should be determined by sampling prior to any construction activity. Areas of high productivity should be avoided to the maximum extent possible. Sampling design should be developed with input from state and federal resource agencies.

3. Mitigation should be provided for the degradation or loss of habitat from placement of the outfall structure and pipeline as well as the treated water plume.

4. Containment equipment and sufficient supplies to combat spills should be on-site at all facilities that handle oil or hazardous substances.

5. Each facility should have a "Spill Contingency Plan," and all employees should be trained in how to respond to a spill.

6. To the maximum extent practicable, storage of oil and hazardous substances should be located in an area that would prevent spills from reaching the aquatic environment.

7. Construction of roads and facilities adjacent to aquatic environments should include a storm-water treatment component that would filter out oils and other petroleum products.

8. The use of pesticides, herbicides and fertilizers in areas that would allow for their entry into the aquatic environment should be avoided.

9. The best land management practices should be used to control topsoil erosion and sedimentation.

Dredging

Impacts

- Infaunal and bottom-dwelling organisms.
- Turbidity plumes.
- Bioavailability of toxic substances.
- Damage to sensitive habitats.
- Water circulation modification.

Conservation Measures

1. To the maximum extent practicable, dredging should be avoided. Activities that require dredging (such as placement of piers, docks, marinas, etc.) should be sited in deepwater areas or designed in such a way as to alleviate the need for maintenance dredging.

Projects should be permitted only for water-dependent purposes, when no feasible alternatives are available.

2. Dredging in coastal and estuarine waters should be performed during the time frame when MUS and prey species are least likely to be entrained. Dredging should be avoided in areas with submerged aquatic vegetation and coral reefs.

3. All dredging permits should reference latitude-longitude coordinates of the site so information can be incorporated into Geographic Information Systems (GIS). Inclusion of aerial photos may also be required to help geo-reference the site and evaluate impacts over time.

4. Sediments should be tested for contaminants as per Environmental Protection Agency and U.S. Army Corps of Engineers requirements.

5. The cumulative impacts of past and current dredging operations on EFH should be addressed by federal, state and local resource management and permitting agencies and considered in the permitting process.

6. If dredging needs are caused by excessive sedimentation in the watershed, those causes should be identified and appropriate management agencies contacted to assure action is done to curtail those causes.

7. Pipelines and accessory equipment used in conjunction with dredging operations should, to the maximum extent possible, avoid coral reefs, seagrass beds, estuarine habitats and areas of subaquatic vegetation.

Marine Mining

Impacts

- Loss of habitat function.
- Turbidity plumes.
- Resuspension of fine-grained mineral particles
- Composition of the substrate altered.

Conservation Measures

1. Mining in areas identified as coral reef ecosystem should be avoided.

2. Mining in areas of high biological productivity should be avoided.

3. Mitigation should be provided for loss of habitat due to mining.

Water Intake Structures

Impacts

- Entrapment, impingement, and entrainment.
- Loss of prey species.

Conservation Measures

1. New facilities that rely on surface waters for cooling should not be located in areas where coral reef organisms are concentrated. Discharge points should be located in areas that have low concentrations of living marine resources, or they should incorporate cooling towers that employ sufficient safeguards to ensure against release of blow-down pollutants into the aquatic environment.
2. Intake structures should be designed to prevent entrainment or impingement of MUS larvae and eggs.
3. Discharge temperatures (both heated and cooled effluent) should not exceed the thermal tolerance of the plant and animal species in the receiving body of water.
4. Mitigation should be provided for the loss of EFH from placement of the intake structure and delivery pipeline.

Aquaculture Facilities

Impacts

- Discharge of organic waste from the farms.
- Impacts to the seafloor below the cages or pens.

Conservation Measures

1. Facilities should be located in upland areas as often as possible. Tidally influenced wetlands should not be enclosed or impounded for mariculture purposes. This includes hatchery and grow-out operations. Siting of facilities should also take into account the size of the facility, the presence or absence of submerged aquatic vegetation and coral reef ecosystems, proximity of wild fish stocks, migratory patterns, competing uses, hydrographic conditions and upstream uses. Benthic productivity should be determined by sampling prior to any operations. Areas of high productivity should be avoided to the maximum extent possible. Sampling design should be developed with input from state and federal resource agencies.
2. To the extent practicable, water intakes should be designed to avoid entrainment and impingement of native fauna.

3. Water discharge should be treated to avoid contamination of the receiving water and should be located only in areas having good mixing characteristics.

4. Where cage mariculture operations are undertaken, water depths and circulation patterns should be investigated and should be adequate to preclude the buildup of waste products, excess feed and chemical agents.

5. Non-native, ecologically undesirable species that are reared may pose a risk of escape or accidental release, which could adversely affect the ecological balance of an area. A thorough scientific review and risk assessment should be undertaken before any non-native species are allowed to be introduced.

6. Any net pen structure should have small enough webbing to prevent entanglement by prey species.

7. Mitigation should be provided for the EFH areas impacted by the facility.

Introduction of Exotic Species

Impacts

- Habitat alteration.
- Trophic alteration.
- Gene pool alteration.
- Spatial alteration.
- Introduction of disease.

Conservation Measures

1. Vessels should discharge ballast water far enough out to sea to prevent introduction of non-native species to bays and estuaries.

2. Vessels should conduct routine inspections for presence of exotic species in crew quarters and hull of the vessel prior to embarking to remote islands (PRIAs, NWHI and northern islands of the CNMI).

3. Exotic species should not be introduced for aquaculture purposes unless a thorough scientific evaluation and risk assessment are performed (see section on aquaculture).

4. Effluent from public aquaria display laboratories and educational institutes using exotic species should be treated prior to discharge.

6.5 EFH Research Needs

Additional research is needed to make available sufficient information to support a higher level of description and identification of EFH and HAPC. Additional research may also be necessary to identify and evaluate actual and potential adverse effects on EFH, including, but not limited to, direct physical alteration; impaired habitat quality/functions; cumulative impacts from fishing; or indirect adverse effects, such as sea level rise, global warming, and climate shifts.

The following scientific data are needed to more effectively address EFH provisions:

- The distribution of early life history stages (eggs and larvae) of MUS by habitat.
- Description of juvenile habitat (including physical, chemical, and biological features that determine suitable juvenile habitat).
- Food habits (feeding depth, major prey species, etc.).
- Habitat-related densities for all management unit species life history stages.
- Habitat utilization patterns for different life history stages and species.
- Growth, reproduction, and survival rates for management unit species within habitats.
- Inventory of coral reef ecosystem habitats in the EEZ of the Western Pacific Region.
- Location of important spawning sites.
- Identification of post-larval settlement habitat.
- Establishment of baseline parameters (CPUE) for coral reef ecosystem resources.
- High resolution mapping of bottom topography, bathymetry, currents, substrate types, algal beds, and habitat relief.

NMFS guidelines suggest that the Council and NMFS periodically review and update the EFH components of FMPs as new data become available. The Council recommends that new information be reviewed, as necessary, during preparation of the annual reports by the CRE Plan Team. EFH designations may be changed under the FMP framework processes if information presented in an annual review indicates that modifications are justified

CHAPTER 7

SCIENTIFIC DATA AND RESEARCH NEEDS

7.1 Ongoing and Proposed Coral Reef-related Research

In response to threats to coral reef ecosystems, President Clinton issued Executive Order 13089 - Coral Reef Protection in June 1998 to direct state and federal agencies to identify actions that may affect U.S. coral reef ecosystems and to use programs and authorities to protect and enhance the condition of these ecosystems.

Before the executive order was signed, state and federal government authorities, in collaboration with NGOs and international government authorities, recognized the necessity of preserving coral reef resources. Each region began formulating a plan of action to strengthen coral reef resource management in response to and with support from the U.S. Coral Reef Initiative. These plans focus on the collection of baseline assessments and identifying problems and areas of concern.

Table 7.1 summarizes the variety of coral reef projects ongoing or proposed around the Pacific Region. (Table 7.1 may be found at the end of this chapter.) The Council supports these research initiatives, because much of the information gained from these projects will complement the Council's research initiatives proposed in this chapter. While the extent of possible research on coral reef ecosystems is tremendous, the Council and its advisory bodies focused on research questions directly related to ecosystem management needs and issues that cut across the various FMPs.

7.2 Council Recommendations

The coral reef ecosystems covered under this FMP are geographically distinct, with management areas separated by 5,000 miles of Pacific Ocean. Species composition and richness vary widely between regions, as do fishing and non-fishing threats to the coral reefs.

An adaptive management strategy underlies this FMP because it is based on ecosystem principles. The research outlined in Table 7.1 addresses traditional species-specific management questions. While these projects can help to answer ecosystem-related questions, the Council's research recommendations more specifically support ecosystem-based adaptive management.

Specific questions focus on the multi-use nature of coral reefs, the role of the various coral reef habitats, trophic interactions and the effect of fishing, the value and function of MPAs, and the

individual and synergistic effects that anthropogenic and natural disturbances have on the ecosystem. Particularly important research would address the interactions between fisheries, because the established crustacean, bottomfish, and precious coral fisheries all occur to some extent in the coral reef ecosystem. The following recommendations are derived from needs outlined by the Plan Teams for each of the FMPs, the Ecosystem and Habitat and Indigenous Rights Advisory Panels, and the Scientific and Statistical Committee.

7.2.1 Summary of Council-proposed Research

American Samoa

1. Examine recovery rates and yields of coral reefs that have been severely damaged by sustained high fishing pressures (Tutuila), with those where fishing pressure is much lower (Manu'a) or entirely absent (Rose Atoll MPA).

CNMI/ Guam

2. Socio-economic and cultural study of the fishing communities with respect to potential resource allocation.
3. Various projects addressing the multiple land-based threats to the near-shore coral reef ecosystem.

Main Hawaiian Islands

4. Effect of alien species on coral reef ecosystems, speed of dispersion.
5. Improve Fishery Statistical Surveys to complement commercial fisheries monitoring programs and to facilitate capturing landing and effort data from recreational fishing sectors.
6. Study of historic fisheries data.

Northwestern Hawaiian Islands

7. Protected species.
8. Effects of ecotourism.
9. Study of deep benthic habitat in relation to ecosystem.
10. Interactions between fisheries operating within the coral reef ecosystem.

PRIAs

11. Assessments and monitoring as benchmarks for total and species specific biomass, species composition and how habitat structure relates to species density.

All Areas

12. Mapping.
13. Rapid ecological assessments, biomass surveys, long-term remote and direct monitoring.
14. Education.
15. Marine debris.
16. Effectiveness of MPAs as management tools.
17. Archaeo-ichthyological studies.
18. Relationship between habitat and stock abundance.
19. Determination of indicator species for rapid assessment of reef's health.
20. Relation of natural and anthropogenic stressors.
21. Trophic interactions for ecosystem modeling.
22. Standardization of data collection systems to facilitate use in management.

7.2.2 Region-specific Research Needs

The islands of the Western Pacific Region extend in a great arc over the Central and Western Pacific and include parts of Micronesia and Polynesia. The four inhabited archipelagos—Hawaii, Northern Mariana Islands, Guam and American Samoa—all have different geographic, social, and economic characteristics, which influence the types of coral reef fisheries research required in each location. Furthermore, large areas of the Western Pacific Region are uninhabited or under military control and therefore off-limits to commercial fishing. Research in these areas may not be driven primarily by fishery-related issues but by other concerns, such as protected species interactions in the case of the Northwestern Hawaiian Islands, or as benchmarks for comparison between fished and unfished sites.

American Samoa

American Samoa has a rapidly increasing population, most of which is found on the main large island of Tutuila. The island's population is mainly Polynesian and they are strongly linked through ancestral ties with the people of neighboring (Western) Samoa.[1] Population growth is driven by both new births and the migration of Western Samoans, who can get work permits for American Samoa. Very high harvests of reef fish and invertebrates from American Samoan reefs were documented in the late 1970s.

However, a combination of natural and anthropogenic effects has had a serious impact on American Samoan reefs, particularly on Tutuila, with the effect of depressing catch rates and the volume of fish produced through reef fishing. These include a crown-of-thorns outbreak in the 1970s, which ultimately destroyed 95% of live coral cover in some locations, followed by two severe hurricanes in 1990 and 1991. The hurricanes destroyed most of the coral growth to a depth of 10-15 m, particularly on the north side of the island. This was followed by a mass coral

[1] Western Samoa renamed itself Samoa in 1998, despite protest from American Samoa.

bleaching event in 1994, probably connected with El Niño. These disturbances, coupled with increasing human impacts such as sedimentation on the reefs, eutrophication of nearshore waters, coastal construction, and solid and chemical waste discharges have resulted in major changes to coral reef habitats and associated reef fish assemblages.
Successive damage to the Tutuila reefs means that American Samoa may be a natural laboratory to look at the behavior and recovery of fish populations in conditions where production has declined through a mix of habitat destruction and high fishing pressure. In response, the commercial fishery has changed its focus over the years from reef fishing to bottomfishing, and currently to longline fishing for albacore and other pelagic fish. Consumer demand for reef fish is now being met in large part by imports from Samoa (formerly Western Samoa). Fishing pressures on reef fish stocks in the less populated Manu'a Islands, to the east of Tutuila, have not changed in the same manner. Fish stocks are not considered over-exploited, and traditional coral reef fishing is currently practiced. Because one of the MPAs slated for implementation through this FMP is at Rose Atoll, American Samoa offers the potential to examine the recovery rates and yields of coral reefs that have been severely damaged by sustained high fishing pressures with those where fishing pressure is much lower or entirely absent.

Commonwealth of the Northern Mariana Islands and Guam

High population growth due to migrants is a feature of both Guam and the Northern Mariana Islands. Most of the immigrants come from East and Southeast Asia to work in the garment industry. Because of their cultural preferences they eat a lot of fish and other seafood. Therefore, they add to the demand for fishery production from coral reef areas. Small-boat fishermen dominate fishing in nearshore areas, catching deep- and shallow-water reef fish and bottomfish species. Due to their proximity to Asia, the potential for a live reef fish fishery exporting to Asia is greatest in these islands. The aforementioned Southeast Asian population—because of its high per capita rate of seafood consumption—will put additional pressure on coral reef resources. Because of this potential increase in fishing pressure, a socio-economic and cultural study of potential resource allocation in their fishing communities has been suggested.

The other major influence on the reefs of the Mariana Islands stems from the growth of the tourist industry in both Guam and CNMI. This has led to the landscaping of large areas of the coast for hotels, golf courses, shops, and other leisure activities. Construction brings with it the threat of sedimentation that smothers live corals, while the development of extensive golf courses may have an effect on near-shore lagoon waters through eutrophication from fertilizer-enriched runoff. Finally, the activities of the tourists themselves can harm reefs. Through spearfishing and charter fishing they add to local fishing pressure. Important habitat-related benthos is lost when they take shells and corals for souvenirs. They can also destroy habitat by walking on reefs in boots and diving fins; using jet-skis in shallow water has a similar, but potentially more widespread, effect. The latter activity has been blamed for diminishing habitat for rabbitfish, which are a popular target species on Guam.

CNMI is also subject to military activity on the island of Farallon de Medinilla (FDM), which is the only northern island in the Mariana chain with substantial coral reefs. FDM is also one of the few potential locations where fisheries can expand in the future. It has been used as a target in U.S. military activities for many years, with subsequent disturbance to the reef from direct bombing and accelerated erosion of the island as well.

Coral reef fisheries research in Guam and the CNMI should focus on how to achieve the best balance between tourism and fishing, given that the leisure industry is the single largest industry in both places. Bombing of FDM has been reported to have only a limited direct effect on the coral reef, but it removes a large area of coral reef from use by fishermen, who must fish more intensively on the remaining reef areas. This may have the undesired effect of placing stresses to stocks occupying those locations.

Main Hawaiian Islands

Like the Mariana Islands, the Main Hawaiian Islands' reefs are affected by the growing tourist industry in Hawaii, where large parts of the coastline have been landscaped for hotels, golf courses, and other leisure activities. Over six million people visit Hawaii each year, while the state has a resident population of about one million people. However, the Hawaiian Islands are much larger than their Micronesian counterparts, and larger areas of the coast are also untouched.

Of all areas within the Western Pacific Region, fishermen in the MHI have the most diverse array of fishing gears and fisheries. These include specialist targeting of small reef fish for the aquarium industry; fish trapping; a variety of crustacean trapping methods; directed fisheries for nearshore small pelagic fishes; and more typical methods like hook-and-line, gill net, seine net, cast net, and spear fishing. Alien species have been introduced into Hawaii through bilge and ballast water, by well-intentioned projects, and through federally supported aquaculture programs. The bluelined snapper (*Lutjanus kasmira*) was one of most contentious introductions; this species has spread throughout the state's coastal waters since its original introduction from French Polynesia. It has been blamed for the subsequent decline of bottomfish species even though there is no evidence for this. Although popular elsewhere in the Pacific, people in Hawaii are unfamiliar with it, and—although common—they do not like to eat it.

Extensive research has been conducted on Hawaii's reefs, but comparatively little is known about reef fisheries in Hawaii. Ironically, large volumes of data are compiled by the State of Hawaii Division of Aquatic Resources on commercial landings and nominal effort of coral reef fisheries by various gear types, with some data extending back to the late 1940s. Furthermore, a detailed survey of fishing in the Hawaiian Islands in the early 1900s provides an important benchmark. Besides landings and nominal effort, there are also indices of fishing effort contained in other databases, such as the Department of Boating and Ocean Recreations (DBOR) small vessel registration records. These data include registration of vessels for commercial fishing and for pleasure, with breakdown by size class and propulsion type. Much of these data remain unanalyzed and their management value unrealized. For example, this type of data was

used to generate production models and MSY for bottomfish fisheries in the MHI (Ralston and Polovina 1982).

In February 2001, the Division of Aquatic Resources, in partnership with NMFS, re-initiated fishery statistical surveys for the MHI. These surveys are designed to collect data on participation, effort, and catch composition, primarily from the vessel-based recreational fishing sector. The Hawaii Marine Recreational Fisheries Surveys (HMRFS) consist of three components: (1) random digit surveys of Hawaii residents to estimate participation and effort for private boats and shore fishing, (2) weekly telephone surveys of 10% of Hawaii charter boat operators, and (3) an intercept survey of private and charter boat fishermen to collect catch data. This component of HMRFS is similar to the creel surveys conducted in other island areas. Re-establishing a detailed survey of fishing in the MHI is essential to increasing managers' knowledge of landings and nominal effort for coral reef fisheries. Not only will it help them to better understand coral reef fisheries in the commercial sector, but in other sectors—including recreational fishing—as well.

In summary, coral reef ecosystem problems in the MHI are similar to those in the Mariana Islands: the MHI also suffer from the impacts of urbanization and the effects of coastal landscaping driven by tourism and population expansion. But because the MHI are relatively large with some inaccessible coasts, there are extensive coastal areas free from these anthropogenic influences. This allows areas with different land uses and population densities to be compared in order to see the impacts on coral reef fisheries. In addition, there are unresolved questions about the impacts of exotic species on indigenous fauna, particularly the successful proliferation of the bluelined snapper. Lastly, unlike other areas of the Western Pacific Region, large volumes of data extending over several decades are available on commercial reef fisheries in Hawaii. It should also be noted that there are many different surveys and sampling programs in Hawaii for both commercial and recreational fisheries. All these data sources should be assessed in order to see what information can be gleaned to better manage Hawaii's coral reef fisheries.

Low-use Marine Protected Areas

The NWHI are a special concern, both regionally and nationally. Native people and foreign fishermen have fished in this area for hundreds of years. However, very little is known about the level of fishing pressure before Council-implemented management. The low-use MPAs that this FMP implements for the NWHI will begin seaward of what is currently a *de facto* no-take MPA (out to 10 fathoms), based on current regulations and fishing practices, and will generally extend from 10-50 fathoms.[1] It has been hypothesized that MPAs are havens where large, fecund species can repopulate the surrounding reef. However, this hypothesis needs to be studied in the presence of regulated fishing pressure. The low-use MPAs of the NWHI will be an ideal location for this research.

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[1]As described in Section 5.2, the CRE-FMP designates as no-take MPAs EEZ waters 0-10 fm as well as 0-50 fm around three other atolls, French Frigate Shoals, Laysan and the northern half of Midway.

No-take Marine Protected Areas

This FMP will also implement no-take MPAs in remote Howland, Baker, and Jarvis Islands, and Kingman Reef. These islands have experienced the least fishing pressure of any location under Council jurisdiction. They are also far removed from non-fishing impacts. Therefore, they are the best sites to determine a benchmark for total and species-specific biomass, species composition, and how habitat structure relates to species density. Assessments are currently underway at many of these locations, and many coral reef scientists want to conduct projects in these near-pristine environments. In order to use the research in these areas for fisheries management, the Council recommends that the scientists coordinate their work. This will allow independent data sets to be coordinated with management-related research elsewhere.

7.2.3 Council Recommendations for Ecosystem-based Research

Each of the topics below has been suggested by one or more of the plan teams and advisory panels involved in the drafting of the Coral Reef Ecosystem FMP. They are the Coral Reef Ecosystem, Bottomfish, Crustacean, Ecosystem and Habitat, and Precious Corals Plan Teams and Advisory Panels, the Indigenous People Advisory Panel, and the Scientific and Statistical Committee.

Interactions of Other FMP's MUS in the Coral Reef Ecosystem

This FMP proposes close coordination between the plan teams of the Bottomfish, Crustacean and Precious Coral FMPs and the Coral Reef Ecosystem Plan Team. Each of the plan teams recommended research on various associations and interdependencies, thus giving a more integrated picture of the coral reef ecosystem. A greater understanding of these interactions will aid in identifying and addressing issues for resolution among the various FMPs.

Effects of Gear and Marine Debris on Coral Reef Habitat

Marine debris is an important concern, especially in the NWHI. This debris generally comes from North Pacific fisheries not under Council jurisdiction. A multi-agency effort has been active in removing and cataloguing tons of this debris. The Council supports this effort but believes issues regarding gear and debris originating from Western Pacific fisheries is also of concern. The Council has recommended research on gear and debris effects on the deeper benthic environment. On several occasions concern has been raised about the impact lobster traps have on the coral reef habitat, but little research has been conducted to date. Lost traps impact in ghost fishing is negligible, as research shows that lobsters can exit traps over time. Tangle nets were used in the late 1980s to harvest precious coral from the NWHI. The effects from this fishing has not been analyzed, although their impact has been analyzed in other areas. The NWHI omnibus proposal will have a far greater impact on management issues within the Council's jurisdiction, and has been recommended by the Crustacean and Precious Corals Plan Teams and advisory panels. Submersible-supported cruises in the NWHI and MHI in 2001 found minimal impact from bottomfish gear and precious corals harvesting, respectively.

Trophic Interactions

Simulation models for coral reef ecosystems (ECOPATH and ECOSIM, see Section 2.4) have become sophisticated tools, which can aid resource managers in predicting cascading effects from changes in the system. While these models can provide valuable insight, they require some basic data on trophic interactions. These models will never be able to simultaneously include the thousands of species found in the ecosystem. Research must first determine appropriate model species to use in a given coral reef ecosystem. This will require an understanding of the trophic interactions between habitat, primary production, and representative species of herbivores, omnivores, and top predators.

Role of Habitat in Stock Abundance

Researchers have observed correlations between habitat and stock abundance in several environments. Each of the implemented FMPs' plan teams were interested in designing projects that would address specific questions under this heading.

The Bottomfish Plan Team proposed a project on the importance of precious coral habitat and coral reef habitat on the survivability of juvenile bottomfish MUS. The Crustacean Plan Team proposed a project to differentiate the habitat qualities of the known lobster banks and how these differences contribute to successful recruitment and survival of lobster. The Precious Coral Plan Team is interested in how recruitment of gold coral is affected by bottom habitat. This question is also directly related to possible research on the way in which precious coral habitat affects the abundance of bottomfish, eels, octopus, and other species that use it as refuge.

The teams have also suggested more general research on how the percent cover of live coral affects overall species abundance. Live coral coverage varies widely, due mainly to land-based activities in populated areas and how well it is sheltered from storm events in remote areas. At depths shallower than 10 m coral cover can be determined through satellite imagery, which has become very accessible to scientists in recent years. Combining this information with stock assessments could be very useful in determining productivity and sustainable yields.

Effect of MPAs in the Ecosystem and Their Role as Management Tools

Marine protected areas have become a high profile conservation tool over the past decade. The President's initiative to designate 20% of all U.S. coral reefs as MPAs by 2010 underscores a national commitment to their designation. However, for all of their acceptance as valuable conservation and fishery management tools, very little definitive evidence is available on the effect of MPAs beyond their immediate boundaries. Thus, additional research is needed to best determine their most effective size and locations so that in the future they can be truly effective management tools.

This FMP implements MPAs in the NWHI and PRIAs. The PRIAs have never had much fishing pressure and relatively little anthropogenic disturbance in the past. Designating the entire coral reef habitat as "no-take" for most of these islands ensures that these sites are preserves and not

tools for management. The NWHI, in contrast, has experienced fishing pressure in the past and will continue to experience it in the low-use MPAs. Interactions between the low-use and no-take MPAs under varying oceanographic conditions and fishing pressure along the NWHI archipelago should be examined to better understand what makes MPAs more or less successful in terms of fisheries management and sustainable yield.

Interactions and Individual Effects of Anthropogenic and Natural Stressors

Coral reefs throughout the Pacific are subject to high surf and surge associated with strong seasonal storms. Reefs found near populated areas are subject to land-based stressors and various other human activities. In areas with less shelter from storms, natural events determine the state of the reef. In sheltered areas, which are often near population centers, anthropogenic activities have a greater effect on the reef. Much research has assessed the causes and effects of, and mitigation options for, coral reef threats. In contrast, little research has been conducted to determine the synergistic effects of natural and anthropogenic stresses or combined anthropogenic stresses. In order to focus on the most serious threats to the ecosystem, and to foster interagency cooperation to address these threats, more research of this type is needed.

Additionally, climate and ecosystem shifts may occur over decadal scale cycles or longer which in turn, result in changes in recruitment and productivity of coral reef ecosystem resources. In the past, a climactic shift is believed to have occurred in the central North Pacific in the late 1980s. This produced an ecosystem shift in the NWHI that resulted in a lowering of carrying capacity and declined productivity. Additional research on both short-term and long-term ecosystem variability is needed in order to understand its effects on resources.

Determining Indicator Species or Using the Most Commonly Landed Species to Assess Ecosystem Health

Coral reef monitoring is an expensive and time-consuming process. The value of intensive monitoring has been questioned by some scientists, but deemed vital by others. It is impossible to study every organism in the coral reef ecosystem to determine the state of their health. Thus, as is done in terrestrial and freshwater environments, appropriate indicator species must be identified from which overall ecosystem health can be extrapolated. Baseline studies on their population densities, age structure and seasonal variation could then be completed. If indicator species can be identified, intensive monitoring can be reduced and research money will be available to address emerging issues and specific management needs.

Protected Species

Many protected and endangered species rely on the coral reef environment, especially in the NWHI. Specific research programs are in place to study monk seals, sea turtles, and seabirds. These are very important programs for this FMP because protected species are a major factor in fisheries regulations. The Council continues to use data derived from these programs and continually puts forth new questions to help address issues in fisheries management.

7.3 Other Research Addressing Ecosystem Management

A great deal of research effort has been expended studying the coral reefs of the Hawaiian Islands over the past 100 years. This includes gathering fishery data, reef surveys and monitoring, trophic studies, and a host of other efforts. NMFS, the U.S. Fish and Wildlife Service and the Hawaii Department of Land and Natural Resources undertook a tripartite study of the NWHI in the late 1970s and early 1980s, culminating in two symposia in 1980 and 1983. The wide scope of this research is a benchmark for future research in the NWHI.
Anthropogenic threats are limited in the NWHI. Land-based activities, which cause the greatest damage to reefs in populated areas, are virtually absent. Threats from fishing activities are also limited, due to a limited entry program and other regulatory controls for the two established NWHI fisheries. Limited entry permits for the NWHI fisheries are limited to seventeen permits for the bottomfish fishery and 15 permits for the crustacean fishery. Generally between five and seven lobster vessels actively fish one or two months a year. They are able to fish over a distance of 1,100 miles covering 11,554 km^2 of coral reef habitat. The renewed precious coral fishery has yet to venture to the NWHI, but substantial potential for harvest has been identified.

Potential threats from emerging fisheries, marine debris accumulating on NWHI reefs from north Pacific fisheries, and the health of the resident endangered species region-wide are the major concerns of the Council. In addition, this FMP is a demonstration plan for the ecosystem approach to fisheries management. The following project proposals were developed, keeping in mind the abundance of accumulated knowledge, the true threats to the various reefs under the Council's authority, and the emerging importance of the ecosystem approach to fisheries management. These efforts are principally guided by specific management questions derived from all of the Council's FMPs.

7.3.1 NWHI Omnibus Research Proposal

Project Deep Reef is a two-year study of the deep reef benthic fishery in the NWHI, using Deepworker 2000 submersibles. The project's goal is to obtain information about deepwater habitats by conducting habitat and stock assessments for lobsters, bottomfish, precious corals, and coral reef ecosystems in order to include all of the NWHI deep reef habitat resources in the Council's FMPs.

For lobsters, specific projects may deal with:

- Monk seal prey dependency.
- Habitat specifics for productive vs. unproductive area comparisons.
- Impact of ghost fishing on lobsters.
- Impact of lobster traps on coral reef habitats.
- Night versus day behavior and stock density differences.
- Characterization of steep-wall habitats for lobsters.

For bottomfish, specific projects may deal with:

- Characterization of juvenile and adult bottomfish habitats.
- Placement of potential reserves.

For precious corals, specific projects may deal with:

- Stock assessments for deep banks and pinnacles particularly around Midway.
- Impact of past dredging by foreign fleets at 180 Fathom Bank (north of Midway).
- Definition of habitat requirement of monk seals for gold coral and arrowtooth eels.

For coral reef ecosystems, specific projects may deal with:

- Depth and range extensions for deep coral reef ecosystems.
- Impacts of the other benthic fisheries in the NWHI on coral reef ecosystems.
- Designation of "protected areas" to establish marine preserves.

7.3.2 Archaeo-ichthyological Research

The archaeological, historical and socio-cultural records from Pacific Islands are increasingly recognized as important data sources for fishery management. Since most fishery biology studies are short-term efforts conducted over a few years at best, and rarely over several decades, they represent only snapshots of a fishery in time. The study period may include years during which conditions in the fishery are extremely favorable, or years when the fishery is in a production trough. The NWHI lobster fishery is a good example of this; it expanded during a favorable oceanic inter-decadal cycle, which produced over-optimistic estimates of fishery production. Landings then fell by an order of magnitude during a subsequent regime shift to a less productive oceanic cycle.

Data from archaeological investigations may cover many centuries rather than a few years and give a much more balanced perspective on resource use and sustainability. Dalzell (1998) has reviewed a number of different archaeological studies that contain insights into coral reef resources use in the Pacific Islands. Excavated mollusc shells and fish bones allow researchers to reconstruct the species composition of pre-historic fishing. In some instances it is possible to reconstruct size frequencies from the data, and in turn generate life history parameters of exploited fish stocks over many centuries.

The archaeological and historical record can also clarify the social and cultural importance of fisheries, and traditional property rights. This is especially important when urbanization and European colonization has caused these practices to decline. This has been amply demonstrated in New Zealand (Aotearoa), where the original Polynesian Maori population was economically and socially marginalized following European settlement in the nineteenth century. Europeans generally ignored Maori concepts of marine tenure and fishery access rights.

However, archaeological studies have produced evidence of a diverse range of Maori fishing activities: they exploited a wide range of fishes and marine mammals—such as seals—and also preserved large amounts of fish. Indeed, in some areas, such as the Muriwhenua region of New Zealand's North Island, fishing became a principal source of nutrition as human populations increased and food from hunting and agriculture became increasingly limited. The Maori have used such evidence to successfully gain recognition of traditional fisheries property rights, which were guaranteed under the 1840 Treaty of Waitangi (Dalzell 1998).

Johannes (1998) has argued that traditional fishery knowledge and folklore of Pacific Islanders is an invaluable assemblage of observations on the biology and ecology of reef and lagoon fishes. He also published a landmark paper in which he used traditional knowledge of fishermen to illustrate the spawning strategies of reef and lagoon fish in the Pacific Islands (Johannes 1978). He has discussed at length the value of traditional knowledge and traditional tenure systems and other customs for the management of Pacific reef and lagoon fisheries (Johannes 1998). Much of Hawaii's cultural fishing heritage has been lost following contact and colonization, however, Carlos Andrade (pers. comm. to Paul Bartram) has suggested that the songs and chants of the people of Ni'ihau Island may be an important source of traditional knowledge on resource use and abundance in the pre-historic NWHI. In Northern Europe a similar oral knowledge source, the Icelandic Sagas, have been used to establish the long term history of herring and cod fisheries (Beverton 1962).

In summary, conventional scientific studies on reef fisheries are needed to manage the resources. There is also information from archaeological, historical, and socio-cultural sources that can provide information for fishery management. Fishery managers in the Western Pacific need to acquaint themselves with these sources and evaluate them for their utility.

7.3.3 Hawaii Coral Reef Initiative

The University of Hawaii, in collaboration with the State DLNR Division of Aquatic Resources, has established the Hawaii Coral Reef Initiative (HCRI) Research Program. The primary purpose of the program is to support monitoring and research activities aimed at building capacity to manage Hawaii's coral reef ecosystems. To fulfill its mission, the program works with local, state and federal agencies, as well as private organizations, in order to achieve the following goals:

- Assess major threats to coral reef ecosystems and provide information for more effective management.
- Advance understanding of biological and physical processes that affect the health of coral reefs.
- Develop a database and information system to store and access data and results.
- Conduct public awareness programs on threats to coral reef ecosystems.
- Implement education and training for coral reef scientists and managers.

Specific objectives of the program are to:

- Monitor coral reef health at sites around the main Hawaiian Islands.
- Monitor impacts of aquarium fish harvesting to West Hawaii coral reefs.
- Identify algae and develop a quantitative sampling method that supports coral reef monitoring.
- Develop real-time water quality monitoring of some coral reefs and the impact of runoff, using macroalgae as an indicator of pollution.
- Develop a rapid assessment method for describing coral reef resources of the NWHI.
- Assess the effectiveness of MPAs to conserve fishery resources and the impact of fishing in a management area.

For 1999-2000, the HCRI Research Program has sponsored four projects, including the statewide Coral Reef Assessment and Monitoring Program (CRAMP), which is designed to identify the controlling factors, both natural and anthropogenic, contributing to the overall health and condition of Hawaii's coral reefs. In addition, the HCRI Research Program will provide professional training for Department of Aquatic Resources staff, broaden public outreach and education efforts, and develop a website to profile management initiatives, research, and the ecosystem.

Table 7.1: Coral reef related research, monitoring, and management activities in the region.

Ongoing Coral Reef Initiatives
National Marine Fisheries Service **Monitoring:** rapid and long term assessments, with ships, satellites, buoys in NWHI, PRIAs. **Fishing impacts:** habitat and trophic linkages. **Management:** work with Council and Coral Reef Ecosystem Fishery Management Plan. **MPAs:** effectiveness and EFH. **Protected species:** seal and turtle studies. **Education:** marine debris. **Mapping:** reef habitat and oceanographic properties. **Debris:** remove, assess, identify source and impacts. **Fisheries research:** biology and ecology of coral reef fish. **Socio-economic:** small boat survey. **Other:** determine indicator taxa for quick assessment
US Fish & Wildlife Service **Monitoring:** reef fish stock assessments, seabirds in NWHI, monitoring of all NWRs in region, except Guam. **Management:** review refuge and ecological services programs. **Protected species:** seal trophic study, green turtle, dolphin. **Mapping:** reef habitat mapping of NWHI, Guam, PRIAs in progress. **Debris:** monitor and removal at Tern Island, French Frigate Shoals. **Fisheries research:** *ulua* tagging. **Socio- economic:** PCBs and asbestos on Tern Island and PRIAs. **Other:** alien species control and eradication.
International Coral Reef Initiative Seeks to develop, coordinate and implement policy, coastal and marine management, law enforcement and education programs in collaboration with governments and other organizations for the protection of coral reefs. The International Coral Reef Initiative will also produce an annual report evaluating the health, status and success of implemented programs.

Ongoing Coral Reef Initiatives
Global Coral Reef Monitoring Network **Monitoring:** tourist monitoring program, rapid assessments. **Management:** strengthen institutional linkages. **Education:** produce annual reports. **Socio- economic:** link regional socio-economic and cultural organizations.
Great Barrier Reef Marine Park Authority **Monitoring:** assess natural variability. **Management:** advise marine park managers. **Education:** increase information dissemination.
James Cook University **Monitoring:** resource assessment. **MPAs:** response to fishing pressures. **Fisheries research:** life history, age demographics. **Socio- economic:** tourism impacts. **Other:** coral recruitment.
South Pacific Commission **Fishing impacts:** analyze fisheries data. **Management:** advise countries; management of live reef fisheries. **Education:** training and gear development. **Fisheries research:** sustainability of live reef fish fisheries.

Proposed Coral Reef Initiatives
Coral Reef Task Force **Monitoring: national coordination, web-based data system.** **Fishing impacts: stop destructive practices.** **Management: link marine and land practices, foster ecosystem approach to fisheries management.** **MPAs: strengthen protection, goal of 20% coverage by 2010.** **Education: education coordinator, user groups, decision makers.** **Mapping: high and low resolution; emphasizes MPAs, change.** **Alien Species: work with coral reef aquaculture.** **Socio- economic: user conflict, community- based management.** **Land pollution: water quality, create partnerships, control discharge.** **Other: Create coral reef disease consortium, foster international cooperation.**
Management needs and strategies from the U.S. Pacific Island Coral Reef Initiative Funded by NOAA and DOI, Office of Insular Affairs
American Samoa **Monitoring: reef fish and invertebrate surveys.** **Management: revise laws, enhance enforcement.** **MPAs: educate public on importance.** **Education: marine resource education center.** **Land pollution: water quality assessment.** **Other: laws and enforcement.**
CNMI **Monitoring: bottomfish surveys, standardize protocol.** **MPAs: identify areas and collect baseline information.** **Education: State of the Reef Report.** **Other: deploy eight FADs**

Management needs and strategies from the U.S. Pacific Island Coral Reef Initiative Funded by NOAA and DOI, Office of Insular Affairs
Guam
Monitoring: Territorial Seashore Reserve Plan, restore Tumon Bay.
Fishing impacts: gillnet impact on resource.
Education: Project Reef Check, Tumon Bay outreach.
Debris: remove gillnets.
Other: coral cultivation, recruitment, reseeding & settlement.
Land pollution: runoff in Tumon Bay reef.
Hawaii
Monitoring: CRAMP- monitor 30 sites; Rapid Ecological Assessment in the NWHI.
Education: community-based education and monitoring.
Mapping: purchase satellite images.

CHAPTER 8

REGULATIONS, PERMIT APPLICATIONS AND DATA FORMS

8.1 Draft Regulations for other western Pacific fisheries Fishery Management Plans

The Coral Reef Ecosystem Fishery Management Plan amends the Bottomfish and Seamount Groundfish, Crustaceans, Pacific Pelagics and the Precious Corals Fishery Management Plans under 660.18, by prohibiting the harvest of all management unit species in no-take areas defined in the Coral Reef Ecosystem FMP and in the CFR §660.12 for western Pacific fisheries. The CRE FMP also amends these existing FMPs under 660.13 to require vessel insurance for operating or transiting in MPAs. These new regulations are included in subpart B - Western Pacific Fisheries - General.

In addition, the CFR §660 Subpart B, Western Pacific Fisheries- General will be amended with the addition of the following line in 660.12 (Definitions):

§660.12 Pacific pelagic management unit species, will be amended by striking the following: Dogtooth tuna (*Gymnosarda unicolor),* Family *Alopiidae,* Family *Carcharhinidae,* Family *Lamnidae,* Family *Sphyrnidae* and ;

Adding the following: (1) Pelagic thresher shark (*Alapias pelagious*), (2) Bigeye thresher shark (*Alopias superciliousus*), (3) Common thresher shark (*Alopias vulpinus*), (4) Silky shark (*Carcharhinus falciformis*), (5) Oceanic whitetip shark (*Carcharhinus longimanus*), (6) Blue shark (*Prianace glauca*), (7) Shortfin mako shark (*Isurus axyrinchus*), (8) Longfin mako shark (*Isurus paucus*), and (9) salmon shark (*Lamna ditropis*).

8.1.1 Regulations

§ 660.11 Purpose and scope.

(b) Regulations specific to individual fisheries are included in subparts C, D, E, F, and J of this part.

§ 660.12 Definitions

In addition to the definitions in the Magnuson-Stevens Fishery Conservation and Management Act, and in §600.10, the terms used in subpart B through F and subpart J have the following meanings:

Coral reef ecosystem management unit species means all of the taxa listed in Table 3, Currently Harvested Coral Reef Ecosystem Management Unit Species, and Table 4, Potentially Harvested Coral Reef Ecosystem Management Unit Species, of this part and do not include the species defined as "bottomfish management unit species," "crustaceans management unit species," "Pacific pelagic management unit species" and "precious corals management species:"

Low use marine protected area means an area of the EEZ where fishing for or harvesting of coral reef resources is allowed only under a special permit, as specified. Low-use areas are defined as the EEZ around the Northwestern Hawaiian Islands shallower than 50 fathoms which have not been designated no-take, waters shallower than 50 fathoms around Johnston Atoll (16°45' N lat., 169°31' W long.), Wake Island (19° 18' N lat., 166° 35' E long.), Palmyra Atoll (5°53' N lat., 162°05' W long.), and the southern half of the Midway Atoll NWR bisected by the 28° 14' N parallel.

No-take marine protected area means an area of the EEZ that is closed to fishing for or harvesting of all defined management unit species. The no-take areas designated in the Coral Reef FMP apply to harvesting of MUS from every Western Pacific Council Fishery Management Plan. These areas are defined as follows: Federal waters shallower than 10 fathoms in the Northwestern Hawaiian Islands and federal waters shallower than 50 fathoms around Jarvis Island (0°23' S, 160°01' W), Howland Island (0°48' N lat., 176° 38' W long.), Baker Island (0° 13' N lat., 176°38' W long.), Kingman Reef (6°23' N lat., 162°24' W long.), Laysan Island (25° 45' N lat., 171°45' W long.), French Frigate Shoals (23° 45' N lat., 166°15' W long.), the northern half of the Midway Atoll NWR bisected by the 28° 14' N parallel, and Rose Atoll (14° 33' S lat., 168°09' W long.).

Pacific pelagic management unit species means the following fish:

Pacific Pelagic Management Unit Species List

Scientific Name	English Common Name
Coryphaena spp.	Mahimahi (dolphinfishes)
Acanthocybium solandri	Wahoo
Makaira mazara: *M. indica*	Indo-Pacific blue marlin Black marlin
Tetrapturus audax	Striped marlin
T. angustirostris	Shortbill spearfish

Xiphias gladius	Swordfish
Istiophorus platypterus	Sailfish
Alapias pelagicus	Pelagic thresher shark
Alopias superciliousus	Bigeye thresher shark
Alopias vulpinus	Common thresher shark
Carcharhinus falciformis	Silky shark
Carcharhinus longimanus	Oceanic whitetip shark
Prionace glauca	Blue shark
Isurus oxyrinchus	Shortfin mako shark
Isurus paucus	Longfin mako shark
Lamna ditropis	salmon shark
Thunnus alalunga	Albacore
T. obesus	Bigeye tuna
T. albacares	Yellowfin tuna
T. thynnus	Northern bluefin tuna
Katsuwonus pelamis	Skipjack tuna
Euthynnus affinis	Kawakawa
Lampris spp.	Moonfish
Gempylidae	Oilfish family
family Bramidae	Pomfret
Auxis spp., *Scomber* spp.; *Allothunus* spp.	Other tuna relatives

Remote U.S. Pacific island possessions means the islands of Wake, Howland, Baker, Jarvis, Johnston atoll, Palmyra atoll and Kingman Reef.

Special permit means a permit issued to allow fishing of coral reef ecosystem resources in restricted marine protected areas and to fish for any potentially-harvested coral reef taxa.

§ 660.13 Permits and fees.

(c) Application.

(3) Insurance: All fishing vessels (including those permitted under existing FMPs) operating or transiting in areas designated as marine protected areas shall be required to have insurance to cover vessel removal and pollution liability in the event of a grounding, depending on category of vessel, type of permit, and fishing area.

§ 660.14 Reporting and recordkeeping

(a) *Fishing record forms.* The operator of any fishing vessel subject to the requirements of §§ 660.21, 660.41, 660.81, or 660.101 must maintain on board the vessel an accurate and complete record of catch, effort and other data on report forms provided by the Regional Director. All information specified on the forms must be recorded on the forms within 24 hours after completion of each fishing day. Each form must be signed and dated by the fishing vessel operator. For the fisheries managed under §§ 660.21, 660.41, and 660.81, the original logbook form for each day of the fishing trip must be submitted to the Regional Director within 72 hours of each landing of management unit species. For the fisheries managed under § 660.101, the original logbook form for each day of the fishing trip must be submitted to the Regional Director within 30 days of each landing of management unit species.

(b) *Transshipment logbooks.* Any person subject to the requirements of § 660.21(c) or holds a special permit under 660.101(a.1.iii) must maintain on board the vessel an accurate and complete NMFS transshipment logbook containing report forms provided by the Regional Administrator. All information specified on the forms must be recorded on the forms within 24 hours after the day of transshipment. Each form must be signed and dated by the receiving vessel operator. The original logbook for each day of transshipment activity must be submitted to the PIAO Administrator within 72 hours of each landing of Pacific pelagic management unit species. The original logbook for each day of transshipment activity must be submitted to the PIAO Administrator within seven days of each landing of coral reef ecosystem management unit species.

(f) *Availability of records for inspection.*

(4) *Coral reef ecosystem management unit species.* Any person who has a Coral Reef Ecosystem permit and who is required by state laws and regulations to maintain and submit records of catch and effort, landings and sales for coral reef ecosystem management unit species by this subpart and subpart J of this part must make those records immediately available for federal inspection and copying upon request by an authorized officer.

(g) *State reporting.* Any person who has a permit under §660.21, 660.61, or 660.101 and who is regulated by state laws and regulations to maintain and submit records of catch and effort, landings and sales for vessels regulated by subparts C, E and J of this part must maintain and submit those records in the exact manner required by state laws and regulations.

§ 660.18 Area restrictions.

Fishing, harvesting or taking of management unit species under all FMPs described in subparts C, D, E, F, and J is prohibited in no-take MPAs as defined in §660.12 and;

(1) within the EEZ landward of the 10-fathom curve, as depicted on National Ocean Survey Charts, Numbers 19016, 19019 and 19022, around the Northwestern Hawaiian Islands.

(2) within the EEZ landward of the 50-fathom curve, as depicted on National Ocean Survey Charts, Numbers 19019, 19401 and 19481, around the Northwestern Hawaiian Islands of Laysan, French Frigate Shoals, and the north half of Midway, as defined in the no-take Marine Protected Area definition.

(3) within the EEZ landward of the 50-fathom curve, as depicted on National Ocean Survey Charts, Numbers 83116, 83153 and 83157, around the Pacific Remote Island Areas of Jarvis, Howland and Baker Islands, and Kingman Reef as defined in the no-take Marine Protected Area definition.

(4) within the EEZ landward of the 50-fathom curve, as depicted on National Ocean Survey Charts, Number 83484, around Rose Atoll, as defined in the no-take Marine Protected Area definition.

Subpart J – Western Pacific Coral Reef Ecosystem Fisheries

§ 660.101 Permits and fees.

(a) Applicability.

(1) Special Permit: Any person or vessel of the United States fishing for, taking or retaining coral reef ecosystem management unit species/taxa must have a special permit if that vessel is used:

(i) To fish for any coral reef ecosystem management unit species/taxa in low-use marine protected areas around the Northwestern Hawaiian Islands or remote U.S. Pacific island possessions, as defined in § 660.12.

(ii) To fish for any potentially-harvested coral reef ecosystem management unit species/taxa in the EEZ around American Samoa, Guam, the main Hawaiian Islands, or the portion of the EEZ measured from a baseline drawn in such a manner that each point on it is 3 nautical miles from the Northern Mariana Islands.

(iii) To transship coral reef ecosystem management unit species shoreward of the outer boundary of the EEZ.

(iv) To fish for any coral reef ecosystem management unit species/taxa for which it has been specifically required to obtain a special permit through framework action.

(v) To fish for any coral reef ecosystem management unit species/taxa with any gear not specifically allowed in this subpart.

(2) Exceptions:

(i) Any vessel fishing for MUS covered under a separate FMP does not need an additional permit to fish as outlined by this FMP.

(ii) Any vessel fishing for currently harvested coral reef ecosystem species/taxa outside of a marine protected area, unless specifically enacted via a framework measure.

(iii) Collecting of marine organisms for scientific research or assessment purposes (permit issued directly by NMFS).

(b) *Validity*. Each permit will be valid for fishing only in the fishery management subarea specified on the permit.

(c) *General requirements*. General requirements governing application information, issuance, fees, expiration, replacement, transfer, alteration, display, sanctions and appeals for permits are contained in 660.13.

(d) *Low use marine protected area special permit*. No direct or incidental harvest of coral reef ecosystem management unit species may be conducted in low-use marine protected areas unless authorized by a special permit issued by the PIAO Administrator in accordance with the criteria and procedures specified in this section (other than identified in exceptions).

(1) *Application*. An applicant for a special permit must submit to the PIAO Administrator, at least 60 days before the desired date of permit action, a written application including, but not limited to, the following information:

(i) The date of the application.

(ii) The applicant's name, mailing address, and telephone number.

(iii) A statement describing the objectives of the fishing activity for which a special permit is needed, including a general description of the expected disposition of the resources harvested under the permit (i.e., stored live, fresh, frozen, preserved; sold for food, ornamental, research, or other use).

(iv) For each vessel to be covered by a special permit:

(A) Vessel name (if applicable)

(B) Name, address, and telephone number of owner and operator

(C) USCG documentation, state license, or registration number

(D) Home port

(E) Length of vessel

(F) Net tonnage

(G) Gross tonnage

(H) Documentation of vessel insurance to cover cost of vessel removal and pollution liability (name of insurer and amount of insurance coverage against accidental grounding and oil spill).

(vi) A description of the planned fishing operation, including general timing, duration and location of fishing and gear operation, resources (directed and incidental) expected to be harvested under the special permit, expected catch,

and estimated ecosystem-level, habitat, and protected species impacts of the proposed harvest.

(viii) The signature of the applicant

(2) *Incomplete applications.* The PIAO Administrator may request from an applicant additional information necessary to make the determinations required under this section. An applicant will be notified of an incomplete application within 10 working days of receipt of the application. An incomplete application will not be considered until corrected in writing.

(3) *Issuance.*

(i) If an application contains all of the required information, the PIAO Administrator will forward copies of the application to the Council, the USCG, the fishery management agency of the affected state, and other interested parties, accompanied by the following information:

(A) The current utilization of domestic annual harvesting and processing capacity of the directed and incidental species for which a special permit is being requested.

(B) The current status of resources to be harvested (direct and incidental) in relation to the overfishing definition in the FMP.

(C) Estimated ecosystem, habitat, and protected species impacts of the proposed activity.

(D) Other biological and ecological information relevant to the proposal.

(ii) Following receipt of a complete application, the PIAO Administrator will consult with the Council and the Director of the affected state fishery management agency concerning the permit application and will receive their recommendations for approval or disapproval of the application. The applicant will be notified in advance of a meeting (if needed) at which the application will be considered, and invited to appear in support of the application, if the applicant desires.

(iii) Following a review of the Council's recommendation and supporting rationale, the Regional Administrator may:

(A) Concur with the Council's recommendation and, after finding that it is consistent with the goals and objectives of the FMP, the national standards, and other applicable laws, approve a special permit; or

(B) Reject the Council's recommendation, in which case, written reasons will be provided by the Regional Administrator to the Council for the rejection.

(iv) Within 30 working days after the consultation in paragraph (ii) of this section, or as soon as practicable thereafter, NMFS will notify the applicant in writing if the decision to grant or deny the special permit and, if denied, the reasons for the denial. Grounds for denial of a special permit include the following:

(A) The applicant has failed to disclose material information required, or has made false statements as to any material fact, in connection with his or her application.

(B) According to the best scientific information available, the harvest to be conducted under the permit would detrimentally affect any coral reef resource or coral reef ecosystem in a significant way.

(C) Issuance of the special permit would inequitably allocate fishing privileges among domestic fishermen or would have economic allocation as its sole purpose.

(D) Activities to be conducted under the special permit would be inconsistent with the intent of this section or the management objectives of the FMP.

(E) The applicant has failed to demonstrate a valid justification for the permit.

(F) The activity proposed under the special permit would create a significant enforcement problem.

(G) The applicant has failed to provide documentation of vessel insurance which provides for the cost of vessel removal and pollution liability.

(v) The Regional Administrator may attach terms and conditions to the special permit, if it is granted, consistent with the management objectives of the FMP, including but not limited to:

(A) The maximum amount of each resource that can be harvested and landed during the term of the special permit, including trip limits, where appropriate.

(B) The number, sizes, names and identification numbers of the vessels authorized to conduct fishing activities under the special permit.

(C) The times and places where fishing may be conducted.

(D) The type, size, and amount of gear which may be used by each vessel operated under the special permit.

(E) Data reporting requirements.

(F) Such other conditions as may be necessary to ensure compliance with the purposes of the special permit consistent with the objectives of the FMP.

(4) *Duration.* Unless otherwise specified in the special permit or a superceding notice or regulation, a special permit is effective for no longer than one year, unless revoked, suspended, or modified. Special permits may be renewed following the general procedures in § 660.13.

(5) *Alteration.* Any special permit that has been altered, erased, or mutilated is invalid.

(6) *Validity*. A permit is valid only for the particular vessel(s) named in the application.

(7) *Inspection*. Any special permit must be carried aboard the vessel(s) for which it was issued. The special permit must be presented for inspection upon request of any authorized officer.

(8) *Sanctions*. Failure of the holder of a special permit to comply with the terms and conditions of a special permit, the provisions of § 660.13, any other applicable provisions of this part, the Magnuson Act, or any other regulation promulgated thereunder, is grounds for revocation, suspension, or modification of the special permit with respect to all persons and vessels conducting activities under the special permit. Any action taken to revoke, suspend, or modify a special permit will be governed by 15 CFR part 904 subpart D. Other sanctions available under the statute will be applicable.

(9) *Protected species*. Persons fishing under a special permit must report any incidental take or fisheries interaction with protected species (i.e., all species of sea turtles, seabirds and marine mammals) on a form provided for that purpose. Reports must be submitted to the Regional Administrator within three days of arriving in port.

(10) *Appeals of permit actions*.

(i) Except as provided in subpart D of 15 CFR part 904, any applicant for a permit or a permit holder may appeal the granting, denial, conditioning, or suspension of their permit or a permit affecting their interests to the Regional Administrator. In order to be considered by the Regional Administrator, such appeal must be in writing, must state the action(s) appealed, and the reasons therefore, and must be submitted within 30 days of the original action(s) by the Regional Administrator. The appellant may request an informal hearing on the appeal.

(ii) Upon receipt of an appeal authorized by this section, the Regional Administrator will notify the permit applicant, or permit holder as appropriate, and will request such additional information and in such form as will allow action upon the appeal. Upon receipt of sufficient information, the Regional Administrator will rule on the appeal in accordance with the permit eligibility criteria set forth in this section and the FMP, as appropriate, based upon information relative to the application on file at NMFS and the Council and any additional information, the summary record kept of any hearing and the hearing officer's recommended decision, if any, and such other considerations as deemed appropriate. The Regional Administrator will notify all interested persons of the decision, and the reasons therefor, in writing, normally within 30 days of the receipt of sufficient information, unless additional time is needed for a hearing.

(iii) If a hearing is requested, or if the Regional Administrator determines that one is appropriate, the Regional Administrator may grant an informal hearing

before a hearing officer designated for that purpose after first giving notice of the time, place, and subject matter of the hearing in the Federal Register. Such a hearing shall normally be held no later than 30 days following publication of the notice in the Federal Register, unless the hearing officer extends the time for reasons deemed equitable. The appellant, the applicant (if different), and, at the discretion of the hearing officer, other interested persons, may appear personally or be represented by counsel at the hearing and submit information and present arguments as determined appropriate by the hearing officer. Within 30 days of the last day of the hearing, the hearing officer shall recommend in writing a decision to the Regional Administrator.

(iv) The Regional Administrator may adopt the hearing officer's recommended decision, in whole or in part, or may reject or modify it. In any event, the Regional Administrator will notify interested persons of the decision, and the reason(s) therefore, in writing, within 30 days of receipt of the hearing officer's recommended decision. The Regional Administrator's action constitutes final action for the agency for the purposes of the Administrative Procedures Act.

(v) Any time limit prescribed in this section may be extended for good cause, for a period not to exceed 30 days by the Regional Administrator, either upon his or her own motion or upon written request from the appellant or applicant stating the reason(s) therefore.

(11) *Fees*. A fee is charged for each application for a restricted marine protected area special permit, including permit transfers and permit renewals. The amount of the fee is calculated in accordance with the procedures of the NOAA Finance Handbook, available from the Regional Administrator, for determining the administrative costs of each special product or service. The fee may not exceed such costs and is specified with each application form. The appropriate fee must accompany each application. Failure to pay the fee will preclude issuance of a special permit.

§ 660.102 Prohibitions.

In addition to the prohibitions in § 600.725 of this chapter, it is unlawful for any person to:

(a) Fish for, take, retain, possess or land any coral reef resource in any portion of the management area as defined in § 660.12 unless:

(1) A valid permit has been issued for the fishing vessel and area, as specified;

(2) A permit is not required, as outlined in the permit section of these regulations or;

(3) The coral reef resources possessed on board the vessel originated outside the management area and this can be demonstrated through receipts of purchase, invoices, fishing logbooks or other documentation.

(b) Fish for, take, or retain any coral reef ecosystem resource:

(1) That is determined overfished and announced by the Regional Administrator.
(2) By means of gear or methods prohibited under allowable and restricted gear in this subpart.
(3) In no-take marine protected areas (except for scientific research).
(4) In low-use marine protected areas unless a valid special permit has been issued.
(5) In violation of any permit issued under § 660.13 or in the permit section of this subpart.

(c) Fish for, take, or retain any wild live rock or live hard coral for commercial purposes except under a valid special permit for scientific research (issued by NMFS), aquaculture seed stock collection or traditional and ceremonial purposes by indigenous people.

(d) Engage in fishing without a valid permit or facsimile of a valid permit on board the vessel and available for inspection by an authorized officer, when a permit is required under § 660.13 or in the permit section of this subpart, unless the vessel was at sea when the permit was issued, in which case the permit must be on board the vessel before its next trip.

(e) File false information on any application for a general permit under § 660.13 or a special permit.

(f) Fail to file reports in the exact manner required by a state law or regulation, as required, provided that the person is required to do so by applicable state law or regulation.

(g) Falsify or fail to make, keep, maintain, or submit any logbook or logbook form or other record or report required.

(h) Refuse to make available to an authorized officer or designee of the Regional Administrator for inspection or copying, any records that must be made available.

(i) Fail to affix or maintain vessel or gear markings, as required.

(j) Violate a term or condition of a special permit.

(k) Fail to report any take or interaction with protected species as required.

(l) Fail to notify officials as required.

§ 660.103 Notification.

(a) *Before fishing in low-use marine protected area.* The permit holder for a fishing vessel subject to the requirements of the special permit, or agent designated by the permit holder, shall provide a notice to the Regional Administrator at least 72 hours (not including weekends and federal holidays)

before the vessel leaves port on any fishing trip, any part of which occurs in any portion of the EEZ designated as a low-use marine protected area. The vessel operator will be presumed to be an agent designated by the permit holder unless the PIAO Administrator is otherwise notified by the permit holder. The notice must be provided to the office or telephone number designated by the PIAO Administrator. The notice must provide the official number of the vessel, the name of the vessel, the intended departure date, time, and location, the name of the operator of the vessel, and the name and telephone number of the agent designated by the permit holder to be available between 8:00 a.m. to 5:00 p.m. (Hawaii time) on weekdays for NMFS to contact.

(b) *Before landing after fishing in low-use marine protected area.* The operator of a fishing vessel that has been granted a special permit under §660.101 and that has made a trip that harvested coral reef resources in a low-use marine protected area must contact NMFS Enforcement at least 24 hours before landing, and report the port and the approximate date and time at which the coral reef resources harvested on the trip will be landed.

§ 660.104 Allowable gear and gear restrictions.

(a) *Allowable gear and methods.* Coral reef ecosystem resources may be taken only with allowable gear and methods, as follows:

(1) hand harvest;
(2) spear;
(3) slurp gun;
(4) hand net/dip net, hoop net (for Kona crab);
(5) throw net;
(6) barrier net (for aquarium fish);
(7) surround/purse nets for targeted schools (e.g., baitfish, big-eyed scad, goatfish) with a minimum of bycatch, and must be attended by swimmers or divers at all times;
(8) hook-and-line (includes handline [powered or not], rod-and-reel, and trolling);
(9) traps (with conditions); and
(10) remote-operating vehicles/submersibles.

(b) *Poisons, explosives, intoxicating substances.* Coral reef resources may not be taken by means of poisons, explosives, or intoxicating substances. Possession of these materials by any vessel having a coral reef ecosystem permit or that is otherwise established to be fishing for coral reef ecosystem resources in the EEZ is prohibited.

(c) *Spearfishing with scuba.* Coral reef resources may not be taken by means of spearfishing with scuba at night (from 6 pm to 6 am) in the Northwestern Hawaiian Islands or the Pacific Remote Island Areas.

(d) *Possession of gear.* Possession or use of trawl nets, gill nets, hookah breathers, or any other gear that is not expressly allowed under these regulations by any vessel holding a permit or that is otherwise established to be fishing for coral reef ecosystem resources in the EEZ is prohibited. Possession of any gear not approved under §660.104 or approved by the PIAO Administrator in the permit process while established to be fishing for coral reef resources in the EEZ is prohibited.

(e) *Existing FMP fisheries.* Existing FMP fisheries shall follow the allowable gear and methods outlined in their respective plans.

(f) *Non-listed gear.* Anyone wishing to fish with gear not included in this list must describe the gear and its method of deployment in the special permit application. A ruling on the allowability of this gear type will be determined by the PIAO Administrator after consultation with the Council and the director of the affected state fishery management agency.

§ 660.105 Unattended Gear and Gear Identification.

(a) *Identification.* The owner's identification must be marked legibly on all fish and crab traps on board the vessel or deployed in the water by any vessel holding a permit under §660.13 or in this subpart or that is otherwise established to be fishing for coral reef ecosystem resources in the EEZ.

(b) *Enforcement action.*

(1) Unattended traps not marked in compliance with these regulations and found deployed in the EEZ will be considered unclaimed or abandoned property, and may be disposed of in any manner considered appropriate by NMFS or an authorized officer.

(2) Unattended surround nets or bait seine nets found deployed in the EEZ will be considered unclaimed or abandoned property, and may be disposed of in any manner considered appropriate by NMFS or an authorized officer.

§ 660.106 Area Restrictions

(a) *Low-use MPAs*: Fishing for coral reef ecosystem resources in low-use marine protected areas is allowed only by persons or by vessels for which a special permit has been issued:

(1) Within the EEZ to an inner boundary coterminous with the 10-fathom curve, as depicted on National Ocean Survey Charts, Numbers 19016, 19019 and 19022, around the Northwestern Hawaiian Islands, except for the EEZ landward of the 50-fathom curve around Laysan, French Frigate Shoals, and the southern half of Midway, as defined in 660.12.

(2) Within the EEZ, as depicted on National Ocean Survey Charts, Numbers 83637 and 81664, around the Pacific Remote Island Areas of Palmyra, Johnston Atoll and Wake Island.

(3) Permitted vessels fishing under other FMPs follow regulations in their respective FMP.

(b) Anchoring by fishing vessels over 50 feet in overall length is prohibited in the EEZ seaward of the Territory of Guam west of 144.5 E longitude except in the event of an emergency caused by ocean conditions or by a vessel malfunction that can be documented.

§ 660.107 Framework for Regulatory Adjustments.

(a) *Procedure for established measures.*

(1) Established measures are management measures that, at some time, have been included in regulations implementing the FMP, or for which the impacts have been evaluated in Council/NMFS documents in the context of current conditions.

(2) Following framework procedures of the CRE-FMP, the Council may recommend to the Regional Administrator that established measures be modified, removed, or re-instituted. Such recommendation shall include supporting rationale and analysis, and shall be made after advance public notice, public discussion and consideration of public comment. NMFS may implement the Council's recommendation by rulemaking if approved by the Regional Administrator.

(b) *Procedure for new measures.*

(1) New measures are management measures that have not been included in regulations implementing the FMP, or for which the impacts have not been evaluated in Council/NMFS documents in the context of current conditions. New measures include but are not limited to: catch limits; resource size limits; closures; effort limitations; permit requirements; reporting and recordkeeping requirements.

(2) Following the framework procedures of the FMP, the Council will publicize, including by Federal Register notice, and solicit public comment on, any proposed new management measure. After a Council meeting at which the measure is discussed, the Council will consider recommendations and prepare a Federal Register notice summarizing the Council's deliberations, rationale, and analysis for the preferred action, and the time and place for any subsequent Council meeting(s) to consider the new measure. At subsequent public meeting(s), the Council will consider public comments and other information received to make a recommendation to the Regional Administrator about any new measure. NMFS may implement the Council's recommendation by rule making if approved by the Regional Administrator.

(i) The Regional Administrator will consider the Council's recommendation and supporting rationale and analysis, and, if he or she concurs

with the Council's recommendation, will propose regulations to carry out the action. If the Regional Administrator rejects the Council's proposed action, a written explanation for the denial will be provided to the Council within two weeks of the decision.

(ii) The Council may appeal denial by writing to the Assistant Administrator, who must respond in writing within 30 days.

(iii) The Regional Administrator and the Assistant Administrator will make their decisions in accord with the MSFCMA, other applicable laws, and the Coral Reef Ecosystem FMP.

(iv) To minimize conflicts between the federal and state/territorial/ commonwealth management systems, the Council will use the procedures in paragraph (a)(2) in this section to respond to state/territorial/commonwealth management actions. Council consideration of action would normally begin with a representative of the state, territorial or commonwealth government bringing a potential or actual management conflict or need to the Council's attention.

§ 660.108 Management subareas.

(a) The fishery management area is divided into six subareas for the regulation of fishing for coral reef ecosystem management unit species:

(1) Main Hawaiian Islands means the EEZ of the Hawaiian Islands Archipelago lying to the east of 161°20' long.

(2) Northwestern Hawaiian Islands means the EEZ of the Hawaiian Islands Archipelago lying to the west of 161°20'. For purposes of the regulations issued under this subpart, Midway Island is treated as part of the Northwestern Hawaiian Islands.

(3) Guam means the EEZ seaward of the Territory of Guam waters.

(4) American Samoa means the EEZ seaward of the Territory of American Samoa waters.

(5) Commonwealth of the Northern Mariana Islands (CNMI) means that portion of the EEZ seaward from a baseline line drawn 3 nautical miles offshore of the Northern Mariana Islands.

(6) Remote U.S. Pacific island possessions means the EEZ seaward of the islands of Johnston, Wake, Palmyra, Kingman Reef, Howland, Jarvis and Baker.

(b) The inner boundary of the fishery management area is a line coterminous with the shoreline of the Midway Islands, and the Remote U.S. Pacific Island Possessions, with the seaward boundaries of the State of Hawaii, the Territory of Guam, the Territory of American Samoa, and with a baseline drawn three nautical miles offshore of the Commonwealth of the Northern Mariana Islands.

(c) The outer boundary of the fishery management area is a line drawn in such a manner that each point is 200 nautical miles from the baseline from which the territorial sea is measured, or is coterminous with adjacent international maritime boundaries. The outer boundary of the

fishery management area north of Guam will extend to those points which are equidistant between Guam and the island of Rota in CNMI.

§ 660.109 Annual Reports.

(a) *Annual reports*. By July 31 of each year, a Council-appointed coral reef ecosystem plan team will prepare an annual report covering the following topics:

(1) Fishery performance data, with detailed catch-effort information for target, non-target (incidental) resources and bycatch.

(2) Summary of new coral reef resource information obtained from fishery-dependent and non-fishery dependent sources.

(3) Essential fish habitat conditions and sources of degradation including fishing and non-fishing impact to EFH and HAPC in all areas.

(4) Coral reef ecosystem-level impacts associated with fishing activities regulated under this and other fishery management plans.

(5) Enforcement activities and problems.

(6) Administrative actions (e.g., data collection and reporting, permits).

(7) State and territorial management actions.

(8) Assessment of need for Council action (including biological, economic, social, enforcement, administrative, and state/territorial/commonwealth/ federal needs, problems, and trends). Indication of potential problems warranting further investigation may be signaled by the following indicator criteria:

(i) Significant change in habitat structure or stability.

(ii) Significant change in trophic structure or biodiversity.

(iii) Significant change in interactions among different fisheries.

(iv) Significant change in mean size of the catch of any species or species group.

(v) Significant change in catch-per-unit-effort for any species or species group.

(vi) Significant change in gear types or methods of fishing.

(vii) Interactions with protected species.

(viii) Significant coral reef ecosystem cumulative effects.

(9) Recommendation for Council action.

(10) Estimated impacts of recommended action.

The FMP establishes a non-regulatory formal process for coordination of the Coral Reef Ecosystem FMP with the existing Bottomfish, Crustaceans, Pelagics and Precious Corals FMPs. Ecosystem issues will be identified and mitigation options identified through interaction among the plan teams.

(b) *Recommendation of management action.*

(1) The Council will evaluate the annual report and advisory body recommendations and may recommend management action by either the state/territorial/commonwealth governments or by federal regulation.

(2) If the Council believes that management action should be considered, it will make specific recommendations to the Regional Administrator after considering the views of its advisory bodies. The Council will assess the need for federal management action.

Table 3 to Part §660. - Currently Harvested Coral Reef Ecosystem Management Unit Species.

Acanthuridae (Surgeonfishes)	Orange-spot surgeonfish (*Acanthurus olivaceus*) Yellowfin surgeonfish (*Acanthurus xanthopterus*) Convict tang (*Acanthurus triostegus*) Eye-striped surgeonfish (*Acanthurus dussumieri*) Blue-lined surgeon (*Acanthurus nigroris*) Whitebar surgeonfish (*Acanthurus leucopareius*) Blue-banded surgeonfish (*Acanthurus lineatus*) Blackstreak surgeonfish (*Acanthurus nigricauda*) Whitecheek surgeonfish (*Acanthurus nigricans*) White-spotted surgeonfish (*Acanthurus guttatus*) Ringtail surgeonfish (*Acanthurus blochii*) Brown surgeonfish (*Acanthurus nigrofuscus*) Elongate surgeonfish (*Acanthurus mata*) Mimic surgeonfish (*Acanthurus pyroferus)* Yellow-eyed surgeonfish (*Ctenochaetus strigousus*) Striped bristletooth (*Ctenochaetus striatus*) Twospot bristletooth (*Ctenochaetus binotatus*)
	Bluespine unicornfish (*Naso unicornus*) Orangespine unicornfish (*Naso lituratus*) Humpnose unicornfish (*Naso tuberosus*) Blacktounge unicornfish (*Naso hexacanthus*) Bignose unicornfish (*Naso vlamingii*) Whitemargin unicornfish (*Naso annulatus*) Spotted unicornfish(*Naso brevirostris*) Humpback unicornfish(*Naso brachycentron*) Barred unincornfish (*Naso thynnoides*) Gray unicornfish (*Naso caesius*)
Balistidae (Triggerfishes)	Titan triggerfish (*Balistoides viridescens*) Clown triggerfish *(B. conspicillum*) Orangstriped trigger (*Balistapus undulatus*) Pinktail triggerfish (*Melichthys vidua*) Black triggerfish (*M. niger)* Blue triggerfish (*Pseudobalistes fucus*) Picassofish (*Rhinecanthus aculeatus*) Wedged Picassofish (*B. rectangulus*) Bridled triggerfish (*Sufflamen fraenatus*)

Carangidae (Jacks)	Bigeye scad (*Selar crumenophthalmus*) Mackerel scad (*Decapterus macarellus*)
Carcharhinidae (Sharks)	Grey reef shark (*Carcharhinus amblyrhynchos*) Silvertip shark (Carcharhinus albimarginatus) Galapagos shark (*Carcharhinus galapagenis*) Blacktip reef shark (*Carcharhinus melanopterus*) Whitetip reef shark (*Triaenodon obesus*)
Holocentridae (Soldierfish/Squirrelfish)	Bigscale soldierfish (*Myripristis berndti*) Bronze soldierfish (*Myripristis adusta*) Blotcheye soldierfish (*Myripristis murdjan*) Brick soldierfish (*Myripristis amaena*) Scarlet soldierfish (*Myripristis pralinia*) Violet soldierfish (*Myripristis violacea*) Whitetip soldierfish (*Myripristis vittata*) Yellowfin soldierfish (*Myripristis chryseres*) Pearly soldierfish(*Myripristis kuntee*) (*Myripristis hexagona*) Tailspot squirrelfish (*Sargocentron caudimaculatum*) Blackspot squirrelfish (*Sargocentron melanospilos*) File-lined squirrelfish(*Sargocentron microstoma*) Pink squirrelfish(*Sargocentron tieroides*) Crown squirrelfish (*Sargocentron diadema*) Peppered squirrelfish (*Sargocentron punctatissimum*) Blue-lined squirrelfish (*Sargocentron tiere*) Ala'ihi (*Sargocentron xantherythrum*) (*Sargocentron furcatum*) (*Sargocentron spiniferum*) Spotfin squirrelfish (*Neoniphon spp.*)
Kuhliidae (Flag-tails)	Hawaiian flag-tail (*Kuhlia sandvicensis*) Barred flag-tail (*Kuhlia mugil*)
Kyphosidae (Rudderfish)	Rudderfish (*Kyphosus biggibus*) (*Kyphosus cinerascens*) (*Kyphosus vaigienses*)

Labridae (Wrasses)	Saddleback hogfish (*Bodianus bilunulatus*) Napoleon wrasse (*Cheilinus undulatus*) Triple-tail wrasse (*Cheilinus trilobatus*) Floral wrasse (*Cheilinus chlorourus*) Harlequin tuskfish (*Cheilinus fasciatus*) Ring-tailed wrasse (*Oxycheilinus unifasciatus*) Bandcheek wrasse (*Oxycheilinus diagrammus*) Arenatus wrasse (*Oxycheilinus arenatus*) Razor wrasse (Xyricthys pavo) Whitepatch wrasse (*Xyrichtes aneitensis*) Cigar wrass (*Cheilio inermis*) Blackeye thicklip (*Hemigymnus melapterus*) Barred thicklip (*Hemigymnus fasciatus*) Threespot wrasse (*Halichoeres trimaculatus*) Checkerboard wrasse (*Halichoeres hortulanus*) Weedy surge wrasse (*Halichoeres margaritacous*) (*Halichoeres zeylonicus*) Surge wrasse (Thalassoma purpureum) Redribbon wrasse (Thalassoma quinquevittatum) Sunset wrasse (Thalassoma lutescens) Longface wrasse (Hologynmosus doliatus) Rockmover wrasse (Novaculichthys taeniourus)
Mullidae (Goatfishes)	Yellow goatfish (*Mulloidichthys spp.*) (*Mulloidichthys* Pfleugeri) (*Mulloidichthys* vanicolensis) (*Mulloidichthys flaviolineatus*) Banded goatfish (*Parupeneus spp.*) (*Parupeneus barberinus*) (*Parupeneus bifasciatus*) (*Parupeneus heptacanthus*) (*Parupeneus ciliatus*) (*Parupeneus ciliatus*) (*Parupeneus cyclostomas*) (*Parupeneus pleurostigma*) (*Parupeneus indicus*) (*Parupeneus multifaciatus*) Bantail goatfish (*Upeneus arge)*
Mugilidae (Mullets)	Stripped mullet (*Mulgil cephalus)* Engel's mullet (*Moolgarda engeli*) False mullet (*Neomyxus leuciscus*) Fringelip mullet (*Crenimugil crenilabis*)
Muraenidae (Moray eels)	Yellowmargin moray (*Gymnothorax flavimarginatus*) Giant moray (*Gymnothorax javanicus*) Undulated moray (*Gymnothorax undulatus*)
Ocotpodidae	Octopus (*Octupus cyanea; O. ornatus*)
Polynemidae	Threadfin (*Polydactylus sexfilis*) -Moi

Pricanthidae (Bigeye)	Glasseye (*Heteropriacanthus cruentatus*) Bigeye (*Priacanthus hamrur*)
Scaridae (Parrotfishes)	Humphead parrotfish (Bulbometapon muracatum) Parrotfishes (*Scarus spp.*) Pacific longnose parrotfish (Hipposcarus longiceps) Stareye parrotfish (Catolomus carolinus)
Scombridae (Dogtooth tuna)	Dogtooth tuna (*Gymnosarda unicolor*)
Siganidae (Rabbitfish)	Forktail rabbitfish (*Siganus aregentus*) Golden rabbitfish (*Siganus guttatus*) Gold-spot rabbitfish (*Siganus punctatissimus*) Randall's rabbitfish (*Siganus randalli*) Scribbled rabbitfish (*Siganus spinus*) Vermiculate rabbitfish (*Signaus vermiculatus*)
Sphyraenidae (Barracuda)	Heller's barracuda (*Sphyraena helleri*) Great Barracuda (*Sphyraena barracuda)*
Turbinidae (turban shells/green snails)	Green snails (*Turbo spp.*)

Aquarium Taxa/Species	**Acanthuridae** Yellow tang (*Zebrasoma flavescens*) Yellow-eyed surgeon fish (*Ctenochaetus strigosus*) Achilles tang (*Acanthurus achilles*) **Muraenidae** Dragon eel (*Enchelycore pardalis*) **Zanclidae** Morrish idol (*Zanclus cornutus*) **Pomacanthidae** Angelfish (*Centropyge shepardi* and *C. flavissimus*) **Cirrhitidae** Flame hawkfish (*Neocirrhitus armatus*) **Chatetodontidae** Butterflyfish (*Chaetodon auriga, C. lunula, C. melannotus* and *C. ephippium*) **Pomacentridae** Damselfish (*Chromis viridis, Dascyllus aruanus* and *D. trimaculatus*) **Sabellidae** Featherduster worm (*Sabellidae*)

Table 4 to Part §660. – Potentially Harvested Coral Reef Ecosystem Management Unit Species.

Other Labridae spp. (wrasses) *(Those species not listed on CHCRT list)*	Ephippidae (batfish)
Other Carcharhinidae, Sphyrnidae *(Those species not listed on CHCRT list)*	Monodactylidae (mono)
Dasyatididae, Myliobatidae, Mobulidae (rays)	Haemulidae (sweetlips)
Other Serranidae spp. (groupers) *(Those species not managed under the Bottomfish FMP or included in proposed bottomfish amendment)*	Echineididae (remoras)
Carangidae (jacks/trevallies) *(Those species not listed on CHCRT list, managed under Bottomfish FMP, or included in proposed bottomfish amendment)*	Malacanthidae (tilefish)
	Acanthoclinidae (spiny basslets)
Other Holocentridae spp. (soldierfish/squirrelfish) *(Those species not listed on CHCRT list)*	Pseudochromidae (dottybacks)
Other Mullidae spp. (goatfish) *(Those species not listed on CHCRT list)*	Plesiopidae (prettyfins)
Other Acanthuridae spp. (surgeonfish/unicornfish) *(Those species not listed on CHCRT list)*	Tetrarogidae (waspfish)
Other Lethrinidae spp. (emperors) *(Those species not managed under the Bottomfish FMP or included in proposed bottomfish amendment)*	Caracanthidae (coral crouchers)
Chlopsidae, Congridae, Moringuidae, Ophichthidae (eels) Other Muraenidae (morays eels) *(Those species not listed on CHCRT list)*	Grammistidae (soapfish)
Apogonidae (cardinalfish)	*Aulostomus chinensis* (trumpetfish)
Other Zanclidae spp. (moorish idols)	*Fistularia commersoni* (coronetfish)
Other Chaetodontidae spp. (butterflyfish)	Anomalopidae (flashlightfish)
Other Pomacanthidae spp. (angelfish)	Clupeidae (herrings)
Other Pomacentridae spp. (damselfish)	Engraulidae (anchovies)
Scorpaenidae (scorpionfish) (excluding *Pontinus macrocephela* which is included in proposed bottomfish amendment)	Gobiidae (gobies)
Blenniidae (blennies)	Lutjanidae *(Those species not managed under Bottomfish FMP or included in proposed bottomfish amendment)*

Other Sphyraenidae spp. (barracudas)	Other Ballistidae/Monocanthidae spp. (*Those species not listed on CHCRT list*)
Pinguipedidae (sandperches)	Other Siganidae spp. (*Those species not listed on CHCRT list*)
	Other Kyphosidae spp.
Bothidae/Soleidae/Pleurnectidae (flounder/sole)	Caesionidae
Ostraciidae (trunkfish)	Cirrhitidae
Tetradontidae/Diodontidae (puffer/porcupinefish)	Antennariidae (frogfishes)
	Syngnathidae (pipefishes/seahorses)
Stony corals	Echinoderms (e.g., sea cucumbers, sea urchins)
Heliopora (blue)	Mollusca
Tubipora (organpipe)	Sea snails (gastropods)
Azooxanthellates (non-reefbuilders)	Trochus spp.
Fungiidae (mushroom corals)	Opistobranchs (sea slugs)
Sm/Lg Polyped Corals (endemic spp.)	*Pinctada margaritifera* (black lipped pearl oyster)
Millepora (firecorals)	Tridacnidae
Soft corals and gorgonians	Other bivalves
Anemones (non-epifaunal)	Cephalopods
Zooanthids	Crustaceans (lobsters, shrimps/mantis, true crabs and hermit crabs) (*Those species not managed under the Crustacean FMP*)
Sponges (non-epifaunal)	Stylasteridae (lace corals)
Hydrozoans	Solanderidae (hydroid fans)
Bryozoans	Annelids
	Algae
Tunicates (solitary/colonial)	Live rock
All other coral reef ecosystem marine plants, invertebrates and fishes not listed under existing FMPs.	

* The Council proposed to include 49 species of fish (caught predominantly in Guam, the CNMI and American Samoa with traditional bottomfish methods) as new Bottomfish MUS at the June 2000 Council meeting. The amendment is to be submitted at the same time as the CRE FMP.

8.2 Draft Permit Applications and Data Entry Forms

The following five forms and their associated directions are examples of the forms that will be required as specified earlier (see section 5.3). These forms have been generated by combining the suggestions from each advisory body. As the general permit and data entry forms may be implemented through a framework process at the recommendation of the Council, and the requirements of the special permit and data entry forms are determined on a case by case basis, these forms should only be viewed as examples of what likely will be required.

General Coral Reef Ecosystem Fishing Permit Application Form

Applicant Information: Date:____/____/____

Name:_____ Phone:_____ Fax:_____

Address: Street _____ Apt # _____ City _____ State _____ Zip Code _____

Vessel Name: _____ Home Port: _____

Length:_____ Net Tonnage:_____ Gross Tonnage:_____

Vessel USCG Documentation / State License / Vessel Registration (circle one)
Number:_____

Vessel operator:

Name:_____ Phone:_____ Fax:_____

Address: Street _____ Apt # _____ City _____ State _____ Zip Code _____

Is this permit solely to transship coral reef ecosystem taxa received from another vessel around the EEZ of American Samoa, Guam, the main Hawaiian Islands or CNMI?_____

In which EEZ Management Subarea will fishing be conducted ? (circle only one)

Main Hawaiian Islands Guam American Samoa CNMI

(Optional) Provide general description of planned fishing operation (e.g., type and amount of gear, intended usage, target and expected catch of incidental species, expected volume of catch, intended disposition of catch, or any additional information). Use back of this sheet, if necessary.

Target Species			Expected Incidental Species		
Species Name	Expected Catch (#, wt.)	Why harvested? [1]	Species Name	Expected Catch (#, wt.)	keep?

[1] Food, ornamental, research, other

This information is true to the best of my knowledge.

Signature:_____

Return to: Pacific Islands Area Office, Southwest Region, NMFS;
Tel: (808) 973-2937; Fax: (808) 973-2941

Instructions for General Coral Reef Ecosystem Fishing Permit Application Form

1. Date the application. A response will be sent to the applicant within 15 days after the receipt of a completed application.

2. Write the name of the vessel for which this permit will be affixed per CFR §660.13 (k). Circle the type of registration the vessel is under and give the appropriate number.

3. Specify whether this permit is for transshipment. If so, describe where and when transshipment will occur as well as which species are likely to be transhipped and for what purpose. This can be done as an attachment. No other information will be needed. Only sign the document. Vessels wishing to transship coral reef ecosystem management unit species shoreward of the outer boundary of the EEZ around the Northwestern Hawaiian Islands and remote U.S. Pacific island possessions must fill out a special permit application.

4. Specify the subarea in which fishing will take place. Each permit will be valid for fishing only in the fishery management subarea specified on the permit.

5. (Optional) Provide general description of planned fishing operation with information regarding gear, target species and related information.

6. Sign.

If an incomplete or improperly completed application is filed, the applicant will be sent a notice of deficiency. If the applicant fails to correct the deficiency within 30 days following the date of notification, the application will be considered abandoned.

Special Coral Reef Ecosystem Fishing Permit Application Form

Applicant Information Date: ___/___/___

Name:_____ Phone:_____ Fax: _____

Address: Street Apt # City State Zip Code

Vessel Name: _____ Home Port: _____

Length:_____ Net Tonnage:_____ Gross Tonnage:_____

Vessel USCG Documentation / State License / Vessel Registration (circle one)

Number:_____

Vessel operator:

Name:_____ Phone:_____ Fax: _____

Address: Street Apt # City State Zip Code

Is this permit solely to transship coral reef ecosystem taxa received from another vessel around the EEZ of the Northwest Hawaiian Islands, the Pacific Remote Island Areas, or any other MPA?_____

Do you agree to accommodate an observer on board while fishing, if required?_____

Does vessel have an individual Vessel Monitoring System?_____

Does vessel have insurance covering removal/clean-up in event of a grounding?_____Name of Insurer:_____

Do you agree to submit data within 30 days of returning to port?_____

Circle any special exemption for which you qualify and would like to be eligible for under this permit application (attach description of conditions under which you apply):

Other FMP

Scientific Bioprospecting General Indigenous Indigenous use of live rock/coral Aquaculture seed stock of coral

In which EEZ Management Subarea will fishing be conducted ? (circle only one)

Main Hawaiian Islands Northwest Hawaiian Islands Guam Guam's Southern Banks

American Samoa CNMI PRIA (specify all) _____

Describe your intended fishing effort, general fishing grounds, gear to be used and methods of collection

Target Species or Taxa				Expected Incidental Species or Taxa		
Species Name	Expected Catch (lb)	How will it be processed?[1]	Why harvested? [2]	Species Name	Expected Catch (lb)	keep?

Use back, if necessary; total expected catch during permit period for target species required for permit approval

[1]Live, fresh, frozen, preserved, other

[2] Food, ornamental, research, other

Attach statement regarding objectives of fishing operation, estimated ecosystem, habitat and protected species impacts, and any additional information to help support approval of this application

This information is true to the best of my knowledge.

Signature:_____

Return to: Pacific Islands Area Office, Southwest Region, NMFS
Tel: (808) 973-2935; Fax: (808) 973-2941

Instructions for Special Coral Reef Ecosystem Fishing Permit Application Form

1. Date the application. A response will be sent to the applicant within 15 days after the receipt of a completed application.

2. Write the name of the vessel for which this permit will be affixed per CFR 660.13 (k). Circle the type of registration the vessel is under and give the appropriate number.

3. Answer the five questions after the information for the vessel operator yes or no. Give the name of the insurer of the vessel for which this permit is being applied. All fishing vessels (including existing FMP fisheries) operating in or transiting a marine protected area must have insurance to cover removal and clean-up.

4. If you intend to harvest live rock or coral, additional information must be attached to show why you are eligible for this exemption. If you intend to harvest in an MPA designated for indigenous use, attach relevant information as well. Scientific and bioprospecting permits may require additional information. Those applying under these circumstances should contact the PIAO before submitting an application.

5. Describe intended fishing effort as best possible (e.g., seasons, duration, etc.).

6. In describing the fishing gear, traps must have permanent legible identification. Describe what the identification is, if applicable. Describe how the gear is intended to be deployed and retrieved.

7. List all expected target and incidental species or taxa in the table and other information as best possible. Provide both numbers and weight for the catch, if appropriate.

8. Sign.

If an incomplete or improperly completed application is filed, the applicant will be sent a notice of deficiency. If the applicant fails to correct the deficiency within 30 days following the date of notification, the application will be considered abandoned.

General Coral Reef Taxa Daily Catch Report

Name of Licensee:_____ Coral Reef Ecosystem Permit No._____
Vessel Name:_____ Radio Call Sign:_____Vessel Number:_____
Area Fished:_____ (follow regional fishing area designations, where applicable)
Type of Gear Used (one report form for each haul with each gear type per day):_____
Date Gear Set: ____/____/____ Time at Start:_____ Units of Gear Set: _____
Date Gear Hauled: ____/____/____ Time at End: _____ Units of Gear Lost:_____
Wind Speed:_____ Wind Direction:_____ Sea Surface Temperature:_____ Average Depth:_____
Target Species (list all):_____
If gear was lost, give explanation as to reason why (no penalty for lost gear).
_____

Describe any observed damage to the coral reef and how it occurred._____
_____
_____
_____

Species	No. Caught	Lbs. Caught	No. Kept	Lbs. Kept	If discarded, why ?	How processed?

Protected Species Observation			
~~Enter Seal & Turtle numbers;~~	~~Monk Seal~~	~~Turtle~~	~~Other~~
~~Observed in area~~			
~~Observed in vicinity of gear~~			
~~Interfering with fishing operations~~			
~~Preying on catch~~			
Entangled, released alive			
Entangled, released dead			

Print Name:_____ Signature:_____ Date:____/____/____

All information must be logged within 24 hours after the completion of the fishing day.
Submit this form to NMFS within 30 days of each landing of coral reef harvest.
NMFS Honolulu Laboratory, 2570 Dole St., Honolulu, HI 96822; fax: (808) 983-2902

Instructions for General Coral Reef Taxa Daily Catch Report

1. From the coral reef ecosystem permit, record the permittee and permit number.

2. If the area fished has a specific regional designation, use it. Otherwise use an understandable description or latitudinal and longitudinal coordinates.

3. List units of gear lost and provide an explanation as to why (strong current, storm, bottom topography, etc). There is no penalty for lost gear. This information is solely used for management purposes.

4. Describe damage to the reef. Again, as long as operating within the regulations, there is no penalty for this. This information is solely used for management purposes.

5. Fill in the table as specifically as practical. If a percentage of number or pounds kept is more appropriate, be as accurate in your estimate as possible. Give reasons for any discarded catch. Describe how processed (e.g., live, fresh, frozen, preserved, etc.).

6. Give numbers for all protected species observed in most appropriate box. Do not list same animal in two separate boxes for the same day. List it in the most specific category (generally more specific down the list).

7. All information must be logged, signed and dated within 24 hours after completion of the fishing day.

8. All daily catch reports must be submitted to NMFS within 30 days of landing catch.

Special Permit/low-use Marine Protected Areas Coral Reef Taxa Daily Catch Report

Name of Licensee:_____Coral Reef Ecosystem Permit No._____
Vessel Name:_____ Radio Call Sign:_____Vessel Number:_____
Area Fished:_____ (follow regional fishing area designations)
Type of Gear Used (one report form for each haul with each gear type per day):_____
Date Gear Set: ____/____/____ Time at Start:_____ Units of Gear Set: _____
Date Gear Hauled: ____/____/____ Time at End: _____ Units of Gear Lost:_____
Wind Speed:_____ Wind Direction:_____ Sea Surface Temperature:_____ Average Depth:_____
Target Species (list all):_____
Observer on board?_____
If gear was lost, give explanation as to reason why (no penalty for lost gear).____
_____
Describe any observed damage to the coral reef and how it occurred._____
_____

Species	No. Caught	Lbs. Caught	No. Kept	Lbs. Kept	If discarded, why ?	How processed?

Protected Species Observation			
Enter Seal & Turtle numbers; identify other in appropriate box	Monk Seal	Turtle	Other
Observed in area			
Observed in vicinity of gear			
Interfering with fishing operations			
Preying on catch			
Entangled, released alive			
Entangled, released dead			

Print Name:_____Signature:_____Date:____/____/____
All information must be logged within 24 hours after the completion of the fishing day.
Submit this form to NMFS within 30 days of each landing of coral reef harvest.

NMFS Honolulu Laboratory, 2570 Dole St., Honolulu, HI 96822; fax: (808) 983-2902

Instructions for Special Permit Coral Reef Taxa Daily Catch Report

1. From the coral reef ecosystem permit, record the permittee and permit number.

2. If the area fished has a specific regional designation, use it. Otherwise use an understandable description or latitudinal and longitudinal coordinates.

3. List units of gear lost and provide an explanation as to why (strong current, storm, bottom topography, etc). There is no penalty for lost gear. This information is solely used for management purposes.

4. Describe damage to the reef. Again, as long as operating within the regulations, there is no penalty for this. This information is solely used for management purposes.

5. Fill in the table as specifically as practical. If a percentage of number or pounds kept is more appropriate, be as accurate in your estimate as possible. Give reasons for any discarded catch. Describe how processed (e.g., live, fresh, frozen, preserved, etc.).

6. Give numbers for all protected species observed in most appropriate box. Do not list same animal in two separate boxes for the same day. List it in the most specific category (generally more specific down the list).

7. All information must be logged, signed and dated within 24 hours after completion of the fishing day.

8. All daily catch reports must be submitted to NMFS within 30 days of landing catch.

NMFS Transshipment Log for Coral Reef Ecosystem Management Unit Species

Vessel:_____ Permit No.:_____ Date:____/____/____
(Vessel receiving fish)

Broker or Shipping Agent:_____

Vessel:_____ Radio Call Sign:_____
(Vessel offloading fish) Permit Number:_____
Total number of days fished:_____ Type of Gear Used: _____
Average units of gear set per day:_____ Area of Catch:_____

Species	Number Received	Total Weight Received (Lbs.)

Print Name:_____ Signature:_____ Date:____/____/____
(Vessel captain / operator)

All required information must be recorded on the form within 24 hours after the day of transshipment.

Submit report to National Marine Fisheries Service within 7 days following the date the vessel arrived in port to land transshipped fish.

NMFS Honolulu Laboratory, 2570 Dole St., Honolulu, HI 96822; fax: (808) 983-2902

Instructions for Transshipment Log Report

1. Vessel receiving ship is the vessel registered to land or transship, shoreward of the outer boundary of the fishery management area, coral reef ecosystem management unit species that were harvested by a vessel in accordance with the CRE FMP.

2. Permit number is the number of the CRE fishing permit issued to the vessel owner by NMFS.

3. Date is the month/day/year that the fish were offloaded to (received by) the vessel.

4. The broker/agent, if any, is the shipping agent handling the transshipment operations for the vessel.

5. Name the vessel offloading the fish (the vessel transferring fish to the receiving vessel).

6. If the vessel offloading fish is a fishing vessel, list type of gear used for fishing and average units of gear set per day. Also list the area (lat/long or sector) that was fished.

7. For each management unit species transferred, enter the number and total weight received.

8. Print the name of the vessel captain/owner submitting the report.

9. Sign and date upon completion of the form.

CHAPTER 9

CONSISTENCY WITH NATIONAL STANDARDS AND OTHER LAWS AND POLICIES

9.1. National Standards for Fishery Conservation and Management

National Standard 1 – *Prevent Overfishing, Achieve Optimum Yield – Conservation and Management Measures Shall Prevent Overfishing While Achieving, on a Continuing Basis, the Optimum Yield from Each Fishery for the United States Fishing Industry.*

The CRE-FMP would, through permit and reporting requirements, monitor and control fishing effort in the EEZ to prevent overfishing of coral reef resources. A special permit and reporting system would be established for new fisheries in the EEZ targeting previously unharvested coral reef resources for which there is insufficient information to define overfishing or optimum yield. A special permit would also be required for any CRE fishing in low-use MPAs. In addition, large tracts of coral reef in the EEZ would be designated as no-take MPAs. These would conserve a large reservoir of spawning biomass and provide "insurance" against periods of poor recruitment or overexploitation of down-current sub-populations. Furthermore, deep-water spawning stocks of fish species that have already been heavily exploited at shallow depths would be protected from intensive harvest using scuba-assisted spearfishing.

National Standard 2 – *Best Scientific Information – Conservation and Management Measures Shall Be Based upon the Best Scientific Information Available.*

For coral reef resources already targeted by existing fisheries and for which there is sufficient information to define sustainable yield, the CRE-FMP would prevent overfishing according to the protocol described in the FMP. For previously unharvested MUS, the FMP would collect detailed fishery-dependent information through a special permit and reporting system. This would be supplemented by fishery-independent data collected through research. Through a framework procedure, the FMP could adapt to new information and unforeseen impacts. An evaluation of new data and the biological, economic, and social impacts of the management system would be made each year as part of the annual status report prepared by the Council for the coral reef fisheries managed in the Western Pacific.

National Standard 3 – *Manage Stocks as a Unit – To the Extent Practicable, an Individual Stock of Fish Shall Be Managed as a Unit Throughout its Range, and Interrelated Stocks of Fish Shall Be Managed as a Unit or in Close Coordination.*

Individual sub-populations of larger stocks of reef species may increase, decrease, or cease to exist locally without adversely affecting the overall population. The condition of the overall populations of particular species is linked to the variability among sub-populations: the ratio of sources and sinks, their degrees of recruitment connection, and the proportion of the sub-populations with high variability in reproductive capacity. Recruitment to populations of coral reef organisms depends largely on the pathways of larval dispersal and "downstream" links. One needs to ask, Are the connections sufficient to actually enhance distant sub-populations or only enough to maintain a homogenous genetic stock? There is poor understanding of the basics, much less the intricacies, of individual stocks and of their interrelationships in the coral reef ecosystem. To compensate, the CRE-FMP proposes extensive no-take MPAs. They do not require detailed knowledge of species while holistically conserving multi-species resources and the functional attributes of coral reef ecosystems.

National Standard 4 – *Do Not Discriminate Between States – Conservation and Management Measures Shall Not Discriminate Between Residents of Different States. If it Becomes Necessary to Allocate or Assign Fishing Privileges among Various United States Fishermen, Such Allocation Shall Be (A) Fair and Equitable to All Such Fishermen; (B) Reasonably Calculated to Promote Conservation; and (C) Carried out in Such Manner That No Particular Individual, Corporation, or Other Entity Acquires an Excessive Share of Such Privileges.*

The allocation of fishing privileges to indigenous participants in coral reef fisheries resulting from the proposed management measures is rationally connected to the furtherance of CRE-FMP objectives. Furthermore, the total potential benefits that indigenous participants may receive from the preferred alternatives outweigh the potential hardship that may be imposed on non-indigenous participants, when the centuries-old dependence of native people on coral reefs and the social importance of indigenous cultural continuity are considered. The measure is reasonably calculated to promote conservation, and no particular individual, corporation, or other entity is expected to acquire an excessive share of the fishing privileges allocated to indigenous participants. Participation in coral reef fisheries will not be limited to residents of the U.S. Pacific Islands.

National Standard 5 – *Efficiency in Utilization – Conservation and Management Measures Shall, Where Practicable, Consider Efficiency in the Utilization of Fishery Resources; Except That No Such Measure Shall Have Economic Allocation as its Sole Purpose.*

Coral reefs harbor a great diversity of marine organisms, but the relative productivity and potential harvest of any single species is limited. Existing methods of harvesting coral reef resources in the U.S. Pacific are highly inefficient, and the CRE-FMP purposely does not promote greater efficiency in these fisheries. In fact, the proposed conservation and management measures would create additional inefficiencies in the form of area closures (i.e., no-take MPAs), special permit and reporting requirements, and fishing gear restrictions.

The preferred alternatives emphasize the need to sustain existing small-scale fisheries for coral reef resources, while limiting the harvest of new resources targeted by new fisheries until

sustainable use can be demonstrated. Particular support is given to fishing communities and indigenous participants because of the importance of coral reef resources as a source of food for local consumption and as a means of preserving and perpetuating indigenous cultural values. The many economic and social benefits of coral reefs to island societies would be maintained by the proposed conservation measures in the plan.

It is impossible to provide a quantitative estimate of how many more coral reef resources would be available if the CRE-FMP is approved and implemented, or how much additional benefit would accrue to the Nation by this increase. It is clear, however, that the value of the potential economic and social benefits derived from the proposed conservation and management measures outweigh the costs that may be imposed on fishing activities affected by the closure of MPAs, special permit and reporting requirements, and gear limitations.

National Standard 6 – *Allow for Variations – Conservation and Management Measures Shall Take into Account and Allow for Variations Among, and Contingencies In, Fisheries, Fishery Resources and Catches.*

The special permit and reporting requirements for low-use MPAs and for new coral reef resources targeted by new fisheries are expected to produce new information, especially for poorly understood coral reef taxa for which there are few data to define sustainable yield. An evaluation of new data and unforeseen biological, economic, and social impacts resulting from the FMP management system will be made each year as part of the annual status report prepared by the Council for the coral reef fisheries managed in the Western Pacific region. During the evaluation, the views and opinions of the full range of stakeholders, including consumptive and non-consumptive users of coral reefs, will be solicited. The conservation and management measures may be adjusted as new information becomes available.

National Standard 7 – *Management Measures Shall Minimize Costs – Conservation and Management Measures Shall, Where Practicable, Minimize Costs and Avoid Duplication.*

Several of the proposed conservation and management measures would add substantially to the responsibilities and costs of fishery administration and enforcement. Specific elements likely to increase the difficulty and cost of fishery management are (1) the designation of seaward boundaries for no-take MPAs, (2) zoning of low-use MPAs, (3) the requirement for wreck removal and pollution liability insurance for all fishing vessels passing through MPAs, and (4) the highly discretionary special permit application and reporting process. The preferred alternative, however, avoids duplication with existing local permits issued by island governments and with federal permits for fishing activities conducted in the EEZ under existing FMPs for lobster, bottomfish, and precious corals.

National Standard 8 – *Importance to Fishing Communities – Conservation and Management Measures Shall, Consistent with Conservation Requirements of this Act (Including the Prevention of Overfishing and Rebuilding of Overfished Stocks), Take into Account the Importance of Fishery Resources to Fishing Communities in Order to (A) Provide for the*

Sustained Participation of Such Communities; and (B) to the Extent Practicable, Minimize Adverse Economic Impacts on Such Communities.

The social and economic history of the populated U.S. Pacific Islands differs considerably from that of the continental U.S. Samoa, Hawaii, and the Mariana Islands were originally settled in ancient times by seafaring peoples. The lack of terrestrial resources in most areas led to great dependence on fishing for food security. This dependence shaped the social organization, cultural values, and spiritual beliefs of the indigenous populations.

The era of European discovery brought the island cultures into direct conflict with western traditions of proprietorship. Repeated contacts with western culture eroded the stability of the social structures and subsistence economies created by indigenous people.

With the exception of American Samoa and small enclaves in Guam, Hawaii, and the Northern Mariana Islands, the modern-day indigenous descendants are dispersed as part of cosmopolitan populations. Island societies have become pluralistic, and many aspects of their economies and cultures have evolved in modern times. Yet, the vast majority of contemporary island residents continue to depend on coral reef resources for consumptive and non-consumptive uses. Most residents consume seafood, and many are at least part-time fishermen. The harvest of coral reef resources is important to U.S. Pacific Island inhabitants as a source of food for local consumption, for local income and employment, and as a means of preserving and perpetuating indigenous cultural values.

The MSFCMA has recognized that Pacific insular areas "contain unique historical, cultural, legal, political and geographic circumstances which make fisheries resources important in sustaining their growth." The proposed conservation and management measures take into account the centuries-old relationships of indigenous people with coral reef resources, and the continuing dependence of modern-day, pluralistic island communities on these resources. The siting of no-take MPAs in remote areas of the EEZ, the proposed allocation of a portion of low-use MPAs for indigenous fishing activities, and the reliance on proposed local reporting requirements in parts of the EEZ adjacent to existing fishing communities and indigenous activities are expected to minimize adverse economic impacts.

National Standard 9 – *Minimize Bycatch – Conservation and Management Measures Shall, to the Extent Practicable, (A) Minimize Bycatch and (B) to the Extent Bycatch Cannot Be Avoided, Minimize the Mortality of Such Bycatch.*

Existing coral reef fisheries in the U.S. Pacific Islands produce little bycatch because of relatively selective gears and diverse food preferences of island seafood consumers. The restrictions on gear and fishing methods are intended to minimize bycatch. A condition of the permit system will require that all bycatch be reported. If a particular fishery, gear, or method is shown to produce excessive bycatch, regulatory or administrative action can be taken.

National Standard 10 – *Promote Safety – Conservation and Management Measures Shall, to the Extent Practicable, Promote the Safety of Human Life at Sea.*

The FMP proposes to designate MPAs where vessel anchorage and passage would be restricted. These measures would not promote vessel safety, but neither are they expected to put vessels at risk because anchoring and passage would not be restricted in emergency situations. The latter are recognized under maritime law (*force majeure*) regardless of any regulations implemented through the FMP.

9.2 Other Applicable Laws and Policies

9.2.1 Federal Laws and Policies

Coastal Zone Management Act (CZMA)

Section 307 (C) of the CZMA requires that any Federal activity affecting the land or water uses or natural resources of a state's coastal zone be consistent with that state's approved coastal management program, to the maximum extent practicable. In this instance, Hawaii, Guam, American Samoa, and the CNMI all have approved coastal zone management programs. This Fishery Management Plan, therefore, must be reviewed to determine if the measures will or are likely to affect the coastal zone. The management measures in this CRE-FMP will be implemented in a manner that is consistent to the maximum extent practicable with the approved coastal zone management programs of American Samoa, CNMI, Guam, and Hawaii. The Council will send a copy of the draft FMP to the state coastal agencies for concurrence.

Endangered Species Act (ESA)

The Endangered Species Act provides for the protection and conservation of endangered and threatened species. Once a species is listed as endangered or threatened, it is afforded protection under the ESA and takings are prohibited. This process ensures that projects authorized, funded, or carried out by federal agencies do not jeopardize the species' existence or result in the destruction or modification of habitat critical to the species existence. Consultation takes place by NMFS, and USFWS as appropriate, and is required if the fishery affects, directly or indirectly, endangered or threatened species or any designated critical habitat. While developing the CRE-FMP, the Council included measures to minimize any adverse impacts. Therefore, the Council has determined that this FMP is not likely to have any significant adverse effects to listed species or their critical habitats.

Under the ESA, NMFS is required to prepare an impact assessment, which may serve as a biological assessment for consultation under Section 7 of the ESA. This document (including Volume II, the EIS) assesses the impacts to endangered and threatened species and their habitats from the management measures in the CRE-FMP.

The species that have been listed as endangered or threatened under the Endangered Species Act and have been observed in the region where reef-related fisheries operate are as follows:

Hawaiian monk seal (*Monachus schauinslandi*)

Olive ridley turtle (*Lepidochelys olivacea*)

Leatherback turtle (*Dermochelys coriacea*)

Loggerhead turtle (*Caretta caretta*)

Hawksbill turtle (*Eretmochelys imbricata*)

Green turtle (*Chelonia mydas*)

Humpback whale (*Megaptera novaeangliae*)

Sperm whale (*Physeter macrocephalus*)

Blue whale (*Balaenoptera musculus*)

Fin whale (*B. Physalus*)

Sei whale (*B.Borealis*)

North Pacific Right whale (*Eubalaena japonica*)

Other listed species that potentially could be affected by the actions proposed under the preferred alternative of the plan are land based. These species could be impacted by potential invasive species accidentally introduced by fishing vessel grounding or discharge of floating debris.

Laysan duck (*Anas platyrhynchos laysanensis*)

Laysan finch (*Telespyza cantans*)

Nihoa millerbird *(Acrocephalus familiaris kingi*)

Nihoa finch (*Telespyza ultima*)

Micronesian megapode (*Megapodius laperouse laperouse*)

Sesbania tomentosa (legume)

Schiedea verticillata (fleshy root herb)

Pritchardia remota (palm)

Amaranthus brownii (weedy herb)

Mariscus pennatiformes (sedge)

Cenchrus agriminioides (*kamanomano*)

Marine Mammal Protection Act (MMPA)

The Marine Mammal Protection Act of 1972, as amended, allows for the incidental take of marine mammals during commercial operations under certain limited circumstances, including incidental takings during commercial fishing. However, all fisheries in the Western Pacific Region are classified as Category III, which designates the fishery as having a remote likelihood

or no known incidental taking of marine mammals. If any interactions do occur, the fishermen are required to report them. In developing the CRE-FMP, the Council considered actions which would minimize adverse impacts from the fishery, and developed mitigation measures.

The following marine mammal species (cetaceans) that are protected under the MMPA, but not listed as endangered or threatened, occur in the areas where reef-related fisheries operate:

Pacific white sided dolphin (*Lagenorhynchus obliquidens*)

Rough-toothed dolphin (*Steno bredanensis*)

Risso's dolphin (*Grampus griseus*)

Bottlenose dolphin (*Tursitops truncatus*)

Spotted dolphin (*Stenella attenuata*)

Spinner dolphin (*Stenella longirostris*)

Striped dolphin (*Stenella coeruleoalba*)

Melon-headed whale (*Peponocephala electra*)

Pygmy killer whale (*Feresa attenuata*)

False killer whale (*Pseudorca crassidens*)

Killer whale (*Orcinus orca*)

Pilot whale (*Globicephala melas*)

Blainsville's beaked whale (*Mesoplodon densirostris*)

Cuvier's beaked whale (*Ziphius cavirostris*)

Pygmy sperm whale (*Kogia breviceps*)

Dwarf sperm whale (*Kogia simus*)

Bryde's whale (*Balaenoptera edeni*)

National Environmental Policy Act (NEPA)

The National Environmental Policy Act requires that any major federal action significantly affecting the human environment must disclose the environmental consequences of the proposed action through an Environmental Impact Statement (EIS). An EIS was prepared for this FMP,

and all required components of the EIS are contained in Volume II, including issues relating to public scoping periods, consulted agencies, impacts, and alternatives.

Paperwork Reduction Act (PRA)

The purpose of the PRA is to control the burden on the public (i.e., fishermen), businesses, county, state, and territorial governments, and other entities of providing information to the federal government. The Act is intended to ensure that the information collected under the proposed action is needed and collected in an efficient manner (44 U.S.C. 3501(1)).

Proposed Data Collection Program:

This FMP will not initially require additional reporting in the populated areas of American Samoa, Guam, CNMI, and the main Hawaiian Islands for Currently Harvested Coral Reef Taxa (CHCRT). In these areas, where local data collection and fishery monitoring already occurs, the Council will work through these existing reporting programs to obtain data. For other Council FMPs, coordinated data processing has been established for Hawaii, Guam, the CNMI, and American Samoa. The CRE-FMP will follow these established procedures. Creel survey, logbook, and/or commercial buyer's data will be collected and processed by the appropriate local agencies. In areas where no reporting systems exist, the Council will develop mechanisms for monitoring and reporting specifically for that locality. Reporting requirements for these areas could include reporting types and quantity of gear used, units of gear set, time at start and end of set, units of gear lost, numbers and weights of species kept, numbers released, reason for discards, how the catch is processed, area(s) fished, length of the trip, average weather conditions, depth of area fished, observed damage to the coral reef, and all protected species interactions. For all fishing in the NWHI and the PRIAs (where allowed), and for emerging fisheries harvesting previously unharvested taxa in the CNMI and MHI, reporting requirements will be established via special permits. The annual report required under the FMP will summarize and analyze the information collected. Island-specific annual report modules will be produced by island agency Plan Team members and provided to the Council where they will be combined with other required materials to produce the CRE-FMP Annual Report. Federal logbooks are submitted directly to the NMFS-HL. Annual reports are due by July 31 of each year.

Although this FMP will not require additional permits to harvest CHCRT in populated areas, in the low-use MPAs in the NWHI and at Palmyra, Johnston, and Wake, a special permit will be required for CHCRT. Also, for emerging fisheries in the CNMI and MHI, a special permit will be required for targeting Potentially Harvested Coral Reef Taxa. For all areas, incidental catch of coral reef taxa taken under other FMP-managed fisheries will require no additional permit or reporting other than existing systems.

Estimate of Permit Application and Reporting Burden and Cost:

The permit application and reporting requirements would require a certain level of scientific expertise, which would bring a certain level of costs. Under the special permit application, the applicant is required to provide a description of the planned fishing operation, including general

timing, duration and location of fishing and gear operation, resources (directed and incidental) expected to be harvested under the special permit, expected catch, and estimated ecosystem-level, habitat, and protected species impacts of the proposed harvest. A typical fisherman's knowledge and expertise is sufficient to meet the special permit reporting requirements. Because reporting costs are variable, the differential effects among entities would be small. Relatively few of the region's coral reef fishery participants would be affected by the measures outlined in the CRE-FMP, and of these participants only a few would be significantly affected.

It is estimated that between 10-20 permits will be issued annually to coral reef-related fisheries in the EEZ of the Western Pacific Region. The general permit application, although not immediately implemented under the preferred alternative, is estimated to require one hour to complete. Therefore, the permitting burden for general permits would be 10-20 hours annually. The special permit is estimated to require two hours to complete, totaling 20-40 hours for the special permit annual burden.

The total reporting burden hours are estimated to be 1,125 hours per year, assuming 15 vessels in the fleet make an average of 10 trips per year, averaging 15 days per trip, and the additional daily burden is 30 minutes. The total burden hours for the special permit are estimated to be 750 hours per year, assuming five vessels in the fleet make an average of 10 trips per year averaging 15 days per trip and the additional daily burden is one hour per fishing day.

See the Regulatory Impact Review (Appendix B) for additional information on estimated reporting burden and cost.

Regulatory Flexibility Act (RFA)

The Regulatory Flexibility Act requires that agencies assess and present the impacts of their proposed actions on small business entities. It has been determined that an initial RFA (IRFA) is required. After public review, a final RFA may be required. The IRFA may be found in Appendix B.

National Wildlife Refuge Administration Act of 1966 (NWRAA)

The NWRAA establishes guidelines, policies, and directives for the administration and management of areas within the National Wildlife Refuge System (NWRS). The NWRAA authorizes the Secretary of the Interior to administer the NWRS for the conservation and management of wildlife and plant resources, while providing for compatible wildlife-dependant recreational activities within the NWRS boundaries. The Act requires congressional action for the divestiture of lands and waters within the NWRS, with few exceptions.

Under the CRE-FMP, no USFWS-managed resources are expected to be negatively affected because the FMP has designated all coral reef habitat found within and around refuges as no-take or low-use MPAs. In no-take MPAs, the harvest of all marine resources is prohibited, including those resources managed under other FMPs. Areas designated as low-use MPAs allows for the continuation of recreational fishing and on-island consumption under the special permit regime.

Any proposed fishing activity within the NWR boundary would require a compatibility determination by the USFWS and thorough evaluation through the special permit system proposed under this FMP.

Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act, as amended, created a coordination process between the USFWS and other federal and state agencies whose actions may modify, impound, divert, or otherwise control waters or other bodies of water. Agencies must consult for the purpose of "preventing loss of and damage to wildlife resources." Added provisions require equal consideration and coordination of wildlife conservation with other water resource development programs and authorizes the Secretary of the Interior to provide public fishing areas and accept donations of lands and funds. Under the CRE-FMP, waters under the joint jurisdiction of the Department of Commerce and the Department of Interior will not be modified, impounded, diverted or controlled by the proposed action. Areas containing coral reef habitat within refuge boundaries, where the USFWS prohibits all extractive uses, are designated no-take MPAs under this FMP. In areas where the USFWS allows recreational fishing and on-island consumption, the CRE-FMP has accommodated this by designating these areas as low-use MPA requiring special permits. Details of MPAs are discussed in Section 5.2- Marine Protected Areas.

Executive Order 8682

Executive Order 8682 established Naval Defensive Sea Areas and Naval Airspace Reservations around the territorial waters of several islands and reefs in the PRIAs. The Order authorizes the Secretary of the Navy to control entry into areas designated as naval defensive seas areas. The CRE-FMP recognizes the authority of the Department of Defense to control entry into naval defensive sea areas around those territories at any time to facilitate military preparedness. Thus, it will in no way affect the authority of the Department of Defense to conduct activities in any area it administers.

Executive Order No. 12866-Regulatory Impact Review

Executive Order 12866 requires that a Regulatory Impact Review (RIR) be prepared for all regulatory actions that are of public interest. This review provides an overview of the problem, policy objectives, and anticipated impacts of the action, and ensures that management alternatives are systematically and comprehensively evaluated so that the public welfare can be enhanced in the most efficient and cost-effective way. Also, the RIR requires analysis of distributive impacts and costs of government administration and private compliance with the proposed measures.

The general purpose of the RIR, as well as the RFA described above, is to make the regulatory process open and transparent so that the steps in the regulatory decision-making process are easily followed. The economic analysis provides decision-makers and the public with the agency's best estimate of the impacts of proposed actions and their alternatives.

In compliance with this EO, an analysis of impacts of regulatory actions is provided in the draft Regulatory Impact Review found in Appendix B.

Executive Order No. 13112- Invasive Species

Executive Order 13112 establishes guidelines to ensure that actions proposed by federal agencies, to the extent practicable by law, take into account and mitigate the introduction of invasive species. The EO also establishes an Invasive Species Council to provide national leadership regarding invasive species and to ensure that federal agency activities concerning invasive species are coordinated, cost-efficient, and effective. The management measures proposed in the CRE-FMP likely will not cause or promote the introduction of invasive species, rather they will minimize the risk of introduction of alien species by restricting access in the no-take and low-use MPA proposed for sensitive coral reef ecosystems. Additionally, special permits, which are issued on a case-by-case basis, will be required for fishing in low-use MPAs in the NWHI, Wake, Palmyra, and Johnston Atoll.

Executive Order No. 13089-Coral Reef Protection

In June 1998 the President signed an Executive Order for Coral Reef Protection, which established the Coral Reef Task Force (CRTF) and directed all federal agencies with coral reef-related responsibilities to develop a strategy for coral reef protection. Federal agencies were directed to work cooperatively with state, territorial, commonwealth, and local agencies; non-governmental organizations; the scientific community; and commercial interests to develop the plan. The Task Force was directed to develop and implement a comprehensive program of research and mapping to inventory, monitor, and address the major causes and consequences of degradation of coral reef ecosystems. The Order directs federal agencies to use their authorities to protect coral reef ecosystems and, to the extent permitted by law, prohibits them from authorizing, funding, or carrying out any actions that will degrade these ecosystems.

Of particular interest to the Council is the implementation of measures to address: (1) fishing activities that may degrade coral reef ecosystems, such as overfishing, which could affect ecosystem processes (e.g., the removal of herbivorous fishes leading to the overgrowth of corals by algae) and destroy the availability of coral reef resources (e.g., extraction of spawning aggregations of groupers); (2) destructive fishing techniques, which can degrade essential fish habitat (EFH) and are thereby counter to the Magnuson-Stevens Act; (3) removal of reef substrata; and (4) discarded and/or derelict fishing gear, which can degrade EFH and cause "ghost fishing."

To meet the requirements of Executive Order 13089, the Coral Reef Task Force issued the *National Action Plan to Conserve Coral Reefs* in March 2000. In response to the recommendations outlined in the *Action Plan*, the President announced Executive Order 13158, which is designed to strengthen and expand Marine Protected Areas.

Executive Order No. 13158–Marine Protected Areas Memorandum of Understanding on Protection of U.S. Coral Reefs in the Northwest Hawaiian Islands

On May 26, 2000, the President announced his commitment to protect the natural and cultural resources found within the marine environment by strengthening and expanding the Nation's system of marine protected areas (MPAs) to protect the natural and cultural marine heritage for future generations. This is to be accomplished by all pertinent federal agencies sharing information, tools, and strategies to develop a national system of MPAs. The Department of Commerce and the Department of the Interior are required to consult with those states that contain parts of the marine environment, and Regional Fishery Management Councils, among others, to promote coordination when establishing and managing MPAs.

Under Executive Order 13158, each federal agency whose authorities provide for the establishment or management of MPAs shall take appropriate actions to enhance or expand protection of existing MPAs and establish or recommend, as appropriate, new MPAs. Throughout the development of the CRE-FMP, the Council, along with the advisory bodies and plan teams, have analyzed existing MPAs and developed recommendations to establish new ones in all areas under Council jurisdiction. This FMP includes those recommendations.

Concurrent with the announcement of the President's Executive Order 13158, a Memorandum of Understanding was delivered by the President. In this memorandum, the President determined that the coral reef ecosystem in the Northwestern Hawaiian Islands deserved strong and lasting protection. To this end, he directed the Secretary of the Interior and the Secretary of Commerce, working cooperatively with the State of Hawaii and consulting with the Western Pacific Regional Fishery Management Council, to develop recommendations within 90 days for a new, coordinated management regime to increase protection of the ecosystem and provide for sustainable use.

In the process of developing the CRE-FMP, the Council has consistently worked cooperatively with the Department of the Interior, the Department of Commerce, and the State of Hawaii, as well as numerous other agencies. Currently, the Chairman of the State of Hawaii Department of Land and Natural Resources is a designated voting member of the Council, and the Pacific Islands Manager of the U.S. Fish and Wildlife Service serves as a non-voting member. In addition, in developing the CRE-FMP the Council relied on members of the various plan teams to develop recommendations based on their combined expertise. Staff members from the U.S. Fish and Wildlife Service and the State of Hawaii Department of Aquatic Resources are represented on the coral reef ecosystem plan team.

The main issues to be addressed by the EO and recommendations from the memorandum of understanding figure prominently in the CRE-FMP. For example, after much discussion, the advisory panels developed an MPA network that will protect coral reef areas of special value in the NWHI and PRIA. The Council advocates that 24% of NWHI coral reefs be classified no-take MPAs. In the areas where human activities are allowed, the FMP establishes measures to ensure that their actions will not degrade the coral reef ecosystem. In addition, throughout the FMP the

Council has considered the potential for human impacts on threatened and endangered species, and developed measures designed to afford the greatest protection.

In addition to the fishery-related cooperative recommendations, the cooperative recommendations should identify any further measures necessary to protect cultural and historic resources and artifacts, and also allow culturally significant uses of the NWHI marine resources by Native Hawaiians. History clearly demonstrates how coral reef ecosystems have been vital to Native Hawaiians, and throughout the CRE-FMP this relationship is documented. The Council developed a Fishery Rights of Indigenous Peoples Advisory Panel to work closely with other advisory bodies, ensuring that the rights of the indigenous peoples are not overlooked.

In addition, the cooperative recommendations should also establish a framework for scientific research and exploration, and establish a framework for facilitating recreation and tourism in the NWHI as well. An important theme in the CRE-FMP is balancing coral reef ecosystem conservation with sustainable human use. The scientific data obtained in the NWHI are critical to an understanding of coral reef ecosystems, which will ensure comprehensive management.

The Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve (Executive Orders 13178 and 13196)

On December 4, 2000, President Clinton announced Executive Order 13178, which established the Northwestern Hawaiian Islands Coral Reef Ecosystem (NWHI-CRE) Reserve. It established conservation measures that restrict activities throughout the Reserve, and Reserve Preservation Areas around certain islands, atolls, and banks, where almost all consumptive or extractive uses are prohibited. Executive Order 13196, issued January 18, 2001, modified the earlier Executive Order by revising some of the conservation measures and making the Reserve Preservation Areas permanent. The reserve is approximately 1,200 nm long and 100 nm wide, and includes all submerged lands and waters seaward of the seaward boundaries of the State of Hawaii and the Midway Atoll National Wildlife Refuge in the NWHI.

The Reserve is intended to be a temporary management regime until completion of the process to designate the NWHI as a National Marine Sanctuary. On January 19, 2001, the NOAA/NOS Office of National Marine Sanctuaries announced its intent to initiate the Sanctuary designation process for the Reserve pursuant to sections 303 and 304 of the National Marine Sanctuaries Act (16 USC 1433, 1434). During this process, NOAA will prepare an environmental impact statement and management plan, which will examine the management, boundary, and regulatory alternatives associated with sanctuary designation. As required, NOAA must also initiate public scoping meetings to solicit information and comments on the range and significance of issues related to sanctuary designation and management. The Executive order states that "the Secretary of Commerce shall supplement or complement the existing Reserve, and ... in consultation with the Governor of the State of Hawaii, determine whether State submerged lands and waters should be included as part of the Sanctuary."

As summarized here, a range of conservation measures are established by the EO. All current commercial federal fishing permits and effort and take are capped at the previous year's level

(from December 4, 2000) except for bottomfish fishing, which is capped to the individual permittee's average annual take over the previous five years. Only vessels with permits valid in the year preceding December 4, 2000, are allowed to operate in the Reserve. An individual harvest quota will be established for each permit holder, but permits are non-transferable (they expire with the individual permit holder). Recreational fishing and pelagic trolling are capped at levels reported taken preceding the order. Additionally, no permits will be issued for any fishing activity that did not have a permit in the year preceding December 4 2000." The Executive orders further states that "the Secretary, following consideration of any advice or recommendations of the Western Pacific Fishery Management Council, may further restrict fishing activities." Other prohibited activities (unless noted otherwise) include no offshore oil or mineral development, no anchoring on live or dead coral where the bottom can be seen, no drilling or dredging, no discharging material, and no removal of living/non-living resources.

In Reserve Preservation Areas, executive orders measures prohibit almost all activities to 100 fm around most islands. These include anchoring where buoys are available or outside a designated area, taking or touching living or dead coral, and discharging or depositing any material except cooling water or engine exhaust. Straight-line latitude /longitude boundaries are to be developed for each Reserve Preservation Area. Bottomfishing and recreational trolling are still allowed to 25 fm around some islands (Nihoa, Necker, Gardner, Maro, Lisianski) and to 50 fm around Laysan. Some banks are closed out to 12 nm from their approximate center; these are the bank east of French Frigate Shoals, SE Brooks Bank, St. Rogatien, the bank west of St. Rogatien and the bank east of Gardner, Raita Bank and Pioneer Bank. However, except for the bank east of French Frigate Shoals and SE Brooks Bank, bottomfishing and recreational trolling are allowed. For Raita Bank and the bank west of St. Rogatien, bottomfishing and recreational trolling will be allowed for five more years. Native Hawaiian uses specified by the Executive order allow subsistence, and cultural and religious uses in the Reserve and Preservation Areas (in yet-to-be-identified sub-areas), provided that these uses do not injure the coral reef ecosystem and related marine resources. The Midway Atoll National Wildlife Refuge (NWR; 22 x 22 nm) is not included in the Reserve. Complementary management with the Hawaiian Islands NWR is proposed, but nothing in the Executive order shall enlarge or diminish the jurisdiction or authority of DOI in managing its Refuge. The Department of Defense and USCG are exempt from the Executive order.

The Secretary of Commerce has not established final departmental policy for several important stipulations in the EO that are unclear. Enforcement agencies are unable to develop a complete enforcement plan and there are no published regulations. It is also unclear how restrictions will be enforced since boundaries defined by bottom contours must be converted to straight-lines defined by latitude-longitude coordinates. How individual fishing caps will be determined based on the "year preceding the December 4 2000 EO" is still being discussed. (According to the Code of Federal Register §660.12, the fishing year begins on January 1 and ends on December 31. How fishing caps will be determined for recreational fishing is also problematic because there is no permit or reporting requirement for recreational fishing in Hawaii.

Ecosystem-Based Fishery Management

Recognizing the potential of an ecosystem-based management approach to improve fisheries management, Congress requested that NMFS convene a panel of experts to assess the extent to which ecosystem principles are currently applied in fisheries research and management and recommend how best to integrate ecosystem principles into future fisheries management and research. In April 1999, this Ecosystems Principles Advisory Panel (EPAP) submitted a report to Congress entitled *Ecosystem-Based Fishery Management*. It concludes that the U.S. must develop governance systems that have as their primary goals ecosystem health and sustainability, rather than short-term economic gain. In addition, the report states that adopting ecosystem-based fishery management and research will result in more sustainable fisheries and healthier marine ecosystems, and also more economically sound coastal communities. The panel provides fisheries management and policy recommendations for implementation by NMFS and the Councils.

As discussed in this FMP, the Council developed the CRE-FMP to incorporate ecosystem approaches into the present regulatory structure. In its *Ecosystem-Based Fishery Management Report*, the EPAP stressed that "FMPs for single species or species complexes should be the basic tool of fisheries management for the foreseeable future. However, management actions alone are not sufficient to implement an ecosystem approach." The mechanism to integrate FMPs with ecosystem principles, goals, and policies recommended by the EPAP is a demonstration Fisheries Ecosystem Plans. This CRE-FMP is intended to serve as the demonstration plan.

9.2.2 Coral Reef Legislation

Several bills have been initiated in response to Executive Order 13089 addressing coral reef conservation, restoration, and preservation. These bills, introduced by both the House and the Senate, would provide grants to state, federal, territorial, and commonwealth natural resource management authorities, or any educational institution or other non-government organization with coral reef conservation expertise. A brief description of the language of the bills as they exist in their current form are outlined below.

Coral Reef Conservation Act of 1999, S.725

This bill was introduced by Senator Snowe to preserve, protect, and restore the health of coral reefs and coral reef ecosystems, to assist in the conservation and protection of coral reefs by supporting conservation programs and providing financial resources for such programs, and to establish a formal mechanism for collecting and allocating monetary donations from the private sector to be used for coral reef conservation projects. Any U.S. state or territory natural resource management authority, other government agency with jurisdiction over coral reefs, or any educational institution or non-government organization with demonstrated expertise in conservation of coral reefs is eligible to apply for the grant. If passed, appropriations of $15 million would be available for each fiscal year 2001-2004.

Coral Reef Protection Act of 1999, S.1253

This Bill was introduced by Senator Inouye to preserve and restore the health of coral reef ecosystems, support coordinated conservation programs, provide financial assistance, and establish a funding allocation mechanism. This grant would be open to any state, federal, or territorial agency with coral reef jurisdiction, or any organization with coral reef expertise. If passed, appropriations of $20 million for each fiscal year 2000-2004 would be available.

Coral Reef Conservation Act of 2000, H.R. 1653

The Coral Reef Conservation Act of 2000, passed into law in 2001, authorizes $16 million annually from 2000-2004 to the Secretary of Commerce for two coral reef programs. The National Program allows the Secretary to conduct coral reef related activities such as mapping, research assessments, monitoring, restoration, marine debris removal and public outreach. This program will also allow the Secretary to conduct activities to enhance compliance with laws that regulate the taking of coral reef resources, develop scientific information on the conditions of coral reefs, and coordinate activities and programs related to coral reefs conducted by federal agencies. The Coral Reef Conservation Program allows the Secretary to fund grant projects that conserve coral reefs and involve affected local communities. Projects funded by this program require a 50% matching fund or in-kind contributions unless waived by the Secretary.

9.2.3 State, Local, and Other Applicable Laws and Policies

Green (1997) summarizes existing state laws and policies that relate to the management of coral reef ecosystems. Every effort has been made to ensure that the management measures in this FMP are compatible with state laws and policies in order to simplify implementation and assist enforcement efforts. Table 9.1 summarizes existing state regulations and resource management activities pertaining to coral reefs.

9.2.4 Safety Considerations: fishery access and weather-related vessel safety

The management measures contained within this FMP will not negatively impact the safety of vessels participating in the coral reef fisheries of the Western Pacific Region. New permit requirements will enhance safety by allowing monitoring of the number and type of vessels participating in coral reef resource harvesting. The proposed framework action to require satellite-based vessel monitoring systems (VMS) to track vessels participating in coral reef fisheries would greatly increase vessel safety by allowing government enforcement agencies to continuously monitor vessel positions. In addition, VMS units provide vessel operators the ability to send emergency signals to the USCG if needed. The framework action to create "no anchor zones" would limit the number of vessels on the banks at one time therefore reducing the likelihood of vessel collisions and groundings. However, more vessels in close proximity to one another increase the response and assistance time if an emergency were to occur enhancing safety at sea.

Table 9.1: Summary of existing state resource management activities in American Samoa, CNMI, Guam, and Hawaii that contribute to the protection of coral reef ecosystems (modified from PBDC 1995).

Activity	American Samoa	CNMI	Guam	Hawaii
1. General Laws and Regulations	DMWR: Manage, protect and preserve marine resources, including coral reef ecosystems; ban spearfishing with scuba (2001). ASEPA: Water quality regulation of activities in the water. FBNMS: Prohibits gathering, taking, breaking, cutting, destroying or possessing corals and other invertebrates. Fishing restrictions also apply. ASCMP: Protect unique areas and resources; develop strategies for coastal hazards; conservation of marine resources; coordination of planning, monitoring, and enforcement by government agencies.	CRM: Coastal use permitting, enforcement and education. DEQ: Environmental quality, earthmoving, stormwater control permitting, pesticide application certification, wastewater disposal system permitting; water quality standards and permitting; recreation water quality monitoring. DLNRM: Submerged lands leasing. (Transferred to Dept. of Public Lands). DFW: Fishing regulations, marine sanctuary regulations, management and enforcement; aquarium fish permitting and enforcement; Public Law 10-year moratorium on the harvest of sea cucumbers and seaweeds. Historic Preservation Office: Submerged historic property protection.	DOA/DAWR: Preservation and protection of fish and wildlife; protection of endangered species and habitats; regulates destructive fishing and sizes of lobster (no spearing), trochus and giant clam; 3 no-take and 2 limited-take MPAs (enforced since Jan 00). DLM: Seashore protection act review for development on shoreline to 10 fm. Territorial Seashore Protection Commission reviews and approves or disapproves development in Seashore Reserves. Parks & Recreation: Recreation water use management plan implementation. GCMP: Reviews, approves or disapproves activities requiring Federal Action in coral reef areas through Federal consistency. GEPA: Water Pollution Control Act, Water Quality Standards, and Soil Control & sedimentation regs. protect water quality and aquatic resources. Clearing and Grading permits designed to protect coral reefs and habitats.	CZM: Preservation of valuable coral reef resources; Federal consistency review. DLNR: Establish and Manage Marine Life Conservation Districts in which taking of coral or altering substrate normally prohibited. DOH: Rules prohibit discharge of pollutants into state waters. NPDES permit required. Admin. Rules 11-54 requires conservation of coral reefs and wilderness areas in AA waters.

Table 9.1 (cont.)

Activity	American Samoa	CNMI	Guam	Hawai
2. Prohibiting or Restricting Taking of Corals	DMWR: Regulations prohibit collecting of coral in less than 60 feet of water; commercial harvest below 60 ft requires permit; dynamite fishing illegal; willful destruction of coral while fishing is illegal; destruction of fish habitat illegal. FBNMS: Regulations state that no corals can be taken; damage prohibited; NMFS enforces—agreement with DMWR for enforcement pending. ASCMP: Rules prohibit dredging or filling of coral reefs and other submerged lands unless public need demonstrated, no environ. preferable alternatives available, and adverse impacts minimized; protect marine resources and unique areas including reefs; only dependent uses permitted.	DFW: Fishing regulations prohibit taking of live or dead coral except for betel lime—all types of coral covered.	DOA: Specific statutes prohibit taking of coral without permit—"need for revision." Seashore Protection Act: Permit required for removal. Only removal for scientific purposes permitted. GEPA: Water Pollution Control Act and Water Quality Standards provide general protection of coral reefs and marine resources (successful out-of-court settlement in coral damage from ship grounding).	DLNR: HRS 188-68 prohibits the intentional taking of, breaking or damaging any live stony coral including any live reef or mushroom coral. Eight species are identified in the statute. Exceptions may be granted for certain scientific, education or other public purpose if adverse impacts are minimized.

Table 9.1 (cont.)

Activity	American Samoa	CNMI	Guam	Hawaii
3. Prohibiting Drilling, Blasting and/or Dredging	ASCMP: Project Notification and Review System reviews all projects in AS. Board's concern in avoiding or mitigating damage to environ., including coral reefs. Enforcement provided by ASCMP (2 wetland conservation officers and 2 compliance officers). Violations result in stop work orders; continued violations referred to AG. DMWR: Prohibit use of explosives on reefs and destruction of fish habitat. Regs enforced by DMWR enforcement officers. EPA: Water Quality Standards required Certificate for any of these activities. FBNMS: Drilling, dredging, blasting and any other alteration of the seabed prohibited.	CRNL Actions affecting reefs subject to CRM permitting. Enforcement via permitting programs by CRM staff. DFW: Regulations prohibit taking of live or dead coral except for betel lime—all types of coral covered.	DLM: Territorial Seashore Protection Commission: Permits required for all such activities within Seashore Reserve (to 10 fathoms). Requirement for EA or EIS which must be approved by Guam EPA. Environmental Protection Plan required and must be approved by GEPA before DPW permit can be issued. GEPA: Section 401 certification required: All operations would require an approved Environmental Protection Plan. Blasting would require approved blasting plan to limit fish kill radius to 100' max. Enforcement done by inspectors from DPW, GEPA, and DLM.	DLNR: HRS 188-23 prohibits possession of explosive for taking of aquatic life. Drilling, dredging and blasting in nearshore waters require Conservation District Use Permit. Because ACOE permit also required, CZM would conduct Federal consistency review. If permit based on CWA 404 permit, Water Quality Certification from DOH also mandatory.

Table 9.1 (cont.)

Activity	American Samoa	CNMI	Guam	Hawaii
4. Prohibiting or Restricting Anchoring	FBNMS: Anchoring must be done so that there is no damage to bottom formations. Mooring buoys have been installed in the past, but currently none. No restrictions exist in other parts of the Territory.	No restrictions. DLNRM has placed mooring buoys in 17 locations. A DFW grant enabled the now extant Marine Technology program at Northern Marianas Community College to install 10 mooring buoys at popular dive sites on Saipan-Tinian in 1995-96.	No law addresses anchor damage to coral reefs. DAWR Installed 30 shallow-water moorings around Guam to address anchor damage.	DLNR: HRS 190 authorizes regulation of anchoring and mooring in Marine Life Conservation Districts; HRS 200 restricts boats in certain reef areas; Day moorings exist in some areas and rules to curb anchoring in coral rich areas have been proposed. CZM: HRS 205A restricts anchoring on coral reefs because of likely adverse environmental and ecological impacts.
5. Prohibiting or Restricting Vessel Discharge	ASEPA: AS law prohibits discharge of oil or hazardous substances from boats. Fines $100-$1,000. USCG also enforces discharge regs (OPA 90) and levies fines for oil and sewage spills. FBNMS: Discharge prohibited.	No local regulations. USCG has regulations under OPA 90 and DEQ is a first responder to a spill.	GEPA: Local water quality standards regulations restrict vessel discharges in local waters; Police Department, GEPA, and DAWR have enforcement authority under Guam Safe Boating Act, Rec. Water Use Mgt. Rules and Regs., Endangered Species Act, Guam Clean Water Act, and Guam Litter Control Act.	DOH: All vessel discharges are prohibited in State waters. USCG: Has OPA 90 rules in effect. DPS Marine Patrol and USCG enforce discharge regulations cooperatively.
6. Control of Other Point Source Pollution	ASCMP: PNRS provides for review of all projects and compliance with Federal and Territorial laws and regs. ASEPA: NPDES permits required for all discharges. AS Environmental Quality Act provides for standards at and distances from discharges. FBNMS: Discharges prohibited.	CRM: Permitting program; enforcement via field monitoring and enforcement program.	USCG: Has OPA 90 rules and enforcement authority. GEPA: NPDES permit required for point source discharges; Section 401 certification required for discharges; water quality monitoring for discharges.	DOH: NPDES permit is primary regulation and control of discharges in coral reef areas. Applications are reviewed for their impact of aquatic ecosystems by DLNR and for consistency with CZM objectives and policies by CZM program. USFWS and NMRS have programmatic monitoring and enforcement responsibilities.

Table 9.1 (cont.)

Activity	American Samoa	CNMI	Guam	Hawaii
7. Control of Non-Point Source Pollution	ASEPA: AS Water Quality Act covers regulations for use of septic tanks, pesticides, activities resulting in soil erosions, littler and solid waste disposal. ASCMP + other agencies: PNRS requires permits for new projects. Admin. rules prohibit discharge of untreated sewage, petroleum products and other pollutants or hazardous material; taking of sand and aggregate material outside designated sites; destruction of reef matter not assoc. w/permitting; disposal of trash; un-permitted dredge and fill activities. Non-regulatory measures include public education aimed at reducing erosion and impact of piggeries; TA provided when required; solid waste and oil collection facilities provided.	CRM: Project permitting, plan approvals; new best management practices evaluation starting. DEQ: Water quality monitoring.	GEPA: Construction Site Erosion and Sediment Controls required. New rules in formative stage including vegetative control and landscaping standards.	DOH: Limited control over non-point source pollution. Storm water runoff from county and industrial sources requires NPDES permit. Have programs that promote methods for controlling non-point source pollution. Counties have promulgated requirements for construction sites. County and other State agencies within the CZM network of agencies have other regulatory and non-regulatory measures that contribute to control of non-point source pollution. Non-regulatory measures include use of siltation basins, grassing, and prohibition of motorized traffic.

Table 9.1 (cont.)

	Activity	American Samoa	CNMI	Guam	Hawaii
8.	Proposed Non-Point Source Pollution Measures	ASCMP: Current policy of stream bank buffer of 25 ft for private and 50 ft. for commercial project now used in environmental review will be made part of ASCMP Admin. rules. Non-regulatory measures include demo project voluntary compliance on proposals, public education, tax incentives and subsidies for those using BMPs.	CRM and DEQ now developing coastal non-point source pollution plan. 6217 marina measures expected to be incorporated. Additional mgt. measures to be developed for golf course development and wildfires. DEQ existing requirements cover storm waters. Marine water quality monitoring expected to be upgraded.	Land-Use Master Plan for Guam contains performance standards designed to reduce non-point source pollution.	Numerous non-regulatory provisions are being considered for marina, agricultural forestry, urban and other activities. State dedicated to developing a workable non-point source pollution plan in the Hawaiian context. Conflicting perspectives and values of feds and state may make it difficult to complete program. Legislative action will drive schedule.
9.	CZMA 6217 Plan Completed	Final approved expected in October 2002.	Final approval expected in 2003.	Final approval expected in June 2003.	Implemented July 2000.

Acronyms:

ASCMP: American Samoa Coastal Management Program
ASEPA: American Samoa Environmental Protection Agency
CRM: Coastal Resources Management, CNMI
CZM: Coastal Zone Management Program, HI
DAWR: Division of Aquatic and Wildlife Resources, DOA, Guam
DEQ: Division of Environmental Quality, CNMI
DFW: Division of Fish and Wildlife, CNMI
DLM: Department of Land Management, Guam
DLNR: Department of Land and Natural Resources, HI
DMWR: Department of Marine and Wildlife Resources, AS
DOA: Department of Agriculture, Guam
DOH: Department of Health
DPS:Department of Public Safety
EPA: Environmental Protection Agency
GCMP: Guam Coastal Management Program
GEPA: Guam Environmental Protection Agency
NPDES: National Pollution Discharge Elimination System
PNRS: Project Review and Notification System, AS
USCG: United States Coast Guard

9.3 Jurisdictional Issues

9.3.1 Introduction

This section reviews the complex issues surrounding marine boundaries in the Western Pacific Region. Delineation of current marine boundaries is discussed and specific areas of contention between various federal and state authorities are summarized.

9.3.2 Exclusive Economic Zone

The 1976 Fishery Conservation and Management Act (the Magnuson Act, and later, after amendments, the MSFCMA)[1] established U.S. jurisdiction from the seaward boundary of the territorial sea out to 200 miles for the purpose of managing fishery resources. Passage of the Magnuson Act was the first unilateral declaration of jurisdiction over a 200-mile zone by a major power. Presidential Proclamation 5030 of March 10, 1983, expanded Magnuson Act jurisdiction by establishing the U.S. exclusive economic zone; it declared, "to the extent permitted by international law ... sovereign rights for the purpose of exploring, exploiting, conserving and managing natural resources, both living and non-living, of the seabed and subsoil and the superjacent waters" in the 200-mile zone. The assertion of jurisdiction over the EEZ of the United States provided a basis for economic exploration and exploitation, scientific research, and protection of the environment under the exclusive control of the U.S. government. Congress confirmed presidential designation of the EEZ in1986 amendments to the Magnuson Act. Under the Magnuson Act, fishery management authority in the EEZ off American Samoa, Guam, Hawaii, the Northern Mariana Islands, and other U.S. islands in the central and western Pacific is the responsibility of the Western Pacific Regional Fishery Management Council.

The EEZ is measured from the "baseline" of U.S. states and overseas territories and possessions out to 200 nautical miles. Under the Magnuson Act , the shoreward boundary of the EEZ is a line coterminous with the seaward boundary, baseline, of each "state." (As used elsewhere in this document, U.S. territories and possessions in the Western Pacific fall within the definition of state under the Magnuson Act (16 U.S.C. 1802, MSFCMA § 3 104-297)). In the case of the CNMI and the PRIAs, the EEZ extends to the shoreline (Beuttler 1995).

Seaward boundaries (territorial seas) for states are recognized as extending out to a distance of three miles from the ordinary low-water mark, as established by the Submerged Lands Act (SLA) of 1953.[2] The Territorial Submerged Lands Act (TSLA) of 1960 was enacted to convey to the

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[1]The MSFCMA was initially referred to as the Magnuson Fishery Conservation and Management Act, which was changed to the Magnuson-Stevens Fishery Conservation and Management Act by the 1996 amendment to the Act.

[2]Under the SLA, the term "boundaries"' or the term "lands beneath navigable waters"' is interpreted as extending from the coastline to three geographical miles into the Atlantic Ocean or the Pacific Ocean, or three marine leagues (9 miles) into the Gulf of Mexico.

governments of American Samoa, Guam and Virgin Islands the submerged lands from the mean high-tide line out to three geographic miles from their coast lines (Beuttler 1995).

The CNMI was part of the United Nations Trust Territory of the Pacific Islands (administered by the U.S.) until 1978 when its citizens chose to be become a U.S. commonwealth by plebiscite and it was agreed to by Congress. Although title of the emergent land was conveyed to the Commonwealth, the U.S. government withheld title to the submerged lands of the archipelago.[3] Submerged lands and underlying resources adjacent to CNMI remain owned by the federal government and subject to its management authority (Beuttler 1995).

In the PRIAs, for which there are no sovereign entities similar to states or territories, various federal agencies have jurisdictional authority. Authority is often established through statutes, Executive orders, and Presidential Proclamations, and marine boundaries are often unclear. For this reason, the extent to which an agency exercises its jurisdictional authority is subject to legal interpretation.

9.3.3 Territorial Seas

State of Hawaii

The State of Hawaii consists of all islands, together with their appurtenant reefs and territorial waters, which were included in the Territory of Hawaii under the Organic Act of 1900. Under the Admissions Act of 1959, Congress granted to Hawaii the status of statehood and all amenities of a state, which included the reversion of title and ownership of the lands beneath the navigable waters from the mean high-tide line seaward, out to a distance of three miles, as stated by the SLA of 1953. Congress excluded Palmyra Atoll Kingman Reef, and Johnston Atoll, including Sand Island, from the definition of the State of Hawaii in 1959. The federal government also retained 1,765 acres of emergent land in the NWHI, which had been set aside by Executive Order 1019 in 1909, establishing the Hawaiian Islands Reservation (HIR). The HIR was later renamed the Hawaiian Islands National Wildlife Refuge (HINWR) after it was transferred from the Department of Agriculture to the Department of Interior in 1939 (Yamase 1982).

Territories of Guam and American Samoa

Pursuant to the TSLA of 1960, the Territories of Guam and American Samoa own and have management responsibilities over the marine resources out to three "geographic" miles. In general, the authority of the MSFCMA begins at three nautical miles from the shoreline at Guam and American Samoa. There are, however, exceptions to the management authority in the Territories. For example, the federal government administers waters in National Wildlife Refuges and naval defense sea areas (NDSA)(see below).

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[3] The Territorial Submerged Lands Act was enacted for CNMI on October 5, 1974 (Beuttler 1995). Congress approved the mutually negotiated "Covenant to Establish a Commonwealth of the Northern Marianas (CNMI in political union with the U.S.)". However, the Covenant was not fully implemented until 1986, pursuant to Presidential Proclamation number 5564, which terminated the trusteeship agreement (Beuttler 1995).

9.3.4 US Fish and Wildlife Refuges and Units

The USFWS has been given authority to manage a number of NWRs in the Western Pacific Region. The USFWS asserts the authority to manage marine resources and activities, including fishing activities within Refuge boundaries pursuant to the National Wildlife Refuge System Administration Act (NWRSAA) of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997, and other authorities (Gillman 2000). The USFWS asserts that NWRs are closed to all uses until they are specifically opened for such uses. They also claim that the USFWS is "solely" charged with making decisions whether to open NWRs for specific purposes that are compatible with the refuge's primary purposes and mission (Smith 2000a).

Executive Order 1019 reserved and set apart Laysan and Lisanski Islands, and Maro and Pearl and Hermes Reefs, excluding Midway, "as a preserve and breeding ground for native birds" to be administered by the Department of Agriculture. The HIR was transferred to the DOI in 1939 and in 1940 renamed the HINWR through Presidential Proclamation 2466, with control transferred to the USFWS. Within the HINWR, the USFWS asserts management authority over coral reef resources to a depth of 10 fm around all islands with the exception of Necker Island, where it asserts a 20 fm boundary. The USFWS acknowledges that all HINWR islands are part of the State of Hawaii, but asserts that the islands are federally owned and administered as a NWR by the USFWS (Smith 2000b; USFWS 1999b).

Kure Atoll was initially included in Executive Order 1019 in 1909, which establish the HIR. However, Kure Atoll was returned to the Territory of Hawaii in 1952 by Executive Order 10413 (Yamase 1982). Kure Atoll is the only State Wildlife Refuge in the NWHI and extends out three miles, to the State's seaward boundary (J. Feder pers. com.).

In the PRIAs, the USFWS—based on interpretation of Executive Order 7358—asserts that its refuge boundaries extend to the extent of the NDSA, which was administered by the Department of Defense before the transfer of surplus land to the USFWS. The USFWS currently manages seven wildlife refuges in the PRIAs: Jarvis, Baker, and Howland Islands, Johnston and Midway Atolls with Kingman Reef and Palmyra Atoll being the most recent additions (Smith 2000b).

On January 18, 2001, the USFWS, through Secretarial Order 3223, declared Kingman Reef and the surrounding submerged lands and waters as a National Wildlife Refuge out to a distance of 12 nautical miles. Additionally, Secretarial Order 3224 declared the tidal lands and submerged lands and waters of Palmyra Atoll as a National Wildlife Refuge out to a distance of 12 nautical miles.[4]

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[4]A September 15 2000, legal opinion by Randolph Moss, Assistant Attorney General, U.S. Department of Justice, states that they are "unconvinced that the President has the authority to establish or expand a wildlife refuge within the U.S. territorial sea (12 miles) or the EEZ using presidential authority recognized in *Midwest Oil*." Because the National Wildlife Refuge System Administration Act does not itself contain a provision authorizing the President to withdraw land for a wildlife refuge, the DOI argues that the President could rely on the implied authority to reserve public lands recognized in *United States v. Midwest Oil Co.* 236, U.S. 459 (1915). The Federal Land Policy and

Midway Atoll NWR, established under Executive Order 13022 in 1996, is located in the NWHI and has a refuge boundary that is within a 22 by 22 mile quadrant surrounding the atoll (the exact boundary is disputed). The Navy established a Naval Air Facility at Midway in 1941. The USFWS established an overlay refuge in 1988 to manage the fish and wildlife on the Atoll. Through the Base Alignment Closure Act of 1990, as amended, the Naval Air Facility closed in 1993 and the property was transferred to the USFWS in 1996 (USFWS 1999a). The mission of the refuge is to protect and restore biological diversity and historic resources of Midway Atoll, while providing opportunities for compatible recreational activities, education and scientific research (Shallenberger 2000). Through a long-term cooperative agreement with a private company (Midway Phoenix Corp.), the refuge has been open to the public for marine recreation and education (Shallenberger 2000).

Johnston Atoll NWR is managed cooperatively with the Navy. The atoll was first established as a federal bird refuge on June 29, 1926, through Presidential Executive Order 4467 to be administered by the Department of Agriculture. In 1934, through Executive Order 6935, the atoll was placed under the jurisdiction of the Navy for administrative purposes and has been used as a military installation since 1939. In 1941 Executive Order 8682 designated Johnston and other Pacific atolls NDSAs. Since 1976, the USFWS, under agreement with the military, assists in management of fish and wildlife resources on the atoll. The USFWS manages a recreational fishing program in the NWR (Smith 2000b).

Administration of Jarvis, Howland, and Baker Islands were transferred from the Office of Territorial Affairs to the USFWS in 1936 to be run as NWRs. The USFWS asserts refuge boundaries out to three nautical miles, and it prohibits fishing and any type of unauthorized entry (Smith 2000b). The USFWS acknowledges the Council's fishery management authority, in coordination with the NMFS, within the "200-nautical mile EEZ" (Smith 2000b).

Rose Atoll NWR, located in American Samoa, was established through a cooperative agreement between the Territory of American Samoa and the USFWS in 1973. Presidential Proclamation 4347 exempted Rose Atoll from a general conveyance of submerged lands around American Samoa to the Territorial Government. The boundary of the refuge extends out to three miles around the atoll and is under the joint jurisdiction of the Departments of Commerce and Interior, in cooperation of the Territory of American Samoa. Here too, the USFWS acknowledges fishery management authority of the Council, in coordination with the NMFS, within the "200-nautical mile EEZ" (Smith 2000b).

Management Act (FLPMA) of 1976 repealed the Presidents authority, effective on and after approval of the Act, to make withdrawals and reservations resulting from acquiescence of Congress (*U.S. v. Midwest Oil Co.*). Moss continued by stating that they find "it likely that a court would find that §704(a) of the FLPMA prohibits the President from relying on the implied *Midwest Oil* authority to withdraw lands, regardless of where those lands are located." Also, he notes that "they do not think history makes it clear that the President may continue make *Midwest Oil* withdrawals in the territorial sea or EEZ following the enactment of the FLPMA."

In the Ritidian Unit of the Guam National Wildlife Refuge, USFWS has fee title, which includes 371 acres of emergent land and 401 acres of submerged lands down to the 100-foot bathymetric contour. The submerged lands adjacent to Ritidian were never transferred to the Territory of Guam pursuant to the TSLA by the Federal government. In 1993, the USFWS acquired the emergent land of the Ritidian Unit and the surrounding submerged lands from the Navy at no cost (Smith 2000b).

9.3.5 Department of Defense Naval Defensive Sea Areas

A number of Executive Orders have given administrative authority over territories and possessions to the Army, Navy, or the Air Force for use as military airfields and for weapons testing. In particular, Executive Order 8682 of 1941 authorizes the Secretary of the Navy to control entry into NDSAs around Palmyra, Johnston, and Midway Atolls, Wake Island, and Kingman Reef. The NDSA includes "territorial waters between the extreme high-water marks and the three-mile marine boundaries surrounding" the areas noted above. The objectives of the NDSA are to control entry into naval defensive sea areas; to provide for the protection of military installations; and to protect the physical security of, and ensure the full effectiveness of, bases, stations, facilities, and other installations (32 CFR Part 761). In addition, the Navy has joint administrative authority with the USFWS of Johnston Atoll and sole administrative authority over Kingman Reef. In 1996 Executive Order 13022 rescinded the Midway Atoll NDSA, and the Wake Island NDSA has also been suspended until further notice.

The Navy exerts jurisdiction over Farallon de Mendinilla in the CNMI and Ka'ula Rock in the main Hawaiian Islands, which are used as military bombing ranges. The Navy also exerts jurisdiction over a variety of waters offshore from military ports and air bases in Hawaii, PRIAs, Guam, and the CNMI.

9.3.6 Issues

Claims between "state" and federal resource management agencies involving marine boundaries over individual islands, reefs and atolls, continue to be unresolved in the Western Pacific Region. Tables 9.2 through 9.4 summarizes these various claims.

Northwestern Hawaiian Islands

The NWHI are primarily uninhabited atolls, islands, banks and shoals and are currently under multi-agency jurisdiction including the State of Hawaii, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service and the Western Pacific Regional Fishery Management Council. Overlaps in jurisdiction and the varying regulatory authorities embodied in the management of this area can create numerous challenges and has led to contention regarding access and use for the region.

The State of Hawaii claims jurisdiction of all submerged lands from the shoreline to the extent of the State's jurisdiction in the NWHI. In accordance with the Hawaii Organic Act of April 30,

1900, c 339, 31 Stat 141 Section 2, and the Hawaii Admissions Act of March 18, 1959, Pub L 86-3, 73 Stat 4 Section 2, the Islands of the Hawaiian Archipelago, together with their appurtenant reefs and territorial waters, with the exception of Midway Atoll, are part of the territory of Hawaii and are managed by the State of Hawaii including all submerged lands and marine resources. The State of Hawaii, Department of Land and Natural Resources has stewardship responsibility for managing, administering and exercising control over the coastal and submerged lands, ocean waters and marine resources under State jurisdiction around each of the Northwestern Hawaiian Islands under Title 12, Chapter 171.3 Hawaii Revised Statutes. Under an Executive Order issued by President Truman, the emergent lands at Kure Atoll are also managed as a State Wildlife Refuge.

In addition to the State of Hawaii, the USFWS also claims jurisdiction over atolls, islands, banks and shoals in the NWHI. Following the Hawaii Admissions Act of March 18,1959, federal agencies were directed to inventory all lands for which there was a continuing need. The USFWS in 1963, reported a continuing need of 1,765 acres of land in the NWHI. This area consisted of only the emergent land in the NWHI as was claimed by the Department of Agriculture as the original boundary of the Hawaiian Island Refuge (Yamase 1982). More recently however, the USFWS claims that the HINWR includes 252,000 acres of submerged lands based on their interpretation of the terms "reef and inlets" contained in Executive Order 1019 (U.S. Fish and Wildlife Service 1986). Within the HINWR, the USFWS asserts management authority over coral reef resources to a depth of 10 fathoms around all islands with the exception of Necker Island where it asserts a 20 fathom boundary. The USFWS acknowledges that all HINWR islands are part of the State of Hawaii, but asserts that the islands are federally owned and administered as a NWR by the USFWS (U.S. Fish and Wildlife Service 1999, Smith 2000). Other jurisdictional disputes also involve East and Tern Islands in French Frigate Shoals. [5] [6]

Issues have developed from a series of directives from President Clinton that focused public attention on protection of U.S. coral reef ecosystems. Executive Order 13089, Coral Reef Protection, issued in June 1998, requires agencies to (1) identify actions that may affect U.S.

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[5]In 1940, Territorial Governor Poindexter, issued an Executive Order in concurrence with the President of the U.S. to set aside East Island, for the use and purpose of the United States as a radar station communication base under the DOC (Yamase 1982). Prior to statehood, the DOC returned East Island to the Territory of Hawaii (Yamase 1982). However, the DOI contends that East Island was part of the HIR as established by Executive Order 1019 in 1909 and later transferred to the DOI in 1939. Therefore, East Island remains included in the HINWR and under authority of DOI.

[6] Tern Island was expanded from 11 to 37 acres in 1942 by military dredging (Yamase 1982). In 1948, the Navy conveyed Tern Island to the Territory of Hawaii which then permitted the U.S. Coast Guard in 1952 to establish a navigational Loran station (Yamase 1982). In 1979, USCG operations were terminated and the Hawaii State Legislature adopted resolutions requesting the Governor to take immediate action to acquire and return Tern Island for use as a fishing base to support commercial activities (Yamase 1982). The Federal government asserts that it retains jurisdiction over Tern Island based on Executive Order 1019 and that the Navy did not have the authority to legally convey title to the Territory of Hawaii, therefore, the conveyance is void (Yamase 1982).

coral reef ecosystems; (2) use their programs and authorities to protect and enhance the condition of such ecosystems; and (3) ensure that any actions they authorize, fund, or carry out will not degrade the conditions of coral reef ecosystems. Agencies whose actions affect U.S. coral reef ecosystems must provide for implementation of measures needed to research, monitor, manage and restore affected ecosystems, including, but not limited to, measures reducing impacts from pollution, sedimentation, and fishing. The E.O. also established the U.S. Coral Reef Task Force composed of the heads of 11 federal agencies and the Governors of the seven states, territories, or commonwealths with responsibilities for coral reefs. In March 2000, the Task Force issued the National Action Plan to Conserve Coral Reefs, which presents a cohesive national strategy to implement EO 13089.

In May 2000, the President issued a Memorandum stating that it is time to implement the Coral Reef Task Force's recommendations in order to comprehensively protect the coral reef ecosystem of the NWHI.[7] The Memorandum directed the Secretaries of Interior and Commerce, in cooperation with the State of Hawaii, and in consultation with the WPRFMC, to develop recommendations for a new, coordinated management regime to increase protection for the NWHI coral reef ecosystem and provide for sustainable use. After considering their recommendations and comments received during the public visioning process on this initiative, President Clinton issued Executive Order 13178 on December 4, 2000, establishing the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve, pursuant to the National Marine Sanctuaries Amendments Act of 2000 (NMSA). The EO was revised and finalized by Executive Order 13196, issued January 18, 2001. Pursuant to Executive Order 13178 and the NMSA, NOAA is initiating the process to designate the Reserve as a national marine sanctuary (66 FR 5509, January 19, 2001). These actions to protect the coral reef ecosystem of the NWHI and provide for sustainable use of the area underscore the immediate need for a comprehensive assessment of the impacts of fishing activity on this ecosystem.

Because the final rules for the Reserve have not yet been published, and an EIS will be prepared for the marine sanctuary, a comprehensive analysis of the impact of the Reserve can not be completely assessed at this time. Preliminary potential impacts to the human environment are addressed in the environmental consequences section of the EIS. However, two alternatives considered by the EIS (3 and 4, described in Chapter 2) are consistent with the concept of establishing marine reserves in the NWHI, as described in the CRE-FMP.

The USFWS and the Council have different opinions about primary fishery management responsibilities in EEZ waters within NWR boundaries. Since the late 1960s, citing USFWS interim administrative policy and interpretation of Executive Order 1019, the USFWS ha

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[7] The President's directive coincided with Executive Order 13158, which requires federal agencies to establish a comprehensive national network of marine protected areas throughout U.S. marine waters. The Executive Order calls for expansion of the nation's MPA system to include examples of all types of marine ecosystems. According to the executive order, a MPA means any area of the marine environment that has been reserved by federal, state, territorial, tribal, or local laws or has regulations to provide lasting protection for part or all of the natural and cultural resources therein.

asserted that they would enforce refuge regulations within the "de facto" boundaries of the HINWR, which include all emergent land and their surrounding waters out to a depth of 10 fm for all islands and later 20 fm around Necker Island (Smith 2000b). Under the authority of the MSFCMA, the Council promulgated fishery regulations within federal waters that correspond with USFWS refuge boundaries of 0-10 fathoms within NWHI federal waters, except at Necker where it is 20 fm (WPRFMC 1986). The Council recognizes state waters in the NWHI from 0-3 miles and asserts management authority over fishery resources in all federal waters (3-200 miles), except at Midway where it asserts authority from 0-200 miles (Gillman 2000).

Main Hawaiian Islands

The State of Hawaii claims jurisdiction beyond its territorial seas of 0-3 nautical miles by claiming archipelagic status over channel waters between the main Hawaiian islands (MacDonald and Mitsuyasu, 2000). The Federal Government does not recognize the State's claim of archipelagic jurisdiction, but interprets the State's seaward authority to stop at three nautical miles from the baseline (Feder 1997; MacDonald and Mitsuyasu 2000). The authority of the Magnuson Act therefore, begins at 3 miles from the shoreline around all main Hawaiian islands in the State of Hawaii. However the State of Hawaii does not agree with this interpretation.

American Samoa

The legal relationship between the Territory of American and the U.S. with regard to fisheries management is unresolved due to a discrepancy in the wording of the deeds of cession signed by the chiefs of what is now American Samoa and the law enacted by Congress which extended U.S. sovereignty over the eastern Samoa islands in 1900. Language contained in the deeds of cession signed by the chiefs of Tutuila district state that they ceded, transferred and yielded up "all these islands of Tutuila and Aunu'u and all other islands, rocks, reefs, foreshores and waters lying between the 13th degree and the 15th degree of south latitude and between the 171st degree and 167th degree of west longitude...." Likewise, the chiefs of the Manu'a Islands also ceded to the U.S. "the whole of eastern portion of the Samoan Islands lying east of 171 degrees west of Greenwich and known as Tau, Olosega, Ofu and Rose Islands, and all other , the waters and property adjacent thereto...."

In contrast, Title 48 United States Code, Section 661, by which Congress accepted, confirmed and ratified these cessions by the chiefs, refer only to the islands, and not to the reefs, foreshores and waters or property adjacent lying between the referenced coordinates. Whether Congress deliberately or unintentionally failed to extend sovereignty over reef and ocean waters transferred by the chiefs of Tutuila and Manu'a is uncertain.

A central premise for ceding eastern Samoa to the U.S. was to preserve the rights and property of the islands' inhabitants. Additionally, American Samoa's constitution makes it government policy to protect persons of Samoan ancestry from the alienation of their lands and the destruction of the Samoan way of life and language and to encourage business enterprise among

persons of Samoan ancestry. Therefore, any federal actions within the EEZ waters of American Samoa that would stymie these rights, including restriction on fishing, may be perceived to be contrary to American Samoa's constitution.

CNMI

Currently, the EEZ includes all waters surrounding CNMI from shore out to 200 miles. However, through the legal system CNMI is pursuing a claim that the Commonwealth is vested authority out to 12 miles from the archipelagic baseline. The Council, for the purposes of fisheries management, defers management in waters 0-3 nm to the CNMI while managing fishery resources 3-200 nm.

Guam

The Territory of Guam questions the legality of the transference of the Ritidian Unit from the Navy to the USFWS. In its property inventory to the General Services Administration the Navy listed the Ritidian Unit as excess lands, not of continual need and available for reversion to the Territory. The area represents ancestral lands of Chamorro families. Therefore, the Territory asserts that the fee title should not have been transferred to the USFWS (J. Guthertz pers. comm.).

In 1976, the Federal Fishery Conservation Zone (later known as the EEZ) was extended to 200 nmi around Guam which gave the federal government authority to manage marine resources within the EEZ. In 1980, the Guam Legislature passed and the Governor signed legislation providing for a 200 mile territorial limit for Guam (DOI 1993). The purpose of this legislation, was to allow the government of Guam to sell foreign fishing rights within Guam's EEZ. In 1996, the Magnuson-Stevens Act authorized the Secretary of State to negotiate foreign fishing agreements for fishing within the EEZ at the request of the Governor of Guam. However, in addition to the "state" waters around Guam, the government has also expressed a continuing interest in obtaining greater authority in managing the EEZ surrounding Guam.

PRIAs

In the PRIAs, primary jurisdiction over nearshore fisheries is an ongoing issue between the Department of the Interior and the Department of Commerce. Management authority is currently unresolved because no clear baseline boundary has been designated from which the seaward boundary of the PRIAs are measured. Seaward boundaries are not clearly defined because some islands in the PRIAs do not appear to have a seaward boundary as defined by U.S. law (i.e., MSFCMA) (Beuttler 1995). For this reason, jurisdictional boundaries have been claimed by federal agencies in terms of fathoms, miles, or the territorial sea. Furthermore, it is recognized that various Executive orders have given administrative authority of the PRIAs to either the DOD or DOI. However, Executive orders themselves do not convey title of submerged lands, unless specifically stated. In any case, based on tentative interpretation by the NOAA legal counsel, MSFCMA authority applies to all marine waters around federally owned possessions (i.e., PRIAs), including marine resources within bays, inlets, and other marine waters to the shoreline (Beuttler 1995).

Additionally, because the NWRSAA does not explicitly authorize the President to withdraw land for a wildlife refuge, the DOI argues that the President could rely on the implied authority to reserve public lands recognized in *United States v. Midwest Oil Co.* 236, U.S. 459 (1915). However, since the Federal Land and Policy Act of 1976 repealed the President's authority, effective on and after approval of the Act, to make withdrawals and reservations resulting from the acquiescence of Congress (*U.S. v. Midwest Oil Co.*), it appears that since 1976 the President has not had the authority to establish or expand a wildlife refuge within the U.S. territorial sea (12 miles) or the EEZ using presidential authority recognized in *Midwest Oil* (Moss 2000). This could call into question asserted marine boundaries of any NWRs established after enactment of the FLPMA.

Table 9.2: Marine boundary claims by various jurisdictions in the Western Pacific Region. Note: a dashed line (-) indicates no jurisdiction.

Island or Area	State/Commonwealth/ Territory	Department of Commerce	Department of the Interior and Department of Defense (as noted)
PRIAs			
Howland I.	-	WPRFMC/NMFS 0-200 nm	USFWS: 0-3 nm
Baker I.	-	WPRFMC/NMFS 0-200 nm	USFWS: 0-3 nm
Jarvis I.	-	WPRFMC/NMFS 0-200 nm	USFWS: 0-3 nm
Johnston I.*	-	WPRFMC/NMFS 0-200 nm	USFWS/US Navy: 0-3 nm
Kingman R.	-	WPRFMC/NMFS 0-200 nm	USFWS: 0-12 nm[1]
Palmyra A.*	-	WPRFMC/NMFS 0-200 nm	USFWS: 0-12 nm[2]
Wake I.***	-	WPRFMC/NMFS 0-200 nm	DOI/USArmy: 0-3 nm
Midway A.*	-	WPRFMC/NMFS 0-200 nm	USFWS: 22x22 nm quad
Hawaii			
MHI	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	
Nihoa I.	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	USFWS: 0-10 fm**
Necker I.	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	USFWS: 0-20 fm**

[1] Boundary formerly 0-3 miles under the jurisdiction of the U.S. Navy. Secretarial Order 3223 extended Department of the Interior's jurisdiction to 12 nm.
[2] Secretarial Order 3224 (Palmyra Atoll) extended USFWS administrative authority from 3 to 12 nm.
*At Palymyra, Johnston, and Midway special permit fishing is only for recreational and on-island consumption; at Midway, the northern half of the atoll would be a no-take MPA and the southern half a low-use MPA.
**USFWS boundary begins at the shoreline; legally defined outer boundary of the Hawaiian Islands NWR is unresolved.
*** As of 1962, the jurisdiction over Wake Island has been vested with the Department of the Interior. Since 1994, the Department of the Army has maintained administrative use of Wake Island.

Table 9.2 (cont.)

Island or Area	State/Territory/Commonwealth	Department of Commerce	Department of the Interior and Department of Defense (as noted)
FFS	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	USFWS: 0-10 fm**
Gardner Pinnacles	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	USFWS: 0-10 fm**
Maro R.	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	USFWS: 0-10 fm**
Laysan I.	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	USFWS: 0-10 fm**
Lisanski I.	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	USFWS: 0-10 fm**
Pearl and Hermes R.	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	USFWS: 0-10 fm**
Kure A.	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	-
Guam	Guam: 0-3 nm	WPRFMC/NMFS 3-200 nm	
Ritadan Unit			USFWS: 100 ft. isobath
CNMI	CNMI: 0-3 nm***	WPRFMC/NMFS 3-200 nm	
American Samoa	American Samoa: 0-3 nm	WPRFMC/NMFS 3-200 nm	
Rose Atoll		WPRFMC/NMFS 0-200 nm	USFWS: 0-3 nm[3]

[3]At Rose Atoll, the Department of the Interior/U.S. Fish and Wildlife Service has a cooperative agreement with the Territory of American Samoa to manage the atoll as a national wildlife refuge, and shares jurisdiction with the Department of Commerce.
**USFWS boundary begins at the shoreline; legally defined outer boundary of the Hawaiian Islands NWR is unresolved.
***The CRE-FMP proposes to defer management in 0-3 nm to the CNMI while managing fisheries 3-200 nm.

Table 9.3 : Comparison of No-take and Low-use Marine Protected Areas of the Coral Reef Ecosystem FMP with the NWHI Reserve Preservation Areas (RPAs), U.S. Fish and Wildlife Service and State/Commonwealth/Territory (a dash indicates no jurisdiction).

Island or Area	CRE-FMP	NWHI Reserve	USFWS	State/Commonwealth/Territory
PRIAs				
Howland I.	No-take zone 0-50 fathoms.	–	Howland Island NWR 0 to 3 nm; No fishing allowed.	–
Baker I.	No-take zone 0-50 fathoms.	–	Baker Island NWR 0 to 3 nm; No fishing allowed.	–
Jarvis I.	No-take zone 0-50 fathoms.	–	Jarvis Island NWR 0 to 3 nm; No fishing allowed.	–
Johnston I.	Low-use special permit zone 0-50 fathoms.	–	Johnston Atoll NWR/Navy (Overlay Refuge) 0 to 3 nm; Recreational fishing program.	–
Kingman R.	No-take zone 0-50 fathoms.	–	Kingman Reef NWR 0 to 12 nm; No fishing allowed.	–
Palmyra A.	Low-use special permit zone 0-50 fathoms.	–	Palmyra Atoll NWR 0 to 12 nm; Recreational fishing allowed.	–
Wake I.	Low-use special permit zone 0-50 fathoms.	–	DOI/US Army to 3 nm; Fishing allowed.	–
Midway A.	No-take zone 0-50 fathoms around northern half of Midway. Low-use special permit zone around southern half of Midway.	–	Midway Atoll NWR between 28°5' and 28°25'; 177°10' and 177°30'; following fishing allowed within Refuge boundaries: 1 lobster/person/day; pelagic rec and charter fishing allowed; no bottomfishing; catch and release ulua fishing.	–

Table 9.3 (cont)

Island or Area	CRE-FMP	NWHI Reserve	USFWS	State/Commonwealth/Territory
Hawaii				
MHI	Special permits for "potentially harvested" species.	–	10 wildlife refuges (none with marine boundaries)	State of Hawaii bottomfish area closures (20 closures across MHI); 10 Marine Life Conservation Districts and 14 Marine Fishery Management Areas in MHI (rules and regulations vary with location)
Nihoa I.	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms around Nihoa and nearby banks.	RPA extends from the seaward boundary of Hawaii State waters (3nm) out to a mean depth of 100 fathoms. Bottomfish and recreational trolling for pelagics permitted seaward of 25 fathoms.	Hawaiian Islands NWR (HINWR) 0 to 10 fathoms. No fishing allowed.	State of Hawaii proposed NWHI Marine Fisheries Management Area (NWHI FMA) 0-3 miles.
Misc. banks around Nihoa and Necker (8)	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	no current restrictions	HINWR 0 to 10 fathoms. No fishing allowed.	–
Necker	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA extends from the seaward boundary of Hawaii State waters (3nm) out to a mean depth of 100 fathoms. Bottomfish and recreational trolling for pelagics permitted seaward of 25 fathoms.	HINWR 0 to 20 fathoms. No fishing allowed.	State of Hawaii proposed NWHI Marine Fisheries Management Area (NWHI FMA) 0-3 miles.
Unnamed bank east of French Frigate Shoal	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA to 12 nm from geographic center. No fishing allowed.	HINWR 0 to 10 fathoms. No fishing allowed.	–

Table 9.3 (cont)

Island or Area	CRE-FMP	NWHI Reserve	USFWS	State/Commonwealth/Territory
FFS	No-take zone 0-50 fathoms.	RPA extends from the seaward boundary of Hawaii State waters (3nm) out to a mean depth of 100 fathoms. No fishing allowed.	HINWR 0 to 10 fathoms. No fishing allowed.	State of Hawaii proposed NWHI Marine Fisheries Management Area (NWHI FMA) 0-3 miles.
Brooks Banks (2)	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms around three banks southeast of St. Rogatien including two Brooks Banks and one bank NW of St. Rogatien.	RPA to 12 nm from geographic center of southeast Brooks Bank, but not closer than 3 nm to the next bank west (northwest Brooks Bank). No fishing allowed.	HINWR 0 to 10 fathoms. No fishing allowed.	–
St. Rogatien Bank	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA to 12 nm from geographic center, but not closer than 3 nm to the next bank east. Bottomfish and recreational trolling for pelagics permitted.	HINWR 0 to 10 fathoms. No fishing allowed.	–
Unnamed bank between Gardner Pinnacles and St. Rogatien Bank	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA to 12 nm from geographic center. Bottomfish and recreational tolling for pelagics allowed for 5 years from order.	HINWR 0 to 10 fathoms. No fishing allowed.	–
Gardner Pinnacles	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA extends from the seaward boundary of Hawaii State waters (3nm) out to a mean depth of 100 fathoms. Bottomfish and recreational trolling for pelagics permitted seaward of 25 fathoms.	HINWR 0 to 10 fathoms. No fishing allowed.	State of Hawaii proposed NWHI Marine Fisheries Management Area (NWHI FMA) 0-3 miles.

Table 9.3 (cont)

Island or Area	CRE-FMP	NWHI Reserve	USFWS	State/Commonwealth/Territory
Raita Bank	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA to 12 nm from geographic center. Bottomfish and recreational trolling for pelagics allowed for 5 years from order.	HINWR 0 to 10 fathoms. No fishing allowed.	–
Maro R.	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA extends from the seaward boundary of Hawaii State waters (3nm) out to a mean depth of 100 fathoms. Bottomfish and recreational trolling for pelagics permitted seaward of 25 fathoms.	HINWR 0 to 10 fathoms. No fishing allowed.	State of Hawaii proposed NWHI Marine Fisheries Management Area (NWHI FMA) 0-3 miles.
Laysan I.	No-take zone 0-50 fathoms. (Crustaceans FMP: Lobster fishing prohibited to 20 nm from geographic center)	RPA extends from the seaward boundary of Hawaii State waters (3nm) out to a mean depth of 100 fathoms. Bottomfish and recreational trolling for pelagics permitted seaward of 50 fathoms.	HINWR 0 to 10 fathoms. No fishing allowed.	State of Hawaii proposed NWHI Marine Fisheries Management Area (NWHI FMA) 0-3 miles.
Misc banks near (SW of) Laysan (4)	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	No current restrictions.	HINWR 0 to 10 fathoms. No fishing allowed.	–
Pioneer Bank	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	Preservation Area to 12 nm from geographic center. Bottomfish and recreational trolling for pelagics permitted.	HINWR 0 to 10 fathoms. No fishing allowed.	–

Table 9.3 (cont)

Island or Area	CRE-FMP	NWHI Reserve	USFWS	State/Commonwealth/Territory
Lisanski I.	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA extends from the seaward boundary of Hawaii State waters (3nm) out to a mean depth of 100 fathoms. Bottomfish and recreational trolling for pelagics permitted seaward of 25 fathoms.	HINWR 0 to 10 fathoms. No fishing allowed.	State of Hawaii proposed NWHI Marine Fisheries Management Area (NWHI FMA) 0-3 miles.
Misc banks near (W of) Lisianski (2)	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	No current restrictions.	HINWR 0 to 10 fathoms. No fishing allowed.	–
Pearl and Hermes R.	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA extends from the seaward boundary of Hawaii State waters (3nm) out to a mean depth of 100 fathoms. No fishing allowed.	HINWR 0 to 10 fathoms. No fishing allowed.	State of Hawaii proposed NWHI Marine Fisheries Management Area (NWHI FMA) 0-3 miles.
Misc. banks in the vicinity of Kure, Midway and Pearl and Hermes (4)	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	No current restrictions.	HINWR 0 to 10 fathoms. No fishing allowed.	–
Kure A.	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA extends from the seaward boundary of Hawaii State waters (3nm) out to a mean depth of 100 fathoms. No fishing allowed.	–	State of Hawaii Wildlife Refuge shoreline to 3 nm. Fishing not prohibited.

Table 9.3 (cont)

Island or Area	CRE-FMP	NWHI Reserve	USFWS	State/Commonwealth/Territory
American Samoa				
Rose Atoll	No-take zone 0-50 fathoms.	–	Rose Atoll NWR 0 to 3 nm; no fishing allowed.	DOI has a cooperative agreement with the Territory of American Samoa to manage Rose Atoll as a national wildlife refuge and shares jurisdiction with DOC
Guam				
Ritadan Unit	–	–	Ritidian Unit0 to 100 foot contour. Recreational fishing allowed	–
CNMI	–	–	–	–

Table 9.4: Comparison of Resource Management Authorities and Fishery Management Measures for Coral Reef Ecosystems in Federal Waters of the Western Pacific Region.

NIHOA, NECKER, GARDNER, MARO, LISIANSKI (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
NWHI Coral Reef Ecosystem Reserve (Reserve) (Federal waters to 50 miles around all islands)	No fishing portion of RPA: Federal waters 0-25 fm.	No fishing.	None.
	Bottomfishing/trolling portion of RPA: Federal waters 25-100 fm.	Limited commercial bottomfishing by permit holders and limited commercial and recreational pelagic trolling (all subject to fishing caps based on catch history).	No anchoring in areas where mooring is available; no discharging of any material except cooling water or engine exhaust.
	Other Reserve waters: Federal waters 100 fm-50 miles.	Limited commercial and recreational fishing (all subject to fishing caps based on catch history).	No increase in level of effort or take; no change in gear type or species targeted.
CRE FMP Federal waters to 200 miles	No-take MPA: Federal waters 0-10 fm.	No fishing.	Insurance requirement.
	Low-use MPA: Federal waters 10-50 fm.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders.	CRE special permit needed to target <u>any</u> coral reef ecosystem resources, insurance requirement.
	Non-MPA: Federal waters 50 fm-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS Federal waters to 10 fathoms [0-20 at Necker]	Refuge: Federal waters 0-10 fathoms [0-20 at Necker].	Activities consistent with Refuge mission- no commercial fishing.	USFWS special use permit required to enter.

Distinguishing Characteristics (this is the most common scenario):

<u>NWHI Reserve</u>

Reserve Preservation Area (RPA)
No fishing RPA 0-25 fm
Fishing RPA 25-100 fm
Recreational fishing 100 fm - 50 miles

<u>CRE FMP</u>

Marine Protected Area (MPA)
No-take MPA 0-10 fm
Low-take MPA 10-50 fm
Non-MPA 50 fm-200 miles

<u>USFWS</u>

Refuge 0-10 fm, 0-20 fm at Necker (no fishing)

NIHOA, NECKER, GARDNER, MARO, LISIANSKI (details)			
Federal waters	**NWHI Reserve**	**CRE FMP**	**USFWS**
0-10 fathoms	No fishing (RPA).	No fishing, insurance requirement (No-take MPA).	No fishing (Refuge). Beyond 10 fathoms, no current restrictions.
10-25 fathoms	No fishing (RPA).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target any coral reef ecosystem resources, insurance requirement (Low-use MPA).	No fishing 0-20 fm at Necker (Refuge). Beyond 20 fm no current restrictions.
25-50 fathoms	Limited bottomfish and pelagic trolling by current permit holders; limited recreational trolling for pelagic (RPA).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target any coral reef ecosystem resources, insurance requirement (Low-use MPA).	No current restrictions.
50-100 fathoms	Limited bottomfish and pelagic trolling by current permit holders; limited recreational trolling for pelagic (RPA).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
100 fm-50 miles	Recreational fishing commercial fishing by bottomfish permit holders; all pelagic trollers (Reserve).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
50 - 200 miles	Outside of Reserve.	Lobster, bottomfish, precious corals, troll/handline and longline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.

FRENCH FRIGATE SHOALS (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
NWHI Coral Reef Ecosystem Reserve (Federal waters to 50 miles)	Entire no fishing RPAs: Federal waters 0-100 fm.	No fishing.	None.
	Other Reserve Areas: Federal waters 100 fm to 50 miles.	Limited commercial bottomfishing by permit holders and limited commercial and recreational pelagic trolling (all subject to fishing caps based on catch history).	No anchoring in areas where mooring is available; no discharging of any material except cooling water or engine exhaust.
CRE FMP Federal waters to 200 miles	No-take MPA: Federal waters 0-50 fm.	Limited commercial and recreational fishing (all subject to fishing caps based on catch history).	No increase in level of effort or take; no change in gear type or species targeted.
	Non-MPA: Federal waters 50 fm-50 miles.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
	Non-MPA: Federal waters 50-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS Federal waters to 10 fathoms	Refuge: Federal waters 0-10 fm.	Activities consistent with Refuge mission- no commercial fishing.	USFWS special use permit required to enter.

Distinguishing characteristics:

CRE FMP

(1) No-take MPA from 0-50 fathoms.

NWHI Reserve

(2) No fishing RPAs extend from 0-100 fathoms.

FRENCH FRIGATE SHOALS (details)			
Federal waters	**NWHI Reserve**	**CRE FMP**	**USFWS**
0-10 fathoms	No fishing (RPA).	No fishing, insurance requirement (No-take MPA).	No fishing (Refuge).
10-50 fathoms	No fishing (RPA).	No fishing, insurance requirement (No-take MPA).	No current restrictions beyond 10 fm.
50-100 fathoms	No fishing (RPA).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
100 fm-50 miles	Recreational fishing, commercial fishing by bottomfish permit holders, and all pelagic trollers (Reserve).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
50 - 200 miles	Outside of Reserve.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.

S.E. BROOKS BANK, 1ST BANK EAST OF FFS, ST. ROGATIEN, 1ST BANK WEST OF ST. ROGATIEN*, RAITA*, PIONEER (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
NWHI Coral Reef Ecosystem Reserve (Federal waters to 50 miles around all islands)	Bottomfishing/trolling RPA: Federal waters 0 - 12 miles. (All fishing is prohibited within 12 miles around S.E. Brooks Banks, and the 1st bank west of FFS).	Limited commercial bottomfishing by permit holders and limited commercial and recreational pelagic trolling (all subject to fishing caps based on catch history).	No anchoring in areas where mooring is available; no discharging of any material except cooling water or engine exhaust.
	Other Reserve waters: Federal waters 12-50 miles.	Limited commercial and recreational fishing (all subject to fishing caps based on catch history).	No increase in level of effort or take; no change in gear type or species targeted.
CRE FMP Federal waters to 200 miles	No-take MPA: Federal waters 0-10 fm.	No fishing.	Insurance requirement.
	Low-use MPA: Federal waters 10-50 fm.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders.	CRE special permit needed to target <u>any</u> coral reef ecosystem resources, insurance requirement.
	Non-MPA: Federal waters 50 fm-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS Federal waters to 10 fathoms	Refuge: Federal waters 0-10 fm.	Activities consistent with Refuge mission-no commercial fishing.	USFWS special use permit required to enter.

Distinguishing characteristics:

<u>NWHI Reserve</u>

(1) The NWHI EO fishing RPA extends from 0-12 miles;
(2) All fishing is prohibited within 12 miles around S.E. Brooks Banks, and the 1st bank east of FFS.

* Under the NWHI EO, the fishing RPAs at these banks will be reviewed after five years.

S.E. BROOKS BANK, 1ST BANK EAST OF FFS, ST. ROGATIEN, 1ST BANK WEST OF ST. ROGATIEN, RAITA, PIONEER (details)			
Federal waters	**NWHI Reserve**	**CRE FMP**	**USFWS**
0-10 fathoms	Limited bottomfish and pelagic trolling by current permit holders; limited recreational trolling for pelagic (RPA).	No fishing, insurance requirement (No-take MPA).	No fishing (Refuge).
10 - 50 fathoms	Limited bottomfish and pelagic trolling by current permit holders; limited recreational trolling for pelagic (RPA).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target any coral reef ecosystem resources, insurance requirement (Low-use MPA).	No current restrictions beyond 10 fm.
50 fm-12 miles	Limited bottomfish and pelagic trolling by current permit holders; limited recreational trolling for pelagic (RPA).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
12 - 50 miles	Recreational fishing, commercial fishing by bottomfish permit holders, and all pelagic trollers (Reserve).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
50 - 200 miles	Outside of Reserve.	Lobster, bottomfish, precious corals, troll/handline and longline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.

Note: All fishing is prohibited within 12 miles around S.E. Brooks Banks, and the 1st bank east of FFS.

LAYSAN (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
NWHI Coral Reef Ecosystem Reserve (Federal waters to 50 miles around all islands)	No fishing portion of RPA: Federal waters 0-50 fm.	No fishing.	None.
	Bottomfishing/trolling portion of RPA: Federal waters 50-100 fm.	Limited commercial bottomfishing by permit holders and limited commercial and recreational pelagic trolling (all subject to fishing caps based on catch history).	No anchoring in areas where mooring is available; no discharging of any material except cooling water or engine exhaust.
	Other Reserve waters: Federal waters 100 fm-50 miles.	Limited commercial and recreational fishing (all subject to fishing caps based on catch history).	No increase in level of effort or take; no change in gear type or species targeted.
CRE FMP Federal waters to 200 miles	No-take MPA: Federal waters 0-50 fm.	No fishing.	Insurance requirement.
	Non-MPA Federal waters 50 fm-20 miles.	Bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders (no lobster fishing).	CRE special permit needed to target potentially harvested coral reef taxa.
	Non-MPA: Federal waters 50 fm-50 miles.	Lobster*, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
	Non-MPA: Federal waters 50-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS Federal waters to10 fathoms	Refuge: Federal waters 0-10 fm.	Activities consistent with Refuge mission- no commercial fishing.	USFWS special use permit required to enter.

Distinguishing characteristics:

CRE FMP

(1) no-take MPA from 0-50 fathoms.

(2) *Crustacean FMP prohibits lobster fishing from 0- 20 miles.

USFWS

(1) assert HINWR also includes State waters 0-10 fm.

LAYSAN (details)			
Federal waters	**NWHI Reserve**	**CRE FMP**	**USFWS**
0-10 fathoms	No fishing (RPA).	No fishing, insurance requirement (No-take MPA).	No fishing (Refuge).
10-50 fathoms	No fishing (RPA).	No fishing, insurance requirement (No-take MPA).	No current restrictions beyond 10 fm.
50-100 fathoms	Limited bottomfish and pelagic trolling by current permit holders; limited recreational trolling for pelagic (RPA).	Bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
100 fm-50 miles	Recreational fishing, commercial fishing by bottomfish permit holders, and all pelagic trollers (Reserve).	Lobster*, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
50 - 200 miles	Outside of Reserve.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.

*Crustacean FMP prohibits lobster fishing from 0- 20 miles at Laysan.

PEARL & HERMES REEF (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
NWHI Coral Reef Ecosystem Reserve (Federal waters to 50 miles)	Entire no fishing RPA: Federal waters 0-100 fm.	No fishing.	None.
	Other Reserve waters: Federal waters 100 fm-50 miles.	Limited commercial and recreational fishing (all subject to fishing caps based on catch history).	No increase in level of effort or take; no change in gear type or species targeted.
CRE FMP Federal waters to 200 miles	No-take MPA: Federal waters 0-10 fm.	No fishing.	Insurance requirement.
	Low-use MPA: Federal waters 10-50 fm.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders.	CRE special permit needed to target any coral reef ecosystem resources, insurance requirement.
	Non-MPA: Federal waters 50 fm-50 miles.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
	Non-MPA: Federal waters 50-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS Federal waters to 10 fathoms	Refuge: Federal waters 0-10 fm.	Activities consistent with Refuge mission-no commercial fishing.	USFWS special use permit required to enter.

Distinguishing characteristics:

NWHI Reserve

(1) No fishing RPAs extend from 0-100 fathoms.

PEARL & HERMES REEF (details)			
Federal waters	**NWHI Reserve**	**CRE FMP**	**USFWS**
0-10 fathoms	No fishing (RPA).	No fishing, insurance requirement (No-take MPA).	No fishing (Refuge).
10-50 fathoms	No fishing (RPA).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target any coral reef ecosystem resources, insurance requirement (Low-use MPA).	No current restrictions beyond 10 fathoms.
50-100 fathoms	No fishing (RPA).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa , insurance requirement (Non-MPA).	No current restrictions.
100 fm-50 miles	Recreational fishing, commercial fishing by bottomfish permit holders, and all pelagic trollers (Reserve).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
50 - 200 miles	Outside of Reserve.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.

MIDWAY (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
NWHI Coral Reef Ecosystem Reserve (0-50 miles around all islands)	Midway Atoll NWR: approximately 22 x 22 miles around islands (not part of Reserve).	No restrictions.	None.
	Other Reserve waters: Federal waters approximately 22-50 miles.	Limited commercial and recreational fishing (all subject to fishing caps based on catch history).	No increase in level of effort or take; no change in gear type or species targeted.
CRE FMP 0 - 200 miles	No-take MPA: 0-50 fm in northern half of Refuge waters.	No fishing.	Insurance requirement.
	Low-use MPA: 0-50 fm in southern half of Refuge waters.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders.	CRE special permit needed to target <u>any</u> coral reef ecosystem resources - will be issued for recreational fishing for on-island consumption only, insurance requirement.
	Non-MPA: 50 fm-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permits.	CRE special permit needed to target potentially harvested coral reef taxa, insurance requirement.
USFWS approximately 22 x 22 mile square around islands	Refuge: approximately 22 x 22 miles around Midway.	Pelagic and lobster recreational and charter fishing permitted within refuge boundaries.	One lobster per person/day, all other catch and release unless record setting, USFWS special use permit required to enter.

Distinguishing characteristics:

<u>USFWS</u>

(1) Refuge waters extend to 22 miles x 22 miles delineated by specific latitude/longitude coordinates;
(2) Midway Atoll NWR not included as part of the NWHI CRE Reserve;
(3) No State claims to territorial waters.

MIDWAY (details)			
Waters	**NWHI Reserve**	**CRE FMP**	**USFWS**
0-50 fathoms in northern half of Refuge waters	No restrictions.	No fishing, insurance requirement (No-take MPA).	Pelagic and lobster recreational and charter fishing (Refuge).
0-50 fathoms in southern half of Refuge waters	No restrictions.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target any coral reef ecosystem resources - will be issued for recreational fishing for on-island consumption only, insurance requirement (Low-use MPA).	Pelagic and lobster recreational and charter fishing (Refuge).
50 fm - 22 miles	No restrictions.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	Pelagic and lobster recreational and charter fishing (Refuge).
22-50 miles	Recreational fishing, commercial fishing by bottomfish permit holders, and all pelagic trollers (Reserve).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	Outside of Refuge.
22 - 200 miles	No restrictions.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	Outside of Refuge.

KURE (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
NWHI Coral Reef Ecosystem Reserve (Federal waters to 50 miles around all islands)	Entire no fishing RPA: Federal waters 0 - 100 fm.	No fishing.	None.
	Other Reserve waters: Federal waters 100 fm-50 miles.	Limited commercial and recreational fishing (all subject to fishing caps based on catch history).	No increase in level of effort or take; no change in gear type or species targeted.
CRE FMP Federal waters to 200 miles	No-take MPA: Federal waters 0-10 fm.	No fishing.	Insurance requirement.
	Low-use MPA: Federal waters 10-50 fm.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders.	CRE special permit needed to target any coral reef ecosystem resources, insurance requirement.
	Non-MPA: Federal waters 50 fm-50 miles.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
	Non-MPA: Federal waters 50-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS None	None.	No restrictions.	No restrictions.
State of Hawaii 0-3 miles	State Wildlife refuge: 0-3 miles from shore.	Fishing with a NWHI Taking Permit.	Hand harvest of lobsters permitted.

Distinguishing characteristics:

State of Hawaii

(1) Kure Atoll State Wildlife refuge, 0-3 miles.

KURE (details)			
Waters	**NWHI Reserve**	**CRE FMP**	**State of HI**
0-3 miles	Not part of Reserve.	No restrictions.	NWHI Taking Permit requirement.
0-10 fathoms (outside of state waters)	No fishing (RPA).	No fishing, insurance requirement (No-take MPA).	No current restrictions.
10-50 fathoms (outside of state waters)	No fishing (RPA).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target any coral reef ecosystem resources, insurance requirement (Low-use MPA).	No current restrictions.
50 - 100 fm (outside of state waters)	No fishing (RPA).	Lobster, bottomfish, precious corals, troll/handline and longline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
100 fm-50 miles (outside of state waters)	Recreational fishing, commercial fishing by bottomfish permit holders, and all pelagic trollers (Reserve).	Lobster, bottomfish, precious corals, troll/handline and longline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
50 - 200 miles	Outside of Reserve.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.

Howland, Baker, Jarvis and Kingman Reef (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
CRE FMP 0 - 200 miles	No-take MPA: 0-50 fm.	No fishing.	Insurance requirement.
	Non-MPA: 50 fm-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS 0 - 3 miles (0-12 miles at Kingman Reef)	Refuge: 0-3 miles 0-12 miles (Kingman).	Activities consistent with Refuge mission - no commercial fishing.	USFWS special use permit required to enter.

Howland, Baker, Jarvis and Kingman Reef (details)		
Waters	**CRE FMP**	**FWS**
0-50 fathoms	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target any coral reef ecosystem resources will be issued for recreational fishing for on-island consumption only, insurance requirement (Low-use MPA).	No fishing (Refuge).
50 fm - 3 miles	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No fishing (Refuge).
3-12 miles	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No fishing (Kingman Reef NWR only).
12 - 200 miles	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	Outside of Refuge.

PALMYRA (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
CRE FMP 0 - 200 miles	Low-use MPA: 0-50 fm.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target <u>any</u> coral reef ecosystem resources - will be issued for recreational fishing for on-island consumption only, insurance requirement.
	Non-MPA: 50 fm-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS 0 - 12 miles	Refuge: 0-12 miles.	Activities consistent with Refuge mission- no commercial fishing.	USFWS special use permit required to enter.

Distinguishing characteristics:

CRE FMP Low-use MPA 0-50 fathoms, harvest of CRE species w/special permit for recreational fishing for on island consumption only.

PALMYRA (details)		
Waters	**CRE FMP**	**FWS**
0-50 fathoms	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target <u>any</u> coral reef ecosystem resources will be issued for recreational fishing for on-island consumption only, insurance requirement (Low-use MPA).	No commercial fishing (Refuge).
50 fm - 12 miles	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No commercial fishing (Refuge).
12 - 200 miles	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	Outside of Refuge.

Johnston and Wake Atoll (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
CRE FMP 0 - 200 miles	Low-use MPA: 0-50 fm.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target any coral reef ecosystem resources - will be issued for recreational fishing for on-island consumption only, insurance requirement.
	Non-MPA: 50 fm-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS 0 - 3 miles	Refuge: 0-3 miles.	Recreational fishing, activities consistent with Refuge mission- no commercial fishing.	USFWS special use permit required to enter.

Distinguishing characteristics:

CRE FMP Low-use MPA 0-50 fathoms, harvest of CRE species w/special permit for recreational fishing for on island consumption only

Johnston and Wake Atoll (details)		
Waters	**CRE FMP**	**FWS**
0-50 fathoms	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target any coral reef ecosystem resources will be issued for recreational fishing for on-island consumption only, insurance requirement (Low-use MPA).	No commercial fishing at Johnston Atoll (Refuge).
50 fm - 3 miles	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No commercial fishing at Johnston Atoll (Refuge).
3 - 200 miles	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	Outside of Refuge.

AMERICAN SAMOA (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
Government of American Samoa (Territorial waters 0-3 miles)	None.	Local regulations.	None.
CRE FMP Federal waters to 200 miles	No-take MPA: Federal waters 0-50 fathoms around Rose Atoll.	No fishing.	Insurance requirement.
	Non-MPA: Federal waters 3-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS Cooperative Agreement with American Samoa (0-3 miles at Rose Atoll NWR)	Refuge: (1) The area inside of the extreme low-water line around the seaward side of the atoll reef; (2) The lands and waters from the Refuge boundary out to 3 miles.	No fishing.	USFWS special use permit required to enter.

Distinguishing characteristics:

The USFWS has a cooperative agreement with the Territory of American Samoa to manage Rose Atoll as a National Wildlife Refuge, and the submerged lands and waters out to 3 miles around the refuge. Magnuson-Stevenson Act jurisdiction begins at the shoreline at Rose Atoll. Under the CRE-FMP Rose Atoll is designated as a no-take MPA from 0-50 fathoms.

AMERICAN SAMOA (details)			
Waters	**GOV'T OF A. SAMOA**	**CRE FMP**	**USFWS**
0-3 miles (except at Rose Atoll)	Local regulations.	No restrictions.	-
3-200 miles	No restrictions.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	-
0-50 fathoms around Rose Atoll	No fishing.	No fishing, insurance requirement (no-take MPA).	No fishing (Refuge).
50 fm-3 miles around Rose Atoll	No fishing.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No fishing (Refuge).

COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
CRE FMP 0-200 miles	Non-MPA: 0-3 miles.	No restrictions.	None.
	Non-MPA: 3-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.

Distinguishing characteristics:

There are no "state" (territorial) waters around CNMI. However, the CRE FMP will not impose any management measures within 0-3 miles from shore.

COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS (details)	
Federal waters	**CRE FMP**
0-3 miles	No restrictions (Non-MPA).
3-200 miles	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).

GUAM (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
Government of Guam 0-3 miles	None.	Local regulations.	None.
CRE FMP Federal waters to 200 miles	Non-MPA: Federal waters 3-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
	Non-MPA: Guam's Southern Banks.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa , no anchoring by vessels greater than 50' in length.
USFWS Federal waters to 100 ft at Ritidian	Refuge: Federal waters 0-100 foot isobath.	Recreational fishing.	USFWS special permit required to enter.

Distinguishing characteristics:

There are no CRE MPAs around Guam, but there is an anchoring restriction for the Southern Banks for vessels larger than 50 ft in length.

GUAM (details)			
Federal Waters	**GOV'T OF GUAM**	**CRE FMP**	**USFWS**
0-3 miles	Local regulations.	No restrictions.	None.
0-10 fathoms (at Ritidian, outside of Guam waters)	No restrictions.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No commercial fishing (Refuge).
10 fathoms-200 miles (outside of Guam waters)	No restrictions.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	-

CHAPTER 10

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APPENDIX A

CATALOGUE OF FISHING GEAR AND IMPACTS TO ESSENTIAL FISH HABITAT

DEFINITIONS

Hook and Line Methods

Albacore trolling means fishing consisting of towing or dragging multiple lines with artificial lures with a vessel underway.

Buoy gear means fishing gear consisting of a float and one or more lines suspended therefrom. A hook or hooks are on the lines at or near the end. The float and line(s) drift freely and are retrieved periodically to remove catch and rebait hooks.

Casting means fishing from shore or a vessel using a pole and casting reel. Includes techniques such as whipping, jigging, dunking, slide baiting, fly-fishing or any technique using a pole and line.

Deep-sea handline means fishing from a vessel using a vertical mainline with single/multiple baited hooks and weight, lowered near the bottom.

Flagline (Longline) means fishing with a mainline one nautical mile or longer in length, suspended horizontally from the surface by floats from which branch lines with baited hooks are attached.

Floatline means fishing using a horizontal mainline, less than one nautical mile in length and suspended from the ocean surface with floats, from which leaders with baited hooks are suspended.

Handline means fishing gear that is set and pulled by hand and consists of one vertical line to which may be attached leader lines with hooks.

Hook and line means one or more hooks attached to one or more lines (can include a troll). Bandit gear means vertical hook and line gear with rods that are attached to the vessel when in use. Lines are retrieved by manual, electric, or hydraulic reels.

Ika-Shibi means fishing (mainly at night) using a vertical mainline with high-test monofilament leader, from which is suspended a baited hook. Muhe'e ("true squid") or opelu typically used as bait.

Inshore handline same as deep-sea handline to include artificial lures (damashi). With the exception of fishing tackle usually consisting of lighter gear than deep-sea handline.

Kaka line (set line) means fishing with a mainline less than one nautical mile in length from which branch lines of baited hooks are attached. Line is set horizontally, on or near the bottom, or in shallow mid water.

Longline means a line that is deployed horizontally and to which gangions and hooks or pots are attached. Longlines can be stationary, anchored, or buoyed lines that may be hauled manually, electrically, or hydraulically.

Palu Ahi (similar to "Ika-shibi") means fishing (usually daytime) with a baited hook and cut pieces of bait ("chum"). This method also includes the use of "danglers" for reporting purposes.

Pole and line (Aku boat) means fishing for aku (skipjack tuna) using live bait and artificial lures. Fish are hooked with pole and line, using a barb less hook (feathered, baited or not).

Rod and reel means a hand-held (including rod holder) fishing rod with a manually or electrically operated reel attached.

Tuna handline means a mixture of fishing methods used to catch pelagic species primarily on offshore sea-mounts and near NOAA weather buoys. It is generally a combination of hand-lining, trolling, and baiting techniques used simultaneously.

Trolling means fishing by towing or dragging line(s) with artificial lure(s) or dead or live bait using a sail, surf or motor-powered vessel.

a) Trolling with Bait: Trolling with bait (dead or alive).
b) Trolling with Lures: Trolling with artificial lures.
c) Trolling with Green Stick: Trolling with the bird, green stick and danglers.

Nets:

Nets fishing includes Gill net, Fence net, Lay net, Cross net, Seine net, Drag net, Bull, pen, Pen, Akule net, Bag net, Opelu net, Hukilau net, Kona crab net, loop net, Lobster net, Throw net, Cast net, Purse Seine, Surround net, Bait net, Shrimp trawl

Aquarium Collecting means fishing with small meshed nets, except throw-nets, and small meshed traps for aquatic life that is kept alive for display.

Bait net means a seine net with very small mesh used to catch certain kinds of fish for bait.

Barrier net means a small-mesh net used to capture coral reef or coastal pelagic fishes.

Bullpen trap means net(s) fixed in position to form a large stationary enclosure.

Bully net means a circular frame attached at right angles to a pole and supporting a conical bag of webbing.

Cast net means a circular net with weights attached to the perimeter.

Cast net (Talaya) means a circular net with weights or chain around the perimeter which is thrown for the purpose of taking or capturing marine animals.

Crab net means a small lift net that is used to catch crabs.

Dip net means a small mesh bag, sometimes attached to a handle, shaped and framed in various ways. It is operated by hand or partially by mechanical power to capture the fish.

Gillnet means a panel of netting, suspended vertically in the water by floats along the top and weights along the bottom, to entangle fish that attempt to pass through it.

Gill net (fence net, cross net, lay net, and pai pai net, etc.) means a curtain like net suspended in the water with mesh openings large enough to permit only the heads of the fish to pass through, ensnaring them around the gills when they attempt to escape.

Gill net (tekin) means any net in which the mechanism for capturing fish is entanglement.

Hoop net means a cone-shaped net having throats and flues stretched over a series of rings or hoops for support.

Kona crab net means a fine stranded netting stretched over a metal frame to form a flat net. Multiple baited nets are set on sandy bottoms trapping crabs when they get entangled in the mesh.

Lift net means a net that captures fish by raising the net from beneath a school of fish. Normally fish are encouraged over and into the net with chum.

Lampara net means a surround net with the sections of netting made and joined to create bagging. It is hauled with purse rings and is generally much smaller in size than a purse seine net.

Lobster net means a net with large eye mesh used to entangle lobsters.

Purse seine means a floated and weighted encircling net that is closed by means of a drawstring threaded through rings attached to the bottom of the net.

Purse seine net means a net that is used to surround a school of fish and is closed by drawing the bottom of the net together to form a bag.

Set net means a stationary, buoyed, and anchored gill net.

Seine net means a net with long narrow wings, that is rigged with floats and weights.

Seine net (hukilau, beach seine, dragnet, pen, surround, etc.) Fishing with a net by moving it through the water to surround fish by corralling and trapping them within the walls of the net.

Surround net (Chenchulum Managam) means any vertical net set to act as a barrier to detain fish in which the fish are not gilled by the net. A surround net is not pursed and therefore is not a type of purse seine.

Throw net means a round shaped weighted outer perimeter net that is thrown over fish.

Trammel net means a net consisting of two or more panels of netting, suspended vertically in the water column by a common float line and a common weight line. One panel of netting has a larger mesh size than the other(s) in order to entrap fish in a pocket.

Trawl means a cone or funnel-shaped net that is towed through the water, and can include a pair trawl that is towed simultaneously by two boats.

Trawl (shrimp trawl) means a net that is dragged through the water by the vessel.

Traps:

Trap fishing means fishing with any of the various fishing devices made into the shape of a box, or enclosure, with one or more openings that allow marine life to enter but keep them from leaving.

Fish trap means a trap primarily used to target fish.

Lobster trap means a trap primarily used to target lobsters.

Crab trap means a trap primarily used to target crabs.

Pot means trap.

Shrimp trap means a trap primarily used to target shrimp.

Trap means a portable, enclosed device with one or more gates or entrances and one or more lines attached to surface floats. Also called a pot.

Other Methods:

Black coral dive means divers harvesting black coral using SCUBA or re-breathers.

Diving Fishing while swimming free dive (skin diving) or swimming with the assistance of compressed gases (SCUBA, re-breathers, etc.). Examples are lobster or namako diving. Does not include diving with a spear (see spearfishing), a net (see various nets), or for limu or opihi (see handpicking).

Fish Aggregation Device (FAD) means any device deployed in the water or water column that is intended to attract and increase the potential yield of fish species. FADs can be anchored or free floating and include devices such as: rafts, buoys, plastic bottles, steel canisters, marine debris and artificial reefs. The use of FADs have generally been associated with pelagic fisheries however, the use of this method is now being expanded to target coral reef species occurring at Penguin Banks in the Main Hawaiian Islands.

Fishpond means an enclosed or semi-enclosed coastal body of water used for fish culture. Fishponds are typically stocked with pua (juvenile striped mullet) or enter through a makaha (gate).

Hand harvest means harvesting by hand.

Handpicked means hand harvesting marine life by various methods.

Powerhead means any device with an explosive charge, usually attached to a spear gun, spear, pole, or stick, that may or may not fire a projectile upon contact.

Tangle net dredge means dredge gear consisting of weights and flimsy netting that hangs loosely in order to immediately entangle fish.

Slurp gun means a tube-shaped suction device that operates somewhat like a syringe by sucking up the fish.

Snare means a device consisting of a pole to which is attached a line forming at its end a loop with a running knot that tightens around the fish when the line is pulled.

Spear means a sharp, pointed, or barbed instrument on a shaft. Spears can be operated manually or shot from a gun or sling.

Spearfishing means fishing with a shaft with one or more sharpened points at one end usually associated with diving. Includes bow and torch fishing and bluewater spearfishing. Spearfishing in federal waters primarily occur at Penguin Bank in the Main Hawaiian Islands.

Submersible means a manned or unmanned device that functions or operates primarily underwater and is used to harvest fish, i.e., precious corals, with mechanical arms.

Submersible (for precious coral) means a vessel (manned or unmanned) capable of diving and/or remaining underwater for selectively harvesting deepwater precious corals.

Pelagic Methods
Aku boat, Pole and line, Ahi boat, Flagline, Longline, Ikashibi (tuna handline), Paluahi (tuna handline), Trolling

Benthic Methods
Deepsea handline, Bottom handline, Inshore handline, Kaka line, Set line

Diving Methods
Spearing, Lobster dive, Coral dive

IMPACT DEFINITIONS

Impacts:

Criteria for Ranking

Low:
Gear and/or method as used has no significant impact on habitat.
Medium:
Gear and/or method as used may have the potential for minor impacts on habitat, however, impacts do not adversely impact EFH.

High
Gear and/or method as used may result in impacts to habitat that do result in a reduction in quantity or quality of EFH. To the extent practicable, these impacts must be minimized through management measures.

Bycatch

Bycatch is a direct measurement of a gear selectivity.

Criteria for Ranking

Low:
Gear and/or method as used is able to target specific individual species or species complexes. Fishermen are able to target species with a high degree of certainty. Non-target species generally are able to avoid the gear or capture. If gear interaction occurs, the non-target species are generally able to escape capture. Generally most of the catch are retained. The overall mortality of incidentally caught species is low.

Medium:
Gear and/or method as used is able to target specific species assemblages. Gear includes specific features that allow for incidentally caught species to escape. Gear features and method of use are capable of specific modifications that enable fishermen to target specific species and size classes. Additionally, gear design may be modified to exclude undesirable species. Further, the gear is capable of being deployed to target specific species. Generally a majority of the catch are retained. The overall mortality of incidentally caught species is generally low to moderate.

High:
Gear and/or method as used is has limited ability to target specific species assemblages. Gear usually does not include specific mechanism(s) that allow for incidentally caught species to escape. Gear design features and method of use are capable of only limited modifications that enable the fishermen to target specific species and size classes. The use of gear may result in significant amounts of incidentally caught species being discarded. Mortality of incidentally caught species is typically moderate to high.

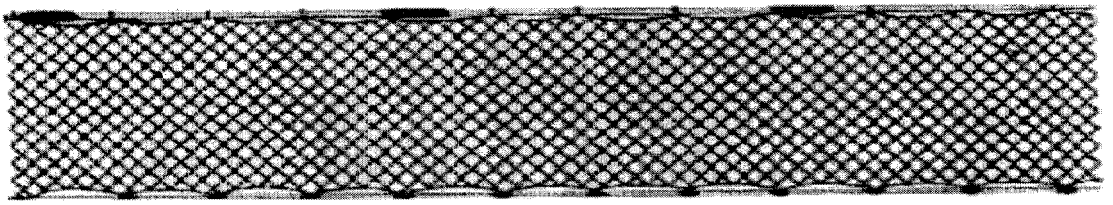
Gear		Impacts to Habitat			Bycatch		
		Low	Medium	High	Low	Medium	High
HOOK and LINE							
Trolling	Trolling w/bait: (Dead or Alive)	✓			✓		
	Trolling w/Lures: (artificial lures)	✓			✓		
	Trolling w/Green stick)	✓			✓		
Handline							
Bottomfish gear							
Deep-sea handline		✓			✓		
Inshore handline		✓				✓	
Kaka line			✓			✓	
Pelagic gear							
Ika-Shibi		✓			✓		
Palu Ahi		✓			✓		
Longline		✓				✓	
Pole and Line		✓				✓	
Rod and Reel		✓				✓	
NET							
Gill Net							
moe moe net				✓		✓	

Gear		Impacts to Habitat			Bycatch		
		Low	Medium	High	Low	Medium	High
Surround Net (Fence net, surround net, pai pai net, laynet etc., attended)							
Akule Surround Net			✓			✓	
Opelu Net			✓			✓	
Purse seine		✓				✓	
Seine Net (Hukilau net)				✓			✓
Hoop net		✓			✓		
Kona crab net		✓			✓		
Trawl				✓			✓
Bait net		✓			✓		
Barrier net			✓			✓	
Cast net			✓		✓		
Crab net		✓			✓		
Dip net		✓				✓	
Lobster net			✓		✓		
TRAP							
Fish Trap (deepwater)			✓			✓	
Fish Trap (handset)		✓				✓	
Lobster Trap		✓			✓		
Crab Trap		✓			✓		
Shrimp Trap			✓			✓	

Gear		Impacts to Habitat			Bycatch		
		Low	Medium	High	Low	Medium	High
OTHER							
Diving		✓			✓		
Hand harvest		✓			✓		
handpicked		✓			✓		
Slurp gun		✓			✓		
Snare		✓			✓		
Spear fishing		✓			✓		
Submersible		✓			✓		
Tangle nets				✓		✓	

Gear Type: **Akule Surround Net**

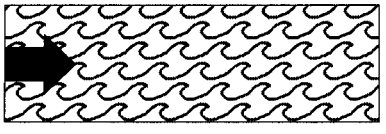
Diagram of typical gear:



Deployment/retrieval:
Akule is known as atule in American Samoa, atulai in Guam and akule in Hawaii, Bigeye scad *Selar crumenophthalmus*) and is abundant in the Pacific Islands. Akule surround nets are constructed of nylon and range in length from 1250-5000 feet and are 40 feet high. The typical mesh size used in net construction is 1 ½ inches. The net is a single panel with a floats on the top and a leadline on the bottom.

Some fishermen use airplanes flying at low altitudes (1,000-1,500 ft) to spot schools of fish and direct the vessel where to set the net. Once a school is located in calm waters with soft bottom, a skiff is used to surround the fish with the net. The skiff is powered by oars, as a motor would scare the fish. After the school is surrounded, several scuba divers are sent down to bring the lead lines together and secure the nets lead lines together. The divers then scare the fish to one side of the net and divide the net in half. The process is repeated until the net is about one fourth of its original size. It is then taken to the vessel and the fish are brailed aboard. In order to successfully entrap the school, nets must be suspended through the entire water column from surface to bottom. The depth fished is approximately 20 ft, not deeper than 40 ft.

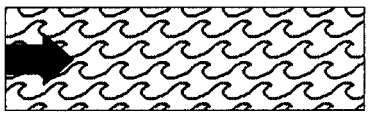
Habitat Impacts:



Surround nets for akule have low impact on coral reef habitat. Akule are found in shallow, nearshore waters of bays and harbors. Fishing usually occurs seaward of the reef in fairly shallow sandy areas. Akule fishermen actively avoid substrates with high or varied benthic relief because of the difficulty such areas present to successfully encircle and capture the targeted school of fish. In areas of high relief or numerous coral outcrops, the net would become entangled, damaging both the net itself and allowing the

school of akule to escape. Use of scuba divers to retrieve the net further minimizes potential impacts to benthic habitat, including coral reefs.

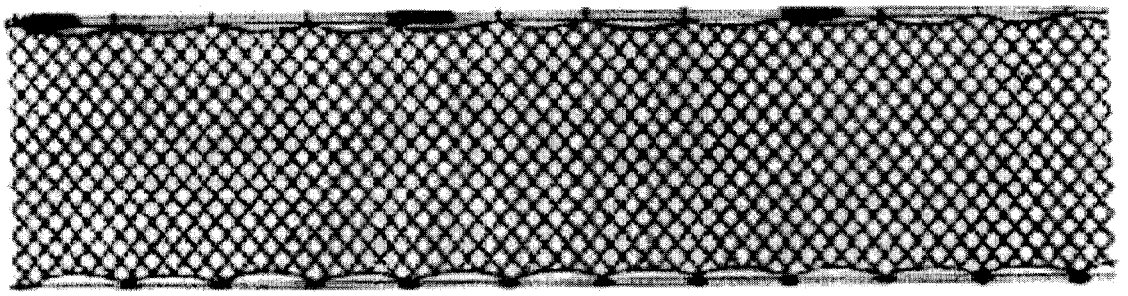
Bycatch:



Deployment and retrieval of akule nets make this gear relatively selective. Substantial effort is made prior to deployment of the net to identify a school of akule in a suitable area, sandy flat sub-straights. During net retrieval, efforts are made by scuba divers to cull out any unwanted species that may have been inadvertently encircled during net deployment. Species culled include sharks and large jacks.

Gear Type: "Moe moe" Net

Diagram of typical gear:



Deployment/retrieval:
"Moe moe" method uses gill nets that are deployed, left unattended for a period of time, then retrieved. Nets are typically made of 12 to 20 pound monofilament. Length can range from 75 to 150 feet and average height is 7 feet. Mesh or eye size is typically 2.75 inches, but can vary depending on species targeted. Most local fishery management agencies have minium mesh size limits for this type of net. The net is a single panel with floats on the top and a leadline on the bottom. Nets can be set on the bottom, in mid-water or on the surface. Most fishers using this type of net set on the bottom.

It is common for several segments (10-12) of moe moe net to be tied together when deployed. Most fishers target depths ranging from the shoreline to 30+ feet. To avoid gear loss and damage, fishers avoid high surge and surf areas. Nets are targeted for sandy areas adjacent to the reef or set along the reef. Gear is usually deployed from a floating platform, eg. large inner tube, dingy, or small boat. A heavy object (ie. lead, rebar, or concrete) is attached to the lead line as an anchor and a large float attached to the float line to mark one end of the net. The rest of the net is then layed out until the other end is reached to which another anchor and float is attached. The Hawaiian term "moe moe" is to sleep. This term is used for this gear because of the timing of deployment and retrieval. Nets are commonly set in the late afternoon or early evening and retrieved in the morning. Fishers check the net every 2-3 hours. Nets are also set during the day for 2-4 hour periods or set in the late afternoon and retrieved before mid-night. When retrieving the gear, it is common for a diver to swim along and untangle the leadline as the net is being pulled and loaded into an inner tube of boat. This helps minimize damage to the net.

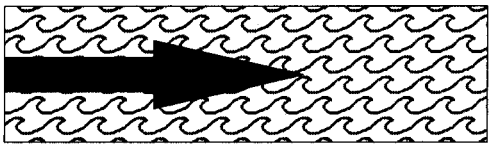
The practice of using moe moe nets in deeper waters, from 150 to 200 feet, has recently become more common. Longer strings of net (up to 3000 feet) are deployed from vessels in these targeted depths. Like the shallow water moe moe net, it is left for a period of time and later retrieved using hydraulics.

Habitat Impacts:

Low Med High

Recent use of large amounts of gill nets set between 10-100 m in depth to catch reef fish in state waters in the Main Hawaiian Islands may adversely impact EFH. The nets are have the potential to be highly unselective and take indiscriminate cross-sections of the fish community. They also have a potential to damage substantial areas of coral if it is carelessly retrieved, or retrieved by power block. Under the CRE-FMP, the use of gillnets are prohibited in federal waters. Potential impacts to habitat include entanglement and breakage of corals.

Bycatch:



Low Med High

Gill nets as used in the moe moe method catch wide range of reef species. Selectivity of fish size can be controlled by varying the mesh. However, in most cases, all species caught in the net are utilized.

Measures to mitigate potential adverse impacts to EFH

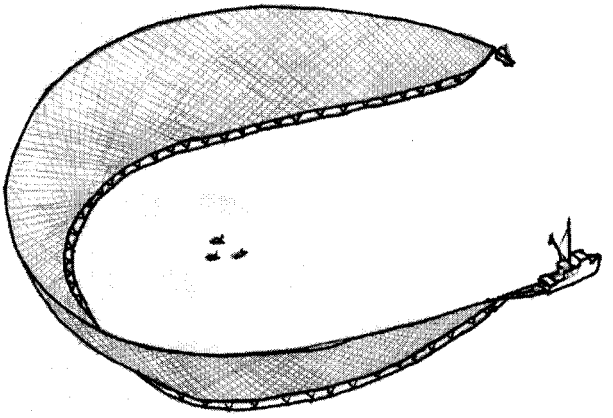
Gear prohibitions:

Currently, gillnet fishing is allowed by some local governments in the Western Pacific Region. Although this type of fishing is seldom used in federal waters, there is a potential for this type of fishing to expand into shallow federal waters adjacent to state waters. Under the CRE FMP, fishing gillnets will be prohibited.

Fishing Gear Catalogue NET

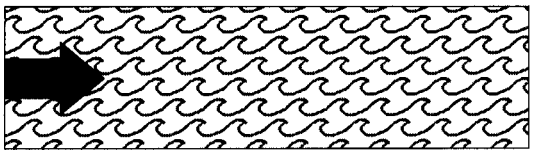
Gear Type: Purse Seine

Diagram of typical gear:



Deployment/retrieval:
The purse seine technique consists of setting, pursing, hauling net, "sacking up" and brailing. After spotting a suitable school, the net is set at high speed with the help of a powerful skiff to encircle the entire school. A winch then hauls the ends of the net together and closes, or "purses", the bottom of the net to trap the fish school by hauling in the purse cable. When pursing is complete, one end of the net is fed through the hydraulic power block which hauls in the net. The net is stacked on the deck by the crew to prepare for the next set. When most of the net is on board, the net is sacked up, which concentrates the fish next to the hull. The catch is then brailed from the net to refrigerated fish holds using a brailer net that can hold about two tons of fish per scoop. Most modern tuna purse seiners usually do not return to port until their fish holds are completely filled, which may take 3-8 week or more. Western Pacific seiners set their nets on free tuna schools sighted on the surface of the ocean during daylight hours, or before dawn on schools found associated with drifting logs or man-made rafts. Pre-dawn log sets are usually successful as the tuna are very close to the log, and setting and pursing can be completed before the fish can avoid the net. Daytime sets are often less successful, but are beginning to account for larger catches due to experience and improvements in fishing technology.

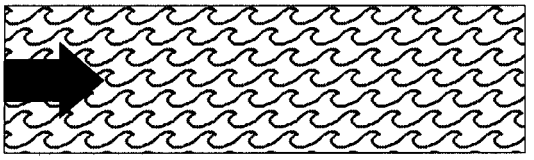
Habitat Impacts:



Low Med High

Purse seine is a surface pelagic gear that poses minimal impacts, if any, to habitat.

Bycatch:



Low Med High

Because tunas are usually not associated with porpoises in the Western Pacific Region, seiners operating there do not have an associated porpoise bycatch. Some purse seine sets do have a large catch of non-target species, and these bycatch levels are higher when setting on schools that are associated with drifting logs and rafts due to the attraction of many fish species to drifting debris in the open ocean. Typical purse seine bycatch includes rainbow runner, dolphinfish, wahoo, marlin, pelagic sharks, mackerel scad, oceanic trigger-fish and rudderfish. The reported bycatch from the US purse seine fleet in the western Pacific has consistently been less than 1% of the total catch.

Gear Type: **Tangle net dredge**

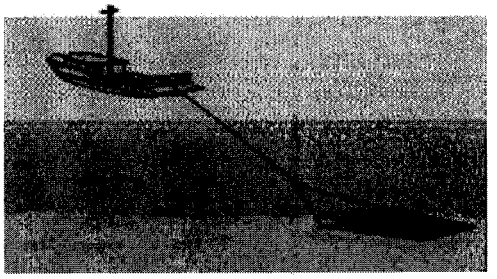


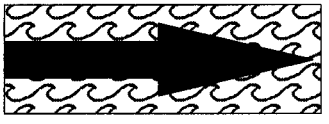
Diagram of typical gear:

Historically, the primary method used to harvest precious corals has been the use of dredges, or tangle nets. There are only two known instances of domestic fishermen using tangle nets to attempt to harvest deepwater precious corals. During the late 1960s a small group of fishermen dredged for pink coral off of Oahu in the Makapuu Bed on a small scale using tangle nets. In 1988 a domestic fishing vessel attempted to harvest deepwater precious coral on the Hancock seamounts. The amount of coral harvested was extremely limited and of poor quality.

The basic gear design of these dredges consists of weighted tangles (a dredge) with attached netting. The weights serve to keep the dredge on the bottom as well as to dislodge the coral, and the attached nets entangle the coral.

Foreign dredge haulers used in the precious coral fishery range in size form 40 to 100 ft. Dredges are deployed with the aid of hydraulic line haulers located amidship. The dredges are raised and lowered over the side of the vessel. Once the dredges are deployed the vessel is allowed to drift positioned at right angles to the current. Japanese vessels normally deploy from 4 to 8 simultaneously. Larger vessels may use as many as sixteen dredges simultaneously. Fishing operations are typically conducted around the clock with crews rotating. The same grounds are often redredged.

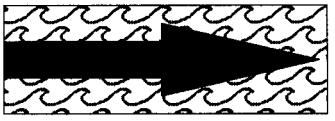
Habitat Impacts:



Low Med High

Tangle nets may be ecologically destructive, as other species and habitat may be disturbed, and it may be wasteful, as some coral dislodged from the bottom may not be recovered.

Bycatch:



This method of harvesting precious corals is non-selective; the dredge simply knocks down all corals in its path. This gear cannot discriminate between types, size, quality or characteristics of living or dead corals. Based on simulated harvests studies conducted in shallow water, it is estimated that dredges only recover 40% of the total amount of corals initially knocked down. Because an area is often redredged several times the overall recovery rate of dislodged coral is probably significantly greater.

Existing measure to mitigate potential adverse impacts to EFH

***Gear restrictions*:**
In the main Hawaiian Islands, the use of non-selective gear is prohibited to harvest precious corals.

***Closed Areas*:**
The harvest of precious coral from the WestPac Refugia Bed, located in the NWHI, is prohibited.

Harvest Limitation Program
Quotas have been established for pink, gold, and bamboo corals for Makapuu Bed and the conditional beds in the NWHI.

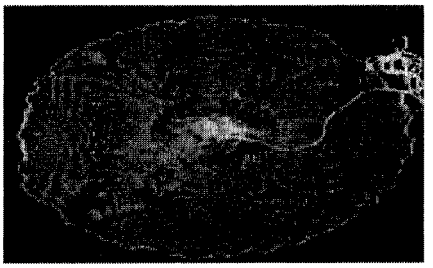
Proposed measures to mitigate potential adverse impacts to EFH

Under a framework adjustment to the Fishery Management Plan for the Precious Coral Fisheries the Western Pacific Region Amendment approved by the Council and currently under review by the NMFS, only selective gear will be allowed to harvest precious corals from all permit areas.

Fishing Gear Catalogue NET

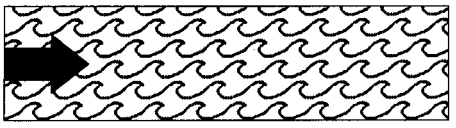
Gear Type: **Throw net**

Diagram of typical gear:



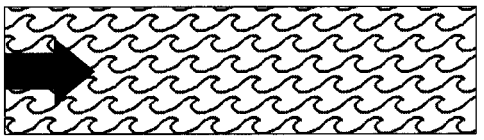
Deployment/retrieval:
Throw nets are circular with a radius that can vary from 8-12 feet. Net are weighted around the edge and are generally made of monofilament but can also be constructed of cotton, nylon, or other material. For example, in Guam traditional throw nets called "talaya" were made of pineapple leaf fibers. Throw nets can include a pocket on the outer edge of the net to trap fish. Pockets are made by layering a larger mesh net on the inside of the nets outer edge. The net is deployed by a skillful fisher who tosses the net over and around a school of fish. The fisher then enters the water to gather the open bottom of the net to trap the fish. Throwing the net so that it fully opens as it enters the ocean surface requires skill and practice. A more difficult aspect of throw net fishing is to develop the skill to approach a school of fish without notice and within a distance from which the net can be successfully deployed. Nets are generally thrown in or near the surf zone.

Habitat Impacts:



Throw nets have a low to moderate impact on coral reef habitat. Nets can be deployed on hard, sandy or a combination of substrates that are immediately adjacent to the shoreline. Fishers generally attempt to target flat areas with minimal rock or coral outcrops to limit the changes of fish to escape. Fishers retrieve nets by hand which serves to minimizes impacts to benthic habitat, including coral reefs.

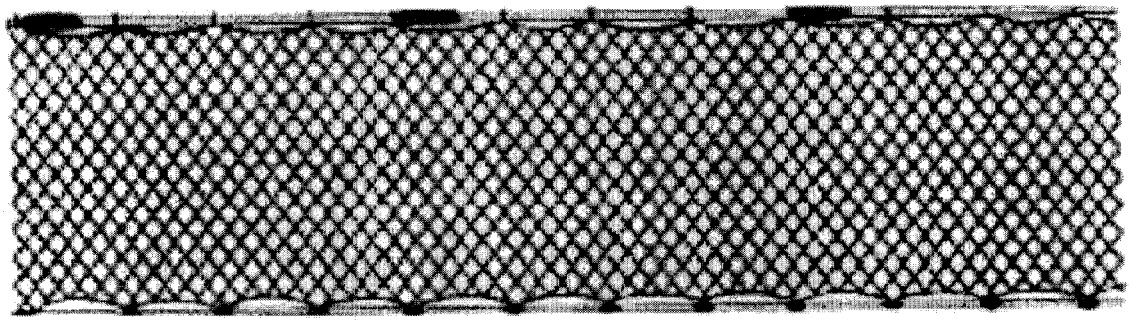
Bycatch:



Throw nets are generally selective due to specific targeting of species by fishers, eg. moi, kala, moana, manini, aholehole and mullet that swim in schools close to shore. However, because fishing is taking place in the surf zone, it is difficult to see all fish that are in the area where the net is to be deployed. Most species that are caught in throw net fishing are retained. Fish that are undersized or undesired are generally returned alive.

Gear Type: **Weke/Taape Surround Net**

Diagram of typical gear:



Deployment/retrieval:
Goat fish and snapper surround nets are constructed of nylon and range in length from 75-100 feet and are 18 feet high. The typical mesh size used in net construction is 2 inches. The net is a single panel with a floats on the top and a leadline on the bottom. A bag net is constructed of nylon with 1.5 inch eyes and is used exclusively to transport fish from the surround net to the surface.

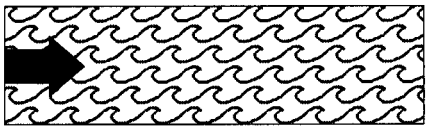
Once a school is located in calm waters with soft bottom, the fish is surrounded with sections of net deployed under water by SCUBA divers or on the surface by skiff. After the school is surrounded, several scuba divers bring the lead lines together and tie the nets together to encircle the school. The net is slowly collapsed by concentrating the fish and removing sections of net until the bag net can be attached and fish corralled into the bag net. Once fish enter the bag net, it is tied off and taken to the vessel where the fish are brailed aboard. Unlike the akule net, this net does not have to be suspended through the entire water column from surface to bottom.

Habitat Impacts:

Surround nets for weke and taape have minimal impact on coral reef habitat. Fishing usually occurs seaward of the reef in shallow sandy areas. Fishermen actively avoid substrates with high or varied benthic relief because of the difficulty such areas present to successfully encircling and capturing the targeted school of fish. In areas of high relief or numerous coral outcrops, the net would become entangled, damaging both the

net itself and allowing the school of fish to escape. Use of scuba divers to set and retrieve the net further minimizes potential impacts to benthic habitat, including coral reefs.

Bycatch:



Low Med High

Surround nets are relatively selective as deployed and retrieved for weke and taape. Substantial effort is made prior to deployment of the net to identify a school in a suitable area, sandy flat substrate. During net retrieval, efforts are made by scuba divers to cull out any unwanted species that may have been inadvertently encircled during net deployment. Species culled include sharks and large jacks.

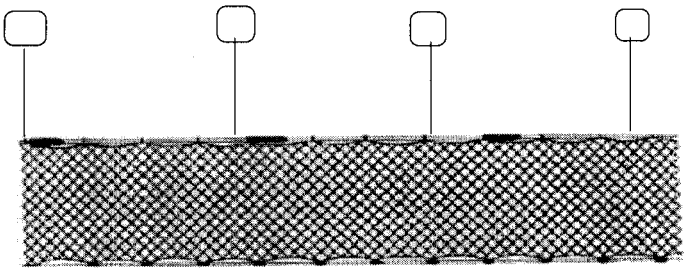
Measures to mitigate potential impacts to EFH

Under the CRE FMP, anyone wishing to fish with weke surround net may be required to apply for a permit with the appropriate local government agency. Anyone wishing to collect an species listed in the CRE-FMP as Potentially Harvested MUS, or anyone wishing to fish in a low-use MPA in the EEZ, must contact either the PIAO directly or will be directed to contact the PIAO by their regional marine fisheries office. If it is determined that the person(s) must complete a special permit application. The applicant must also describe the gear and target species in the special permit section application. A ruling on this gear type will be determined by the NMFS PIAO Administrator after consultation with the Council and the director of the affected state fishery management agency.

Fishing Gear Catalogue NET

Gear Type: **Barrier Net**

Diagram of typical gear:



Deployment/retrieval:
The vast majority of aquarium fishes collected in the Pacific region are captured through the use of barrier nets and hand nets. Pyle (1993) provides a detailed description of barrier nets and their use. The following draws heavily upon this description.

The general design of a barrier net is a rectangular section of monofilament netting, weighted along the bottom with lead or chain, and buoyed along the top with small floats. Although barrier nets vary in size from less than one meter in length to as long as 20 meters, they generally fall into one of two categories: small and large.

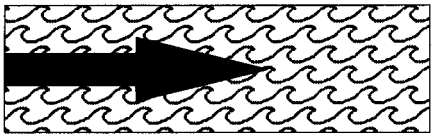
Small barrier nets are typically less than 5 m in length and less than 0.5 m in height. Small barrier nets are deployed by a single diver. The lead line is comprised of a chain or lead weights closely spaced. This allows the net to conformed to the contours of the bottom where it is set. Small barrier nets are set either in a v-shaped configuration or stretched out. The diver uses hand nets to drive the fish into the net.

Large nets are characterized by typically being longer than 10 m in length and one meter in height. Large barrier nets usually are deployed by two or more divers. Large nets are used to target schooling fish such as the surgeonfish, tangs and wrasses.

The net is set in a v-shaped configuration. The divers then carefully drive fish into the net using hand nets. Once the fish are concentrated in the apex of the net, the divers bring the net together, completing the enclosure of the fish within the net.

Nets are deployed contingent upon the targeted species particular habitat preferences.

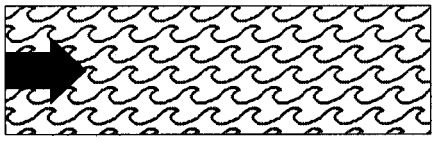
Habitat Impacts:



Low Med High

Barrier nets for aquarium fish have a low to moderate impact on coral reef habitat. Nets are typically deployed on or immediately adjacent to coral reef habitat. The use of scuba divers to deploy and retrieve the net serves to minimizes impacts to benthic habitat, including coral reefs.

Bycatch



Low Med High

Aquarium fish collectors are highly selective when collecting coral reef and other marine organisms. Usually, a collector will target a specific species in locations where they are most abundant and attempt to capture only those which are of value. Other fish may be captured with the target species however, they are usually released back since they have no commercial value.

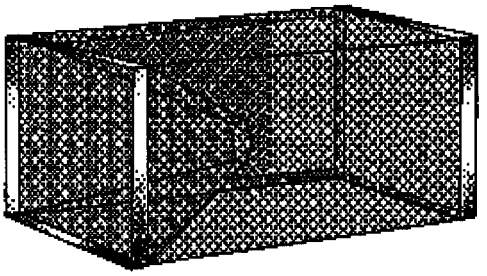
Measures to mitigate potential impacts to EFH

Although aquarium fish collection with barrier net will be allowed under the CRE-FMP, anyone wishing to collect aquarium fish species may be required to apply for a permit with the appropriate local government agency. Anyone wishing to collect an aquarium fish listed as a Potentially Harvested MUS, or anyone wishing to fish in a low-use MPA in the EEZ, must contact either the PIAO directly or will be directed to contact the PIAO by their regional marine fisheries office. If it is determined that the person(s) must complete a special permit application, a ruling will be determined by the NMFS PIAO Administrator after consultation with the Council and the director of the affected state fishery management agency.

Fishing Gear Catalog TRAP

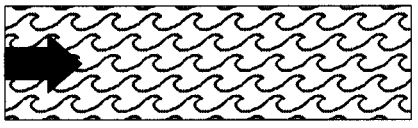
Gear Type: **Crab Trap**

Diagram of typical gear:



Deployment/retrieval:
Traps are deployed individually or on a string set up to 200 feet apart. Floaters are used to mark individual trap locations or the ends of trap strings. Primary species targeted is white crab which live in sandy areas. Depth range for deployment range from 40 to 300 feet. Crab traps are constructed with similar material as used for fish traps but often have heavier frames. A variety of trap designs are used by fishermen. Traps are generally smaller than fish traps and can have multiple compartments. The trap entrance is modeled after a ramp allowing crabs to crawl up the ramp and fall into the trap while prohibiting escape. Soak time can vary between 1 to 3 days and depends on location, season, density of fish and other personal variables. The average soak time is one week. Retrieval is done by hand or with hydraulics. Bait (ahi head, mackerel) is always used in traps for white crabs.

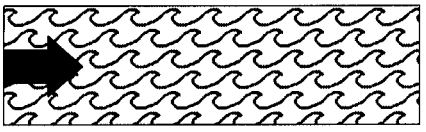
Habitat Impacts:



Portable traps for white crabs pose minimal potential habitat damage due to selective placement in areas with extensive sandy habitat. Coral and other hard substrate are highly avoided.

Because of the low number of traps used and floater lines, fishermen rarely lose traps. Trap door hinges are secured with low quality wire that decompose quickly in the marine environment. This wire will completely corrode within as short of period of time as a month, leaving the trap door open. The galvanized chicken wire used to construct traps also rapidly corrodes in the marine environment. Some fishermen attach zinc to extend the life of traps.

Bycatch:



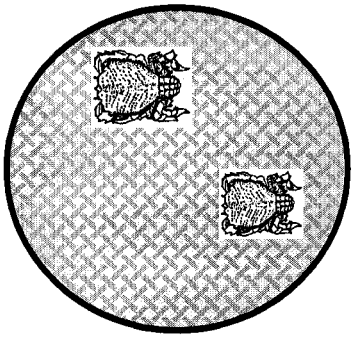
Low Med High

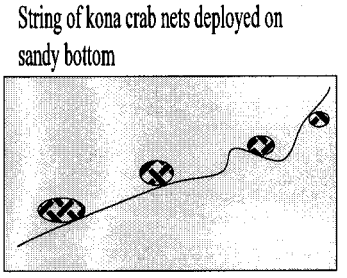
Ghost fishing due to lost traps is rare. Crab traps are species selective based on targeted habitat. Traps are placed on sandy substrate.

Fishing Gear Catalogue NET

Gear Type: **Kona Crab Net**

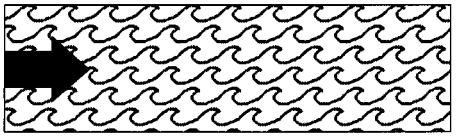
Diagram of typical gear:





Deployment/retrieval:
Nets are deployed on a string with 25 traps per string. Three strings are often used simultaneously. Floaters are attached to mark and retrieve individual strings. Each net consists of a heavy gauge metal hoop or rectangle with monofilament netting stretched tightly across to entangle the crab's legs as they approach bait which is placed in the center. The primary species targeted is kona crab which live exclusively in sandy areas. Depth range for deployment range from 40 to 300 feet. Soak time for each string is short varying from 30 minutes to 1 hour. Strings are retrieved by hand. Kona crab typically do not enter the net during the night therefore fishing is exclusively conducted during the day.

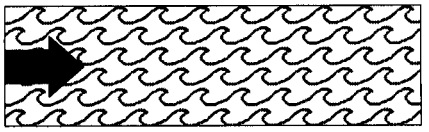
Habitat Impacts:



Low Med High

Kona crab nets have minimal habitat impacts due to selective placement in areas with exclusive sand substrate. Coral and other hard substrate are actively avoided. Ghost fishing due to lost strings or traps are rare. Fishermen rarely lose traps due to the low number used. Lost nets can continue to tangle crabs while bait is still present.

Bycatch:



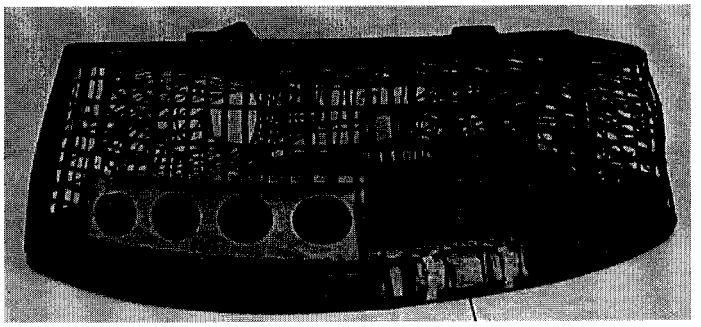
Low Med High

Kona crab nets are highly selective and rarely take other species.

Fishing Gear Catalogue TRAP

Gear Type: **Lobster Trap**

Diagram of typical gear:

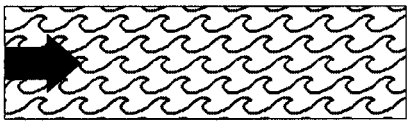


Deployment/retrieval:
The commercial lobster fishery in the NWHI is a trap fishery. The principal species targeted by this fishery is the spiny lobster (*Panulirus marginatus*) and the common slipper lobster (*Scyllarides squammosus*).

All vessels participating in the NWHI lobster fishery use traps manufactured by Fathoms Plus. The trap is dome-shaped and molded from black polyethylene. The trap dimensions are approximately 2.5' x 3.2' x 1'. To ensure traps deploy upright on the bottom, lead weights are secured inside the trap. Each trap has two entrance cones located on opposite sides of the traps. The traps also have two escape vents that allow for the escape of undersized lobsters and other incidental catch such as octopus.

Traps are set in strings of several hundred at depths between 10 to 35 fathoms. The traps are baited with chopped mackerel. Vessels typically set about 800 hundred traps per day.

Habitat Impacts:



Low Med High

Recently, the NMFS NWHI Observer logs and follow-up interviews with observers indicate that both pieces of live coral and entire coral heads are caught in some lobster traps and ground line and landed onboard the lobster vessel. One observer noted that "small broken pieces of coral were frequently (as many as one piece per five traps) wedged in the holes of the traps. Numerous softball-sized and a few basketball-sized whole coral heads came up stuck to the mainline." Typically the coral landed on a fishing vessel is thrown overboard, although there have been reports of pieces kept in live tanks.

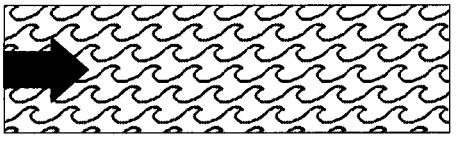
In 1998 the Council, based on the NMFS recommendation, instituted a bank specific quota for the NWHI lobster fishery. This new management regime established quotas for the primary lobster fishing grounds, Maro, Necker and Gardner and one for all other banks. The effect of this action was that lobster vessels were forced to begin exploratory fishing at banks traditionally not fished. Anecdotal reports indicate that the increased observation of coral caught in traps may be due to this exploratory fishing on unfamiliar grounds. Further, members of the Council's Crustacean Plan Team and Advisory Panel report that the problem may have been exacerbated by the inexperience of one vessel's captain.

Typically traps are set in areas of relatively low structural relief, away from coral reef habitat. If traps are set too close to coral reef and other high relief habitats, lobsters cannot be enticed to enter the traps.

The impact of lobster trapping on coral reef habitat is difficult to estimate. Only a portion of the damaged coral reaches the vessel to be seen by observers. Further, the fate of the damaged coral is unknown. Some of the damaged coral may continue growing while others may be covered in sand or swept off the banks. The damage may vary from bank to bank. Trapping at atolls where lobster habitat is limited and coral reef density high may result in more coral damage than islands with large flat algal or sand bank areas.

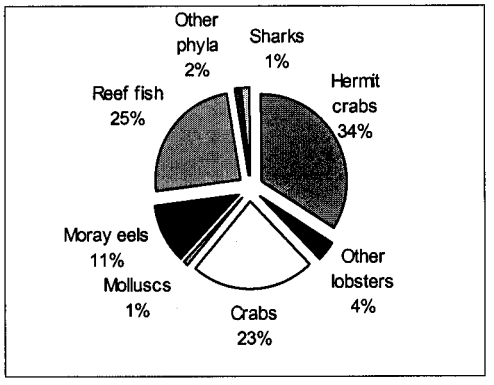
Research is needed to determine the impact of lobster trapping on coral reef habitat. This research may include both expanded observer documentation of coral brought up during trapping and research surveys of coral beds located in areas with and without trapping.

Bycatch:



Low Med High

Current gear restrictions mandate that lobster traps have two entrance cones located on opposite sides of the traps. The traps must also have two escape vents, comprised of four circular holes at least 2 ½ inches in diameter, that allow for the escape of undersized lobsters and other incidental catch such as octopus. This gear restriction has resulted in significant reduction in the incidental take of non-target species.



Because lobster fisheries in Guam, American Samoa, and NMI depend on spearing lobsters or collection by hand, both of which are highly selective methods, the amount of bycatch is likely to negligible.

Polovina (1993) reports that an estimated 2000 traps are lost annually in the NWHI. Parrish and Kazama (1992) found that while lobsters may enter these traps they were also able to exit, and there was no observed mortality associated as with ghost fishing. These researchers concluded that lobsters utilized the traps as shelter.

Existing measure to mitigate potential adverse impacts to EFH

Gear restrictions:
Lobsters may only taken by lobster traps or by hand. The use of nets, chemicals, explosives, hook or spears is prohibited.

Closed Areas:
1) All lobster fishing is prohibited within 20 nm of Laysan Island.
2) Within the EEZ shallower than 10 fathoms.

Closed Seasons:
Lobster fishing is prohibited in the NWHI between January and June.
Lobster fishing is prohibited in the EEZ around the MHI during the months of May, June, July and August.

Harvest Limitation Program
The NWHI lobster fishery is a quota based fishery. This serves in effect to limit the total amount of fishing effort that may occur and thus limits the amount of potential adverse impacts that may result from lobster traps to EFH. The NMFS annually sets a harvest guideline, expressed as quota of the total number of lobsters that may be taken in the NWHI. Because the harvest quota is bank specific it further limits the potential adverse impacts to EFH that may result from lobster traps..

Other Measures:

Limited entry fishery (maximum of 15 permits may be valid at any one time).

Traps may not be left unattended in the water except in the event of an emergency

Vessels may not maintain more than 1200 traps on board, with no more than 1100 assembled at any one time.

Proposed measures to mitigate potential adverse impacts to EFH

Closed Areas:
Under proposed regulations, lobster fishing will be prohibited at French Frigate Shoals to a depth of 50 fm and at Midway to a depth of 50 fm.

References:

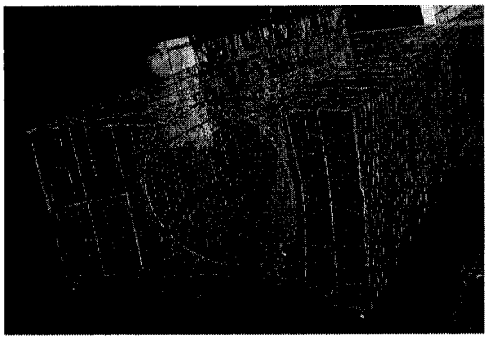
Parrish, F.P., and T.K. Kazama. (1992) Evaluation of ghost fishing in the Hawaiian lobster fishery. Fishery Bulletin. 90: 720-725.

Polovina, J. (1993) The lobster and shrimp fisheries in Hawaii. Marine Fisheries Review. 55(2): 28-33.

Fishing Gear Catalogue TRAP

Gear Type: **Portable Fish Trap: Shallow to medium depth deployment (20-100 feet)**

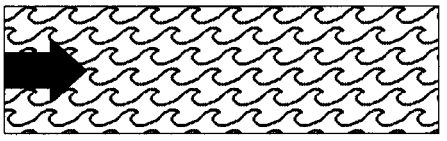
Diagram of typical gear



Deployment/Retrieval

Traps are set individually by divers using SCUBA. A series of traps can range from 8 to18 traps. Range of deployment is from 20 to 110 feet. Shallow set traps can be damaged from surge and are more easily tampered with. Fish traps are generally constructed of concrete wire for the trap frame which is covered with a finer mesh chicken wire. Typical trap dimensions are 2.5 feet high by 6 feet long by 4 feet wide. Soak time can vary between 4 to 14 days and depends on location, season, density of fish, and other personal variables. The average soak time is one week. Bait is rarely used in the shallow to mid-depth traps. Fishermen note that bait may increase the number of fish that enter the trap, but also draws undesirable species such as eels and sharks which can damage catch and increase risks to divers. Trap retrieval is assisted by flotation devices. The retrieval process is as follows: landmarks or GPS is used to locate trap; a new trap is dropped from a vessel behind the existing trap, existing trap is stood on end, air bag is attached, the bag is inflated and the trap is lifted to the surface.

Habitat Impacts:

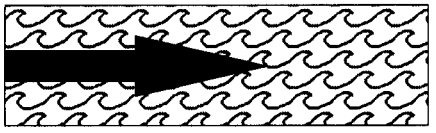


Low Med High

Portable fish traps as used in the Western Pacific Region in shallow to mid water depths pose minimal potential habitat damage due to hand placement and retrieval. Trap placement is critical to produce successful catch. Traps are strategically hand placed near fish houses or koa which typically include areas with high relief ledges or reef edges. Fish enter and are also able to exit these traps making mortality associated with lost traps or ghost fishing minimal. Traps are often utilized as shelter or habitat. In some areas in the region, fishermen purposely place rocks

and coral rubble on and around traps to entice fish to use it as habitat. Because of the low number of traps used, fishermen rarely lose traps. Fishermen note that the largest factor affecting trap loss is due to theft by humans. Trap door hinges are secured with low quality wire that decompose quickly in the marine environment. In general, chicken wire used to construct traps are also highly corrosive. Some fishermen attach zinc to extend the life of traps.

Bycatch:



Low Med High

Overall, fish traps are relatively unselective. Selectivity is increased through trap location and construction. Fish size is controlled by wire mesh size, varying funnel entrance size, and inclusion of vent holes. Small round holes in the corners allow small fish and eels to escape. Using smaller funnel entrances prohibits large jacks from entering and damaging traps. Target species generally include jacks, surgeon fishes, goat fishes, snappers, groupers, etc. Fish traps occasionally catch octopus, lobsters, crabs, and other crustaceans. Discards include aquarium and undersized fish including butterfly, damsels, etc. Fishermen estimate that 90% of discards survive.

Measures to mitigate potential impacts to EFH

Anyone wishing to fish in the low-use MPAs will be required to complete a special permit subject to approval by the NMFS PIAO Administrator after consultation with the Council. Reporting is required through the special permit process and is subject to the following requirements.

1. Report catch, effort and discards by species, location, time and other factors as specified by the Council.

2. Report protected species interactions

3. Report on any lost gear or damage to coral reef

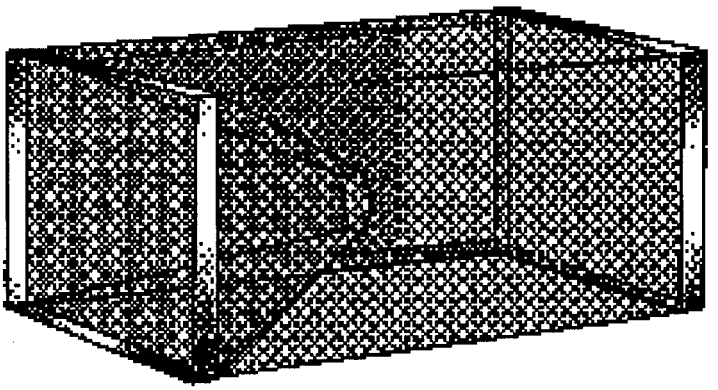
4. Complete daily log sheets within 24 hours after completion of the fishing day

5. Submit reports within 30 days of returning to port

Fishing Gear Catalogue TRAP

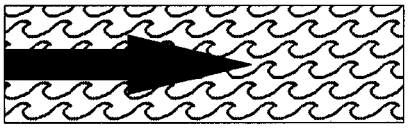
Gear Type: **Portable Fish Trap: deep water deployment (100-300 feet)**

Diagram of typical gear:



Deployment/retrieval:
Traps are deployed individually with up to 30 traps used in a series. Floaters are used to mark trap locations. Fish traps are generally constructed of concrete wire for the trap frame which is covered with a finer mesh chicken wire. Deepwater traps vary in size but are generally slightly larger than shallow to mid-depth traps. Soak time can vary between 4 to 14 days and depends on location, season, density of fish and other personal variables. The average soak time is one week. Traps are hauled using hydraulic lifts.

Habitat Impacts:

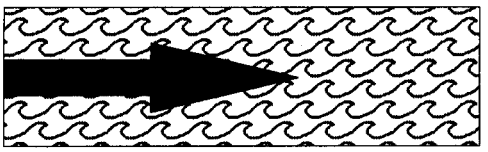


Portable fish traps as used in the Western Pacific Region in deep water depths pose only a moderate potential to damage habitat due to the selective independent placement and retrieval methods used. Trap placement is critical to produce successful catch. Large schools or specific species (weke ula, kumu and taape) are generally scouted with fish finders and targeted. Species include weke ula, moana kale, papio, kumu, and uku. Preferred substrate include hard flat areas mixed with sand, ledges, etc. Bait (ahi head, mackerel) is sometimes used in deep water traps.

Fish enter and are also able to exit these traps making mortality associated with lost traps or ghost fishing minimal. Traps are often utilized as shelter or habitat by reef species. Because of the low number of traps used and floater lines, fishermen rarely lose traps. Trap door hinges are secured with low quality wire that decompose quickly in the marine

environment. In general, chicken wire used to construct traps are also highly corrosive. Some fishermen attach zinc to extend the life of traps.

Bycatch:



Low Med High

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1. Report catch, effort and discards by species, location, time and other factors as specified by the Council.

2. Report protected species interactions.

3. Report on any lost gear or damage to coral reef.

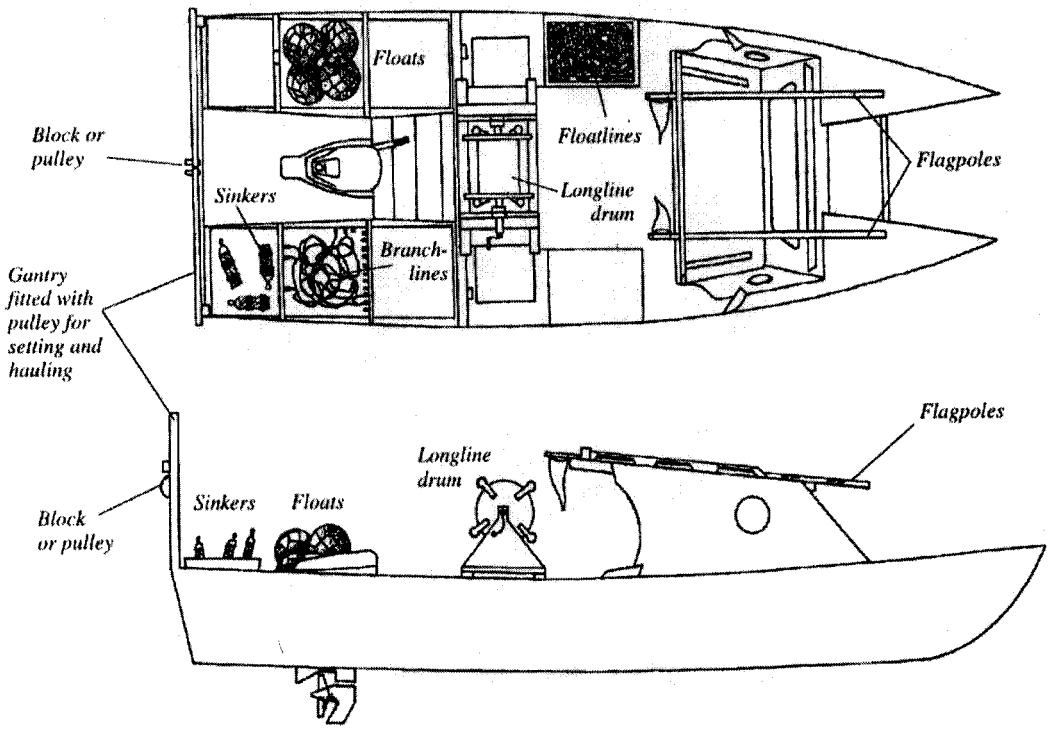
4. Complete daily log sheets within 24 hours after completion of the fishing day.

5. Submit reports within 30 days of returning to port.

Fishing Gear Catalogue Hook and Line

Gear Type: **Pelagic Longline/Alia**

Diagram of typical gear:

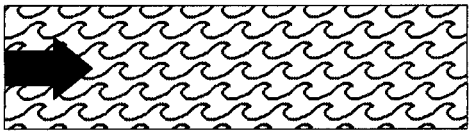


The advent of outboard motors in American Samoa in the 1950s and 1960s meant that the traditional fishing methods declined in favor of the use of motorized dinghies and skiffs for trolling and handlining. The development of offshore artisanal fisheries began in earnest during the early 1980s. It was at this time that the FAO-designed *alia* catamaran was introduced into the islands.

The extensive use of longline gear by the artisanal fleet in American Samoa is a recent phenomenon, with longline catches rising from zero prior to 1994 to almost 800,000 lbs in 1997. The stimulus for fishermen, who generally used only troll gear or handlines, to shift to longline gear was the fishing success experienced by small longline vessels in Western Samoa. The artisanal longline fleet in American Samoa presently consists mainly of 28-32 ft *alia* catamarans, although at least several larger (39 ft) *alia* have been locally constructed and outfitted for longline fishing.

The vessels deploy a short monofilament longline with 200-300 hooks from a hand powered reel through a block or pulley located at the stern The block or pulley is rigged above the transom of the boat so that the line can be set and hauled over the stern of the vessel. The longlines harvest mainly albacore tuna, which are sold to the local tuna canneries. The use of longline gear requires the acquisition of a federal permit from the NMFS Pacific Islands Area Office, but there no restrictions on the number of permits issued. To date, 40 permits have been issued, although only about 17 vessels are active on a regular basis.

Habitat Impacts:



Low Med High

Pelagic longline gear does not adversely affect essential fish habitat. All gear is deployed in the water column and does not interact with bottom substrate. The habitat of pelagic species targeted by longline gear is the open-ocean water column.

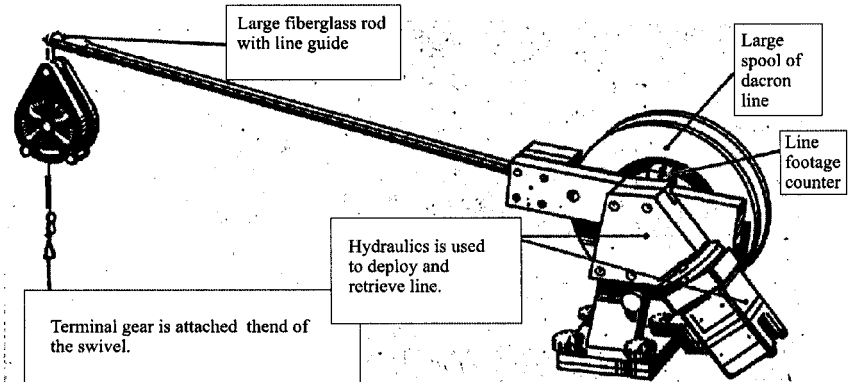
Bycatch:

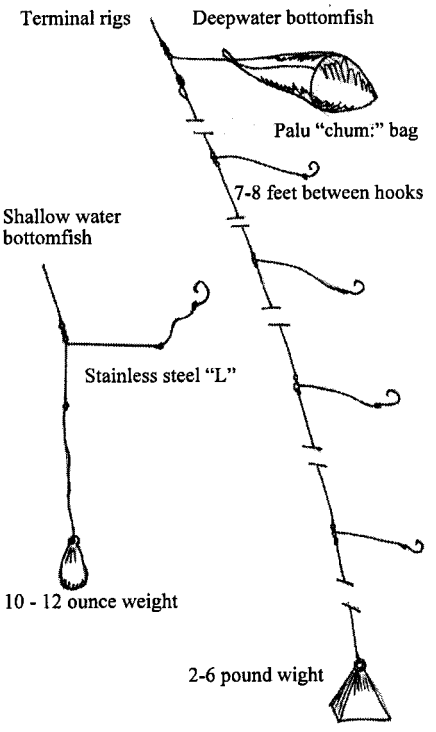
Low Med High

Pelagic longline gear is a relatively selective gear. In addition to tuna or swordfish, usual longline catch includes dolphinfish, wahoo, barracuda, moonfish, pomfrets and sharks.

Gear Type: Bottomfish Handline

Diagram of typical gear:



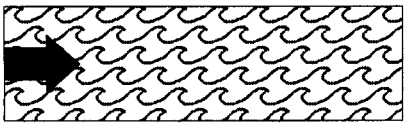


Deployment/retrieval:

The domestic bottomfish fishery for deep-sea snappers and groupers (onaga, ehu, opakapaka and hapuupuu) relies primarily on hydraulic or electric handline gear as diagramed above. The standard deep-sea bottom fishing rig consists of a 130 lb test mainline, to which a terminal rig is attached. The terminal rig consists of a drop line, hook lines three feet in length (40-60 lb hard monofilament), circle hooks and a lead weight. Four to 12 hooks are spaced at 7-8 feet intervals along the main line. A chum bag is attached just above the last hook and filled with finely chopped fish. Each hook is baited with fish or squid. The gear is lowered to the bottom. Depending on species targeted, the gear is fished at depths ranging from 50-150 fathoms. Once at the bottom, the gear is jerked sharply to release the chum bag. The gear is then raised to fish approximately 1 fathom off the bottom. The mainline is hauled either by hand, hydraulic gurdy or electric reel. A hand operated wooden reel is commonly used in American Samoa. Vessels drift or anchor during gear deployment depending on weather conditions, ocean currents, species targeted, and other variables.

Shallow water bottom fishing is conduced in depths from 30-200 feet. Two primary methods include use of rod and reel or handline. Rod and reel is commonly used by recreational and charter fishers. Gear includes use of a stiff rod, spinner reel, 30 pound test line, single baited hook, and sinker. Handline fishers typically use 100 pound test monofilament spun on wooden spools. Terminal gear includes a stainless steel "L" spreader, single baited hook and 10-12 ounce sinker. Fishing is primarily conducted while drifting.

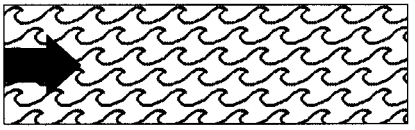
Habitat Impacts:



Low Med High

Bottomfish gear has very limited impacts on habitat. Habitat damage may occur from deployment of anchors during deep water fishing activities. However, damage is highly localized as the total targeted fishing habitat is limited to 100 fathoms contours areas with high relief. Anchoring during fishing operations is generally conducted at depths from 40-60 fathoms, with depths ranging from 30 to 175 fathoms. Reef building corals are generally not found below 50 fathoms, the lower extent of light attenuation. It is estimated that suitable bottomfish habitat where vessel anchoring might occur represents approximately 1% of the total bank habitat. Shallow water bottomfish activities are conducted while drifting, therefore minimizing the potential for anchor damage.

Bycatch:



Low Med High

Being a hook and line rig, this gear is relatively selective, with the ability to successfully target particular species groups dependant upon the skill of the fisher. Experienced vessel crews have the ability to catch the desired species with very little bycatch. Gear is deployed at specific depths and in areas of certain habitat characteristics, e.g. high relief. Fishers target these areas using sophisticated electronic equipment such as depth/fish finders and global positioning devices. It is, however, impossible to completely avoid non-target species.

Logbook data and research programs conducted by the State of Hawaii and the NMFS indicate that bycatch accounts for approximately 8-19% of the total catch in bottomfish fisheries in the Hawaiian archipelago. Sharks, oilfish, snake mackerel, pufferfish, and moray eels are the most numerous discard species; they are not kept by vessels because of their unpalatability. With the recent increase in market demand for shark fins, more sharks are now "finned" before they are discarded. Some carangids (large jacks and amberjacks) are also discarded because of concerns of ciguatera poisoning. The major

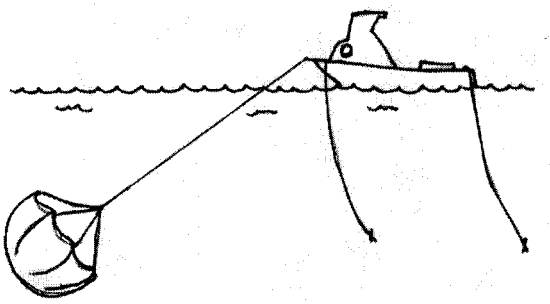
discard species in the NWHI bottomfish fishery are given in the table below. It should be noted that a large percentage of the snappers and the grouper listed below are included as bycatch because of damage from sharks.

Table. NMFS logbook estimates of discards in the NWHI deepwater bottomfish fishery, 1997.

Scientific Name	Common Name	No. Discarded
Seriola dumerilli	amberjack	2,120
Caranx ignobilis	black trevally	1,298
P. filamentosus	pink snapper	215
Charcarhinidae	misc. sharks	166
Epinephelus quernus	seabass	114
Etelis carbunculus	red snapper	98
P. zonatus	yellowband snapper	98
Aprion virescens	jobfish	87
Pristipomoides auricilla	yellowtail snapper	19
Carangidae	misc. jacks	7
Galeocerdo cuvier	Tiger shark	5
Aphareus rutilans	red snapper	2

Gear Type: **Pelagic Handline**

Diagram of typical gear:



Deployment/retrieval:
Handline fishing is an ancient technique used to catch tunas with simple gear and small boats. This technique was developed by Polynesians and Micronesians living on atolls and small islands to catch yellowfin and bigeye tuna. This fishery continues in isolated areas of the Pacific, and is the basis of an important commercial fishery in Hawaii.

The Hawaii handline fishery has nearshore and offshore components. The nearshore fishery operates within a few miles of shore, and targets large yellowfin and bigeye tunas. The full and part-time commercial boats engaged in the nearshore fishery are about(25-35 ft long, and typically operate with a captain and sometimes one crew. In comparison, the mostly full-time commercial offshore handline boats are about 35-56 ft) long, and typically operate with a captain and one or two crew. The offshore fishery targets juvenile bigeye and yellowfin tuna around seamounts and weather buoys that are 50-320 km (35-200 nm) from shore.

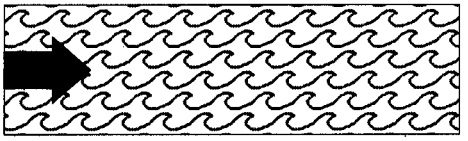
When the fishing area is reached, a parachute sea anchor is deployed to slow the vessel's drift while the fishermen engage in either night *("ika-shibi"* or squid-tuna) or day *("palu-ahi"* or chum-tuna) fishing.

In the nighttime *ika-shibi* fishery, three to four handlines are set, each consisting of a long nylon rope connected to dacron or polypropylene mainline, which is attached to a monofilament nylon leader. The hook is usually baited with mackerel scad, and is lowered with the help of a lead weight. To attract baitfish and tuna to the area, a low wattage light bulb is placed in the water, and the surface is chummed with chopped squid

and/or whole or chopped anchovies. The daytime *palu-ahi* technique adds a weighted, retrievable bag stuffed with chum that is released at a depth of (400-460 ft) to attract tunas to the baited hook. When a fish is hooked, it is manually hauled in, gaffed and then killed by a hit to the head with a bullet or wooden bat. Once the fish is on board, fishermen may bleed it and remove its head and viscera, and then place the fish in a mixture of ice and saltwater. These handling methods help to quickly cool the flesh so it will not become "burnt" (discolored and/or soft).

A nearshore handline trip usually lasts 1-2 days, while an offshore trip may last 1-5 days. Individual fish caught in the nearshore fishery typically weigh 18-90 kg (40-200 lb), and a good trip might land 130-180 kg (300-400 lb). Individual fish caught in the offshore fishery range from 4-32 kg (10-70 lb), and a good offshore trip might land 1,300-1,800 kg (3,000-4,000 lb). Much of the handline fish is sold directly to grocery stores and restaurants or peddled along the roadside, and some is shipped fresh by brokers to the various islands.

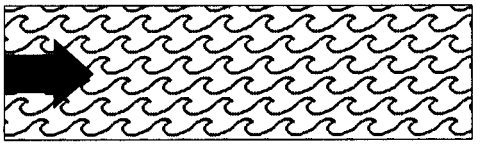
Habitat Impacts:



Low Med High

Pelagic handling gear has minimal habitat impacts. All gear is deployed in the water column without impacting the bottom substrate.

Bycatch:



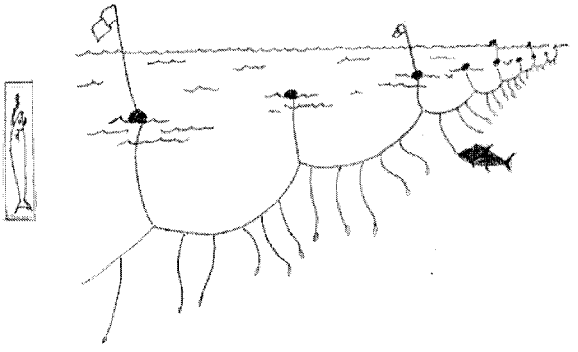
Low Med High

Handline bycatch is mostly utilized, and includes swordfish, dolphinfish and wahoo. Sharks are also caught, but usually not kept. The handline fishery is active year-round, and many handliners also anticipate in the bottomfish and troll fisheries.

Fishing Gear Catalogue — Hook and Line

Gear Type: **Pelagic Longline**

Diagram of typical gear:



Deployment/retrieval:
Modern tuna longlining evolved from techniques developed in Japan several hundred years ago as a relatively simple method to harvest large yellowfin tuna and albacore. This technique is preferred for harvesting large tunas for *sashimi* markets, and swordfish. Longline gear consists of a mainline that is set horizontally near the surface, to which branch lines ('gangions") are clipped at regular intervals, each with a single baited hook.

The mainline is typically 30-100 km (18-60 nm) long, with 400-2,000 baited hooks set each day (with an average of 800 in the Hawaiian fishery). The branch lines are typically 35-50 ft long. When targeting swordfish, buoys are hooked to the mainline at about 500 m (1,650 ft) intervals, with 30-70 ft of line to keep the mainline below the surface. Radar reflectors and radio beacons are used to keep track of the line. To target deeper-swimming bigeye tuna, line shooters are sometimes used to put slack into the mainline to make it sink deeper. These deeper sets use no light sticks and often have 6-7 branch lines between the floats, as compared to 2-3 gangions used when targeting swordfish.

Longliners set and retrieve their gear once a day, with the time of setting and hauling determined by the fish being targeted and prevailing fishing conditions. The mainline is set while the vessel steams across the prevailing current at about 15 km/hr (8 knots, kt) while the crew snaps baited branch lines, typically 60-90 ft long, to the mainline about every 150 feet. The hooks are typically baited with sardine, scad, squid or saury, and a

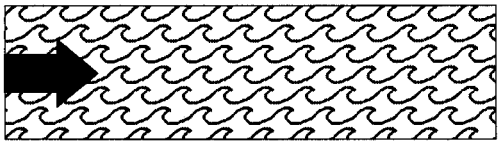
buoy is attached to the mainline about every 12 hooks. To set the mainline deeper where valuable bigeye tuna are found, more branch lines are attached between buoys, longer buoy lines are used, and a line shooter releases more of the mainline to create slack during setting. Marker flags, lighted buoys and radio beacons are attached at regular intervals to mark the line.

Once set, the vessel may drift nearby or steam slowly along the line looking for bobbing floats that signal the presence of a struggling fish, in which case that section of the line is hauled and hooks are re-baited. Otherwise, the line may be left to soak until noon, when the hauling process begins. Retrieval of the gear may take as long as 12 hours. When hauling the line, the vessel must be kept constantly underway at 3-6 km/hr (2-3 kt), with the ship at a 150 to 450 angle to the mainline, as the line is too heavy to haul from a stationary vessel. Retrieval of the line is assisted by a hydraulic line hauler mounted near the foredeck rail. As the mainline is retrieved, the crew removes branch lines, buoy lines, lights and radio buoys, which are readied for the next day's set. After the hauling is complete, damaged sections of the mainline are replaced, and all gear and bait are made ready for the next morning's set.

Longlining for swordfish in the North Pacific is a relatively new fishery for the U.S., and the introduction of chemical light sticks in the late 1970s revolutionized the industry. Lights are attached by rubber bands or line clips to the branch lines about 2 in (6 ft) above the hook. The light sticks produce a chemical luminescence for up to 24 hr. The lights are available in a variety of colors and are thought to attract either the bait upon which swordfish prey, or the swordfish themselves. The light sticks are positively buoyant and of a shape and size that, if inadvertently lost from the branch line or discarded improperly, could create problems if ingested by marine mammals, seabirds or marine turtles.

Due to the potential interaction with marine turtles, shallow-set longline fishing is now prohibited in the entire North Pacific Ocean.

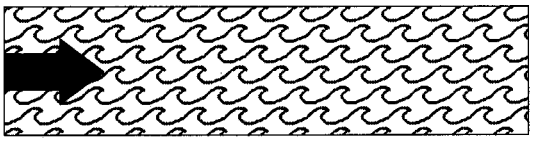
Habitat Impacts:



Low Med High

Pelagic longline gear does not adversely affect essential fish habitat. All gear is deployed in the water column and does not interact with bottom substrate. The habitat of pelagic species targeted by longline gear is the open-ocean water column.

Bycatch:

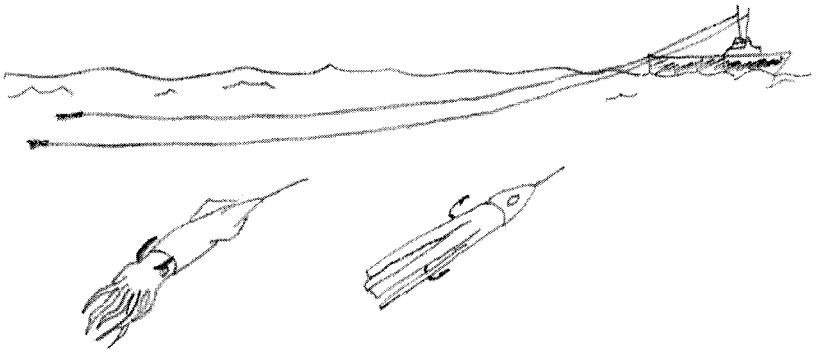


Pelagic longline gear is a relatively selective gear. In addition to tuna or swordfish, usual longline catch includes dolphinfish, wahoo, barracuda, moonfish, pomfrets and sharks, nearly all of which are kept and utilized. Typically, however, only the fins of sharks are kept and dried for shark fin soup, and usually only mako and thresher shark carcasses are landed whole. The incidental hooking of sea turtles is a rare event and there has never been an interaction with the endangered short-tailed albatros (*Phoebastria albatrus*).

Only a small percentage of the hooks on a given longline catch fish; typical catch rates for 1,000 hooks set from an Asian longliner may average 10-13 albacore, and 5-15 yellowfin or bigeye tuna, and a few billfish. Albacore taken on longline gear are mostly large, mature fish over four years old, weighing over 16 kg (35 lb). Yellowfin and bigeye tuna are also larger, older fish ranging to well over 90 kg (200 lb). The large number of hooks set, long trips, lower operating expenses (compared to purse seine vessels), and high value of the catch maintain the economic viability of the fishery.

Gear Type: **Trolling**

Diagram of typical gear:



Deployment/retrieval:
Trolling refers to the towing of artificial lures or natural baits near the surface from a moving boat ("trolling" and "trawling" are sometimes confused, but trawling refers to a vessel towing a net along the bottom or in the water column to harvest fish, shrimp or shellfish). Most areas of the Pacific have a relatively large number of small recreational and commercial trolling vessels, and trolling from chartered boats is popular in some areas. In addition, a fleet of high seas albacore trollers is also active throughout the Pacific.

Trolling is the most popular pelagic fishing method in the region and includes full and part-time commercial (including charter boats) and recreational/subsistence participants. The pelagic troll fishery targets blue marlin, yellowfin tuna, dolphinfish, wahoo and skipjack tuna, and also lands bycatch of sailfish, spearfish, kawakawa, albacore, rainbow runner and sharks. Nearshore trolling target higher level carnivores such as jacks, baracuda, and other predators. Up to six lines rigged with artificial lures may be trolled when outrigger poles are used to keep the lines from tangling. Trolling gear usually consists of short, stout fiberglass poles and lever-drag hand-cranked reels. In addition to lures, trollers occasionally use live or dead bait. For example, small tuna are used to attract marlin, which is the prized catch for chartered vessels. Bigeye scad, mackerel scad, or strips of skipjack tuna are often used when a school of dolphinfish is encountered. Shallow water trolling uses juvenile goat fish or "oama" or juvenile scad

"halalu". When using live bait, the vessel slows to allow the bait to swim naturally.

Another form of pelagic trolling utilizes a single large fiberglass pole in the center of the vessel called a "green stick". A large wooden or plastic lure, often referred to a "bird", is trolled on the surface behind the vessel. The bird is attached to the green stick with heavy monofilament or nylon line. A series of plastic squid lures with single hooks are attached to a separate main line. The squid lures are then attached to the green stick line with rubber bands allowing the lures to skip along the surface of the ocean. When trolled properly, the bird creates excessive surface agitation and appears to be chasing the squid lures which skim along the surface. When fish take the lure, the line breaks away and the fish is fought separately on a rod and reel or by hand.

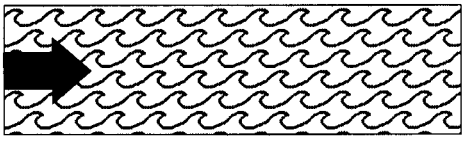
Trollers fish in areas where water masses converge and where the underwater topography changes dramatically, such as near submarine cliffs or oceanic seamounts. Trollers also frequent fish aggregation devices (FADs), or search for drifting logs or flotsam that aggregate tunas, dolphinfish and wahoo. The various segments of the fishery use the same gear and techniques, but differ in catch composition, vessel size, fishing effort and catch disposition. Charter boats target and catch more marlin (40-50% by weight) while non-charter commercial trollers target and catch more yellowfin (about 80% by weight). Charter boats typically measure 30-45 ft whereas non-chartered trolling vessels are usually trailered boats ranging from 15-25 ft in length. Full-time commercial vessels that are not engaged in charters expend the most effort, with an average trip lasting more than eight hours, whereas charterboats stay out 4-8 hr/trip. Part-time commercial and recreational vessels typically fish about 6 hr/trip. In Hawaii, about 70% of the charterboat catch, and 60% of the "recreational" and part-time commercial catch, is sold for food.

Commercial albacore trollers tow 12-18 lines simultaneously from the vessels's stern and from long outrigger poles mounted amidships. The line lengths or depths are adjusted or to permit hauling of any one line without tangling or interfering with the others. The lines are either braided polypropylene, dacron or monofilament nylon and are pulled by hand or hydraulic haulers. Lures have metal heads and feather or plastic skirts, and are rigged with barbless double hooks. Troll vessels never stop when fishing during the day, but may slow and make tight circles or short, straight runs when fishing on an albacore school. Fish are hauled directly to the stern of the vessel where they are quickly taken from the water and unhooked before being stored whole in blast or spray brine freezer holds.

Albacore vessels usually drift at night or steam toward promising fishing grounds as determined by recent fishing activity, sea surface temperatures, or observations of baitfish and albacore on sonar or depth sounding equipment. The use of cooperative, or "code", groups also increases efficiency of the fleet. At dawn, the jigs are deployed and the rest

of the day is a continuous cycle of pulling fish, changing lures, storing the catch, and searching for birds, water temperature fronts or other vessels that might indicate productive fishing areas. At dusk, the jigs are retrieved and stored for the next day of fishing.

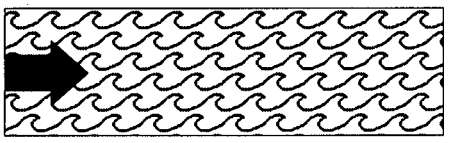
Habitat Impacts:



Low Med High

Trolling has no impact on habitat.

Bycatch:

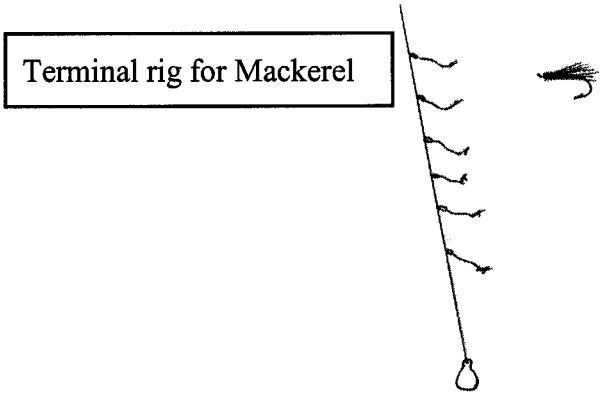


Low Med High

Trolling has very few, if any, bycatch. Trolling effectively targets high level predators which are sought after for consumption or recreation.

Gear Type: **Handline (Big eye/scad/Akule/Atulai/Atule/Mackerel)**

Diagram of typical gear:

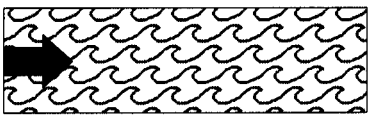


Deployment/retrieval:

Handline fishing is an old technique used to catch akule/atulai/mackerel with simple gear and small boats. The mainline consists of 300 feet of 30 pound test monofilament that is laid in a basket to avoid tangling. The terminal rig can vary but generally is made using 15-20 feet of 20 pound monofilament to which a 3-9 ounce wight is attached. Six or seven small loops are made in the line by tying two overhand knots in 1 foot intervals along the line. Leaders of 6-8 pound test to which hooks are attached are tied to the loops. Artificial lures, such as plastic curly tails with glow beads or nylon strands tied to the hooks with red string, are common for this type of fishing. Japanese ready made leaders can be purchased from fishing stores.

Fishing is conducted at night, moonless nights are generally more productive. Boats anchor in depths of 40 to 50 fathoms before dark or in the early evening. Lights are shown on in the water to attract bait which will in turn attract the mackerel. Mackerel primarily aggregate between 25-75 feet from the surface. The handline rig is dropped to these depths and retrieved slowly by jigging it to the surface. Although there are multiple hooks, fish are brought to the surface once hooked to reduce chances of predators taking the fish or chances of the fish breaking the leader. Once fish start biting, the light is dimmed to concentrate the school below the boat.

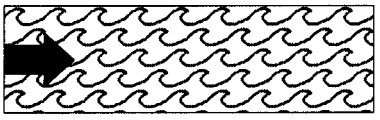
Habitat Impacts:



Low Med High

Mackerel handling gear has minimal habitat impacts. All gear is deployed in the water column without impacting the bottom substrate.

Bycatch:



Low Med High

Bycatch is extremely minimal. The handline fishery is active year-round, and many handliners also participate in the bottomfish and troll fisheries.

APPENDIX B

REGULATORY IMPACT REVIEW (RIR)
AND
INITIAL REGULATORY FLEXIBILITY ANALYSIS
(IRFA)

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INTRODUCTION: ECONOMIC ANALYSIS OF REGULATORY ALTERNATIVES

Executive Order 12866 (E.O. 12866) requires that a Regulatory Impact Review be prepared for all regulatory actions that are of public interest. This review provides an overview of the problem, policy objectives, and anticipated impacts of the action, and ensures that management alternatives are systematically and comprehensively evaluated such that the public welfare can be enhanced in the most efficient and cost-effective way. In accordance with E.O. 12866, the following is set forth: (1) This rule is not likely to have an annual effect on the economy of more than $100 million or to adversely affect in a material way the economy, a sector of the economy, productivity, jobs, the environment, public health or safety, or state, local, or tribal governments or communities; (2) This rule is not likely to create any serious inconsistencies or otherwise interfere with any action taken or planned by another agency; (3) This rule is not likely to materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights or obligations of recipients thereof; (4) This rule is not likely to raise novel or policy issues arising out of legal mandates, or the principles set forth in the Executive Order. Based on these findings, this rule is determined not to be significant under E.O. 12866.

The Regulatory Flexibility Act (5 U.S.C. 601 et seq.)(RFA) requires that agencies assess and present the impacts of their proposed actions on small business entities. In accordance with the RFA, the following is set forth: (1) Details on the need for, and objective of, the measures that are outlined in the FMP which accompanies this document; (2) The proposed measures would apply to individuals who wish to harvest coral reef resources in the federal waters of the Western Pacific Region; (3) All affected individuals are expected to be small business entities; (4) The proposed measures include new reporting requirements; and (5) Some federal rules are known to duplicate, overlap, or conflict with the proposed measures.

The general intent of the RIR and RFA analytical and procedural requirements is to make the decision process open and transparent so that all can understand the what, where, and why of regulatory decision-making and can agree that the required steps of the process were followed. The economic analyses provide decision-makers and the public with the agency's best estimates of the impacts of proposed actions and their alternatives. "In deciding whether and how to regulate, agencies should assess all costs and benefits of available regulatory measures, including the alternative of not regulating" (EO 12866, Section 1). Further, "agencies should select those approaches that maximize net benefits...." The emphasis of the analysis is therefore on the changes in the stream of net benefits that will occur as a result of each of the alternative management measures. The RIR also requires analysis of distributive impacts and the costs of government administration and private compliance with the proposed measures.

1.0 REGULATORY IMPACT REVIEW

1.1 Management Objectives

The objectives of the proposed regulatory actions are reflected in the objectives of the Fishery Management Plan for Coral Reef Ecosystems (FMP), described in Section 1 of the FMP. These are:

Objective 1:
To foster sustainable use of multi-species resources in an ecologically and culturally sensitive manner, through the use of the precautionary approach and ecosystem-based resource management.

Objective 2:
To provide a flexible and responsive management system for coral reef resources, which can rapidly adapt to changes in resource abundance, new scientific information and changes in fishing patterns among user groups or by area.

Objective 3:
To establish integrated resource data collection and permitting systems, a research and monitoring program to collect fishery and other ecological information and to develop scientific data necessary to make informed management decisions about coral reef ecosystems in the EEZ.

Objective 4:
To minimize adverse human impacts on coral reef resources by establishing new and improving existing marine protected areas, managing fishing pressure, controlling wasteful harvest practices, reducing other anthropogenic stressors directly affecting them, and allowing the recovery of naturally-balanced reef systems. This objective includes the conservation and protection of essential fish habitats.

Objective 5:
To improve public and government awareness and understanding of coral reef ecosystems and their vulnerability and resource potential in order to reduce adverse human impacts and foster support for management.

Objective 6:
To collaborate with other agencies and organizations concerned with the conservation of coral reefs, in order to share in decision-making and to obtain and share data and resources needed to effectively monitor this vast and complex ecosystem.

Objective 7:
To encourage and promote improved surveillance and enforcement of the plan.

Objective 8:
To provide for sustainable participation of fishing communities in coral reef fisheries and, to the extent practicable, minimize the adverse economic impacts on such communities.

1.2 Statutory Basis

These management actions are proposed under the Magnuson-Stevens Fishery Conservation and Management Act (as amended in 1996), 50 CFR Part 660. Particular attention has been paid to requirements concerning essential fish habitat as defined in the Sustainable Fisheries Act of 1996. The relationship between the proposed measures and other national laws and policies is described in the Other Applicable Laws and Policies section of the FMP. A summary of existing laws and management measures in the state and territorial waters adjacent to those controlled by the proposed measures is provided in the FMP (Section 9.2.3).

1.3 Problem to be Resolved and Summary Economic Information

The rationale for the proposed management measures is described in detail in the FMP. In summary, many types of human activities have impacted, or have the potential to impact, coral reef resources around the US Pacific islands. The scale of different impacts can range from ocean wide to specific islands and watersheds, to specific reefs.

Stony corals are among the principal reef framework building organisms in the US Pacific Islands. In 1998, global coral bleaching and die off was unprecedented in geographic extent, depth and severity. Several studies have related bleaching to the combination of increased ultraviolet radiation and ocean warming, phenomena that may be exacerbated by human activities. Projected long-term climatic changes are likely to expose stony corals to an increasingly hostile environment and could possibly lead to mass extinctions. Of foremost concern is the degradation and destruction of habitats essential for the reproduction and recruitment of many coral reef species. Much of the previous damage to coral reef habitats in the US Pacific Islands has occurred as a result of non-harvesting activities such as coastal and harbor development, watershed land use practices and runoff, industrial discharges and military use. Harvesting and non-harvesting vessels have the potential to degrade habitat by grounding, anchoring, introduction of invasive species, derelict gear, and other marine debris. The removal of live rock and the use of destructive harvesting techniques, such as explosives and poisons, can also directly affect coral reef habitats. Because many resources that contribute to coral reef habitat are essentially non-renewable (in human time dimension), prevention is a far more effective strategy than mitigation of damage after it has occurred.

The current regulatory regime in the western Pacific allows for open access with uncontrolled and unregulated harvesting of coral reef resources from many of the domestic coral reef ecosystems in the western Pacific. Although deep water bottom fisheries for bottomfish (snappers, groupers and jacks), trap fishing for crustaceans (primarily spiny and slipper lobster), and selected harvest of precious corals (which generally inhabit deeper depths than the coral reef ecosystem) are regulated by their own Western Pacific Regional Fishery Management Council FMPs (which include limited

entry and other regulatory measures to control access and harvest levels), these FMPs fail to fully integrate an ecosystem approach to coral reef management. While fishing and other marine harvesting activities of domestic coral reef ecosystems are at present relatively quite limited, (particularly if excluding the bottomfish, crustacean, and precious coral fisheries), there are a number of possibilities for rapid and relatively unanticipated development of marine resource harvesting potential in this region. Particular opportunities exist for the marine ornamental products trade (including aquarium species and live rock), mariculture, bioprospecting and bio-harvesting (e.g., algae), and ecotourism activities including snorkeling and diving. Although there are some State and/or Territorial/Commonwealth licensing requirements for some of these activities, there are few requirements for the unincorporated US Pacific Islands (PRIAs) and little if any controls on access or total harvest. As a result, coral reef fisheries or other types of marine product harvesting could develop relatively unchecked.

Most of the problems addressed by this FMP are anticipated to derive from future developments rather than from current practices. This means the FMP is largely precautionary, which suggests a risk of unnecessarily precluding activities (which might have lower ecological impacts than anticipated), and thus foregoing the income and human welfare that a renewable natural resource can be expected to generate. The task of economic analysis in this FMP is to provide information to decision-makers and the public that will allow an informal calculus of the trade-offs between future risks and returns (information does not exist for a detailed quantitative cost-benefit analysis).

The following is a brief summary of what is known about the value of coral reef resources in the US Pacific Islands. The information sources for this information appears subsequently in this RIR.

1. The annual ex-vessel value of harvests from coral reef fisheries in the US Pacific Islands is about $15 million of a total ex-vessel value of all domestic marine fisheries in the region of roughly $95 million. In general, the coral reef resources component is much greater than the deep bottom component but much smaller than the pelagic component. The relative ex-vessel value of coral reef fisheries compared to other fisheries varies greatly among island groups, being greatest in American Samoa and least in Hawaii.

2. About 10 percent of the coral reef resource ex-vessel value is from reef areas under federal jurisdiction (or in the case of the CNMI, from the "offshore management zone").

3. At least $3 million per year is spent on managing the coral reef fisheries of the region. In American Samoa, management costs are equal to about 75 percent of the fishery's ex-vessel value. In Hawaii, the relative inputs into management are much lower–roughly 15 percent of ex-vessel value, and in the CNMI and Guam, the relative costs of management are intermediate–in the range of 25 to 35 percent of ex-vessel value.

4. The net value of the region's coral reef fisheries is difficult to estimate because of the lack of information on harvesting costs and consumer surplus, including the non-market values that accrue to both seafood consumers and fishermen, including recreational, subsistence,

and commercial fishermen. Based on tentative assumptions about the non-market benefits that accrue to fishermen, a plausible range of net value is $0 to $15 million per year, or assuming no change in the future trajectory of coral reef utilization, a net present value (NPV) of $0 to $175 million. That is, if the fisheries are operating at the open access equilibrium represented by minimal fisheries management, they may be generating no net value (profits) at all, or they may be generating net values of as much as the total ex-vessel value if there is considerable consumer and producer surplus, as well as non-market value.

5. In terms of the potential net value of coral reef fisheries in the region, the "nearshore" reefs–those within easy access of populated areas and ports–have the advantages of lower harvesting costs but potentially greater harvesting pressure and dangers of over-fishing. Given the higher population levels, management costs may be substantial. Remote reefs may have the advantages of less degraded habitat and higher productivity.

6. The region's coral reefs generate economic value (both market and non-market values) in a number of non-fishery "sectors," including tourism and recreation, the reef as a breakwater, support for other ecosystems, etc. These values accrue to varying degrees to both local communities and to the nation and the world as a whole and their long-term value and utilization depends on their resilience to human, including fishing and other types of harvesting, and other non-human natural processes. Although accurate assessment of the value of all these reef-dependent sectors and sources of value is not possible in the context of this FMP (and has barely been attempted in a few marine park and polluted marine settings), it is apparent that the value of coral reef fisheries are, in general, smaller than the non-fishery values of coral reef ecosystems. For example, a tentative assessment of the annual net value of marine-based tourism in the US Pacific Islands is $400 million to $1.6 billion, or assuming no change in the future, a net present value of $5 to $19 billion. The extent to which this tourism relies on the coral reef ecosystem, and the marginal value of "units" of the coral reef ecosystem to those tourism values, has not been determined.

7. While coral reef fisheries and other forms of harvesting, through extraction of fish and degradation of habitat, have some capacity to degrade the non-fishery values of coral reef ecosystems, compared to impacts from other sources, such as oceanographic conditions and land-based disturbances – including shoreline development – the potential impacts from coral reef fisheries appear small if properly managed.

8. Although the actual and potential net values of the region's coral reef fisheries are modest, especially in comparison with the non-fishery values of the reefs, coral reef fisheries are very important in terms of the indirect economic benefits and social benefits that they generate. The fishing communities and economies of the US Pacific Islands have a high degree of dependence on these fisheries and derive great benefits through the production of food, income, recreation, and values associated with culture and tradition.

9. Indirect economic benefits derived from local coral reefs include local spending by resident consumers, fishermen, and dealers, employment of fishermen and dealers and their suppliers, and expenditures by visiting anglers, divers, and other tourists. Federal funds applied to the management and development of local coral reef fisheries also generate substantial indirect benefits to local economies.

10. The dependence of fishing communities on coral reef fisheries is mostly limited to nearshore reefs close to populated areas. Only small portions of these reefs are under federal jurisdiction.

1.4 Proposed Actions

This FMP proposes management, under federal regulation, of the coral reef resources in the waters of the EEZ around American Samoa, Guam, Hawaii, Northern Mariana Islands and the unincorporated U.S. Pacific islands. The Fishery Management Unit is the entire region from the boundary of territorial waters (generally 3 miles offshore) to the limit of the EEZ (200 miles offshore) with special attention to waters within 50 fathoms. The proposed regulatory and non-regulatory measures are fully described in the FMP.

For the purposes of this FMP, the coral reef ecosystem is defined as substrate from 0-50 fm deep. In most areas, a large portion of these ecosystems fall within state or territorial waters (generally 3 miles from shore). The FMP proposes to regulate those portions that are outside of state or territorial waters and within 200 miles from shore (with an exception made for the Commonwealth of the Northern Mariana Islands where federal waters extend to the shoreline but management activities under this FMP will nevertheless begin at 3 miles from shore). Species to be managed under this FMP are termed management unit species (MUS) and are divided into two groups; Currently Harvested Coral Reef Taxa, which are relatively well understood; and Potentially Harvested Coral Reef Taxa, which have not been historically harvested or are not well understood. Some species already managed under existing FMPs are included as MUS under this FMP as well. These overlapping species would continue to be managed primarily under their current FMPs (Bottomfish, Crustaceans, Precious Corals), however broader ecosystem effects of these harvesting activities would now be addressed via this Coral Reef Ecosystem FMP.

The FMP proposes four (4) alternatives for managing the western Pacific coral reef ecosystem:

> Alternative 1 (No Action) would implement no new regulations, i.e., only the existing Bottomfish, Crustacean, and Precious Coral FMPs would regulate activity in the western Pacific coral reef ecosystem;
>
> Alternative 2 (Minimal Additional Protection) would designate several low-use MPAs, require permits for some takes of Coral Reef Ecosystem Management Unit Species (CRE MUS), limit takes of live rock and coral, and prohibit the use on non-selective gears to harvest CRE MUS throughout the EEZ;

Alternative 3 (Substantial Additional Protection - the Preferred Alternative) would encompass regulations in Alternative 2 and in addition designate several no-take MPAs, require all fishing vessels operating or transiting MPAs to carry wreck clean up and removal insurance, and prohibit the use of nighttime spearfishing for CRE MUS with SCUBA and/or hookah gear in the EEZs of the Northwestern Hawaiian Islands (NWHI) and the Pacific Remote Island Areas.

Alternative 4 (Maximum Additional Protection) would incorporate regulations in Alternatives 2 and 3 and in addition establish no-take MPAs out to 100 fathoms around all of the region's islands and atolls.

The Preferred Alternative for the Coral Reef Ecosystem FMP, i.e., Alternative 3, as approved by the Western Pacific Regional Fishery Management Council (Council) at a meeting in June 2000, would result in three major regulatory actions: (a) designation of marine protected areas; (b) harvesting permit and reporting requirements for harvesting of coral reef resources; and (c) definition of allowable gear and methods of harvesting for coral reef resources. The Council also proposes that the regulations include framework procedures to allow for timely, adaptive management based on new resource information, unforeseen effects, or changes in fisheries. In addition, the Council recommends that a formal procedure be established (under Standard Operating Procedures and Practices) for assessing and controlling ecosystem effects of reef-related fisheries which are managed under the existing FMPs for Bottomfish, Crustaceans and Precious Corals.

Alternative 1 (the No Action alternative) is essentially the existing baseline on which analysis of the action alternatives is based. The difference between the Preferred Alternative (Alternative 3) and the other two action alternatives (Alternatives 2 and 4) is essentially the extent of no-take MPAs designated by the FMP. These differences are delineated in detail in the text of the FMP.

Regarding marine protected areas (MPAs), the Council proposes to designate a series of areas as MPAs, which would be grouped into two types. The first is no-take MPAs in which no fishing or other harvest of coral reef resources would be permitted. The second is low-use MPAs in which controlled harvests of coral reef resources would be permitted. Under the Preferred Alternative, waters out to 50 fathoms surrounding the NWHI islands of Laysan, French Frigate Shoals, and the northern half of Midway would be designated as no-take MPAs. Proposed as no-take MPAs are the waters out to 50 fathoms surrounding Rose Atoll (American Samoa), Jarvis, Howland, Baker and Kingman Reef. Finally, waters out to 10 fathoms surrounding all other NWHI would also be designated as no-take MPAs under the Preferred Alternative. Low-use MPAs would consist of all remaining coral reef management areas (waters 0-50 fathoms) surrounding the NWHI and Palmyra, Johnston and Wake Atolls. Anchoring by harvesting vessels more than 50 feet in length would be prohibited on Guam's southern banks, and could be prohibited elsewhere at a later date under the FMP's framework process.

Regarding harvesting permits and reporting requirements, the Council's Preferred Alternative includes two types of permits, each with its own reporting requirements. The Special permit would

be instituted immediately upon final ruling of the FMP. The Special permit would be required to harvest any coral reef resources from low-use MPAs, as well as for the harvest of any Potentially Harvested Coral Reef Taxa from any coral reef management area. This permit would be issued on a case-by-case basis pending NMFS review and approval of the proposed activity. Accompanying this permit would be a mandatory detailed catch report form. Harvest of Currently Harvested Coral Reef taxa from all non-MPA coral reef management areas would not require a permit initially. Local monitoring systems, familiar to the fishers in each region, currently collect the data which would be required under a General Permit. The quality of the local monitoring systems and the need to institute a General permit will be analyzed in each annual report. While the General permit application and reporting process has been analyzed as a potential framework measure in the FMP, further analysis through the annual reports may alter the final appearance of the General permit. Exceptions to permit requirements would be made for NWHI bottomfish, lobster, or precious corals fishery permit holders who are targeting species managed under their respective FMPs. These individuals would be prohibited from any harvesting within no-take MPAs, but would be allowed to fish within low-use MPAs under their current permit and reporting requirements. No permits would be issued for the collection of live stony coral or live rock for commercial purposes. Preferences would be given for the granting of Special Permits for indigenous harvesting activities in low-use MPAs, with a portion of each such area set aside for such activities.

A detailed list of proposed allowable gears is available in the FMP. In general, the Council proposes to prohibit the use of gears which would destroy coral reef habitat or have the potential for non-selective use. These include poisons, explosives, and intoxicating substances. Certain nets would be allowed if they are tended, and fish traps would be allowed in some areas. The use of manned and remotely operated submersibles would be permitted, as would hook and line fishing, and spear fishing. However, night spear fishing with SCUBA in coral reef areas around the NWHI, and the PRIA would be prohibited. These gear restrictions would apply only in low-use MPAs, such that harvesting in coral reef areas around the Main Hawaiian Islands, the Commonwealth of the Northern Mariana Islands, and most of American Samoa and Guam, would continue as currently allowed under state and local rules.

Finally, the Council's Preferred Alternative includes a requirement that all fishing vessels passing through MPAs would be subjected to insurance requirements to cover wreck removal and pollution clean up in the event of a grounding.

1.5 Description of Coral Reef Sectors

An underlying principle behind the ecosystem approach to fisheries management, as applied in this FMP, is that extractive fisheries and other types of coral reef ecosystem harvesting and activity will affect not just the targeted species, but other species (including their habitats), as well as other fisheries, and non-fishery uses and values. Each of the affected fisheries, uses, and values will be termed "sectors," of which there are three groups. Only the first, "coral reef fisheries," is directly managed by the FMP. This sector includes all harvest of coral reef resources (coral reef MUS taken

from federal waters between 0-50 fathoms) including those currently managed under the Bottomfish, Crustaceans, and Precious Corals FMPs.

Types of Activities[1]

Coral Reef Fishery Sectors:

Food	All commercial, subsistence, and recreational harvest of coral reef resources generally towards food production.
Sport	For-hire fishing for coral reef resources with the primary motivation of recreation.
Ornamentals	Harvest of coral reef resources for use as ornamentals, for home and local use and commercial trade, and including fishes, invertebrates, and live rock.
Natural products	Harvest of coral reef resources for all other purposes, such as coral for bone grafts and production of pharmaceuticals.
Mariculture	At-sea mariculture of coral reef resources, and harvest of coral reef resource broodstock for land-based mariculture.

Non-coral Reef Fishery Sectors:

Deep water bottom fisheries	Fisheries for finfish, crustaceans, and precious corals, in benthic environments deeper than 50 fathoms, including for food, sport, and ornamentals, as described above for coral reef fisheries.
Pelagic fisheries	Fisheries for finfish in pelagic ecosystems, including for food and sport. In general the pelagic fisheries are not directly related to the coral reef ecosystem.

Non-fishery Sectors:

Tourism (non-fishing)	Visitors engaging in scuba diving, snorkeling, boating, swimming, viewing of coral reefs, and other coral reef-related activities, including eco-tourism.
Recreation (non-fishing)	Residents engaging in scuba diving, snorkeling, boating, swimming, viewing of coral reefs, and other coral reef-related activities.

Mining	Extraction of fossil coral and sand from the coral reef ecosystem.
Breakwater	Coral reef ecosystems functioning to protect shorelines from erosion and to provide shelter for navigation and mooring, and other activities.
Ecological support	Coral reef ecosystems functioning as nursery areas, spawning areas, or otherwise in support of resources, fisheries, and ecological services in other ecosystems.
Information	Coral reef ecosystems providing values associated with gaining and sharing information–that is, the non-extractive, "discovery," aspects of research and education, and the values associated with the consequential development and production of marine natural products.
Biodiversity	Coral reef ecosystems providing values associated with varied genetic resources.

Location of Activities

Table 1 presents the size and locations of western Pacific domestic coral reef ecosystems (coral reefs located in waters between 0 and 50 fathoms in depth), as well as the portions which would be included within the proposed FMP management area (those coral reefs located between 0 and 50 fathoms in depth and between 3 and 200 miles from shore).

Table 1. Domestic Coral Reef Areas of the Western Pacific Region

Location	Total coral reef area (km^2)	Coral reef area between 0-3 miles from shore (percent of total)	Coral reef area between 3-200 miles from shore (percent of total)
American Samoa	296	271 (92%)	25 (8%)
Guam	179	69 (39%)	110 (61%)
Hawaii			
Main Hawaiian Islands	2,535	1,655 (65%)	880 (35%)
Northwestern Hawaiian Islands	11,554	2,430 (21%)	9,124 (79%)
Commonwealth of the Northern Marina Islands	579	45 (8%)	534 (92%)
Remote US Pacific Islands	709	620 (87%)	89 (13%)
TOTAL	15,852	5,090 (32%)	10,762 (68%)

Source: Hunter, 1995.

Overall, 68 % of domestic western Pacific coral reefs would be managed under this FMP, however the distribution of reefs between local and federal authorities varies dramatically by area.

Volume II of the FMP provides a summary of the known historical and present uses of domestic coral reefs. Table 2 is a summary of the approximate, recent, total annual ex-vessel values for each of the domestic marine fisheries of the Western Pacific Region's island groups. The focus is on fisheries for coral reef resources (coral reef MUS taken from 0-50 fathoms), but rough estimates of the deep bottom and pelagic fisheries are also provided, both for comparison and because they may be affected by the management measures. Values presented are for the total value (in 1999 dollars) of landings from each area, as well as for the portion located in the proposed FMP management area. Ex-vessel values are the estimated total annual gross value of landings from each fishery, whether sold or not. The ex-vessel values for the sport sectors are the charter fees; the value of the landings in the sport fisheries are included in the food sector. The details behind these values, including the volume of landings on which they are based, are provided for each of the island groups in Tables 3 through 8. The uncertainty associated with these estimates is variable and in some cases quite high; refer to Section 4 for data sources, assumptions, qualifiers, and the periods upon which the estimates are based.

Table 2. Summary of Fisheries Annual Ex-vessel Value ($1,000/year)

	Am. Samoa		CNMI		Guam		MHI		NWHI		Other islands		All islands	
	Total	**FMP**	**Total**	**FMP**	**Total**	**FMP**	**Total**	**FMP**	**Total**	**FMP**	**Total**	**FMP**	**Total**	**FMP**
Coral reef:														
Food	671	8	1,217	54	1,214	118	9,391	1,075	1,295	12	22	21	**13,809**	**1,287**
Sport	m	0	80	4	306	15	71	7	159	159	0	0	**616**	**186**
Ornamentals	10	0	m	0	48	0	1,004	0	0	0	m	m	**1,062**	**m**
Natural products	0	0	0	0	0	0	?	?	0	0	0	0	**?**	**?**
Mariculture	m	0	0	0	0	0	?	0	0	0	0	0	**m**	**0**
Total coral reef	**681**	**8**	**1,297**	**58**	**1,567**	**133**	**10,465**	**1,082**	**1,454**	**171**	**22**	**21**	**15,486**	**1,472**
Deep bottom:														
Food	64	0	166	0	158	0	1,455	0	1,161	0	0	0	**3,004**	
Sport	m	0	30	0	306	0	707	0	m	0	0	0	**1,043**	
Ornamentals	0	0	0	0	0	0	0	0	0	0	0	0	**0**	
Total deep bottom	**64**	**0**	**196**	**0**	**463**	**0**	**2,162**	**0**	**1,161**	**0**	**0**	**0**	**4,047**	
Pelagic:														
Food	444	0	950	0	858	0	48,200	0	8,764	0	10	0	**59,226**	
Sport	10	0	900	0	1,238	0	14,000	0	159	0	0	0	**16,307**	
Total pelagic	**454**	**0**	**1,850**	**0**	**2,096**	**0**	**62,200**	**0**	**8,923**	**0**	**10**	**0**	**75,533**	
TOTAL	**1,199**	**8**	**3,343**	**58**	**4,127**	**133**	**74,827**	**1,082**	**11,538**	**171**	**32**	**21**	**95,066**	**1,472**

Values are approximate, recent, annual gross values of the production side of these fisheries, expressed in 1999 dollars (x 1,000).
"m" means minimal and unquantifiable.

Table 3. American Samoa Fisheries by Area : Annual Volume and Ex-vessel Value

	Annual Total		% of harvest from proposed FMP area	FMP portion	
	Volume (lbs)	Value ($1,000)		Volume (lbs)	Value ($1,000)
Coral reef area harvests:					
Food					
Finfish:					
live	0	0	0	0	0
dead	216,000	393	2	4,000	8
Crustaceans:	7,000	26	0	0	0
lobster					
other crustaceans					
Echinoderms	43,000	87	0	0	0
Molluscs:	73,000	146	0	0	0
mother-of-pearl					
other molluscs					
Other invertebrates	2,000	20	0	0	0
Seaweeds	min	min	0	0	0
Sport	min	min	0	0	0
Ornamentals					
Fishes and other	5,000	10	0	0	0
Hermatypic coral/live	min	min	0	0	0
Black coral	0	0		0	0
Marine natural products	0	0		0	0
Mariculture	min	min	0	0	0
Total coral reef area		**681**			**8**
Deep bottom area harvests:					
Food	27,000	64	0	0	0
Sport	min	min	0	0	0
Ornamentals	0	0	0	0	0
Total deep bottom		**64**			**0**
Pelagic fisheries:					
Food	400,000	444	0	0	0
Sport	120	10	0	0	0
Total pelagic harvests		**454**			**0**
Total all fisheries		**1,199**			**8**

All volume figures are in pounds per year, except the sportfishing sectors, which are in number of angler-trips per year, and ornamentals (except black coral), which are in number of pieces or organisms per year.
"min" means minimal.

Table 4. Northern Mariana Islands Fisheries by Area: Annual Volume and Ex-vessel Value

	Annual Total		% of harvest from proposed FMP area	FMP portion	
	Volume (lbs)	Value ($1,000)		Volume (lbs)	Value ($1,000)
Coral reef:					
Food					
Finfish:					
live	0	0		0	0
dead	446,000	1,070	5	22,000	54
Crustaceans:					
lobster	4,000	19	0	0	0
other crustaceans					
Echinoderms	25,000	68	0	0	0
Molluscs:					
mother-of-pearl	20,000	60	0	0	0
other molluscs					
Other invertebrates					
Seaweeds	min	min	0	0	0
Sport	1,600	80	5	80	4
Ornamentals					
Fishes and other inverts	min	min	0	0	0
Hermatypic coral/live	min	min	0	0	0
Black coral	0	0		0	0
Marine natural products	0	0		0	0
Mariculture	0	0		0	0
Total coral reef		**1,297**			**58**
Deep bottom:					
Food	50,000	166	0	0	0
Sport	300	30	0	0	0
Ornamentals	0	0		0	0
Total deep bottom		**196**			**0**
Pelagic:					
Food	500,000	950	0	0	0
Sport	9,000	900	0	0	0
Total pelagic		**1,850**			**0**
Total all fisheries		**3,343**			

All volume figures are in pounds per year, except the sportfishing sectors, which are in number of angler-trips per year, and ornamentals (except black coral), which are in number of pieces or organisms per year.

Table 5. Guam Fisheries by Area: Annual Volume and Ex-vessel Value

	Annual Total		% of harvest from proposed FMP area	FMP portion	
	Volume (lbs)	Value ($1,000)		Volume (lbs)	Value ($1,000)
Coral reef:					
Food					
Finfish:					
live	0	0		0	0
dead	400,000	1,176	10	40,000	118
Crustaceans:					
lobster	5,000	19	0	0	0
other crustaceans					
Echinoderms					
Molluscs:					
mother-of-pearl	3,000	6	0	0	0
other molluscs	4,000	9	0	0	0
Other invertebrates	1,000	2	0	0	0
Seaweeds	some	unknown	0	0	0
Sport	10,000	306	5	510	15
Ornamentals					
Fishes and other inverts	24,000	48	0	0	0
Hermatypic coral/live	min	min	0	0	0
Black coral	0	0		0	0
Marine natural products	0	0		0	0
Mariculture	0	0		0	0
Total coral reef		**1,567**			**133**
Deep bottom:					
Food	45,000	158	0	0	0
Sport	10,000	306	0	0	0
Ornamentals	0	0			0
Total deep bottom		**463**			
Pelagic:					
Food	660,000	858	0	0	0
Sport	21,000	1,238	0	0	0
Total pelagic		**2,096**			**0**
Total all fisheries		**4,127**			**133**

All volume figures are in pounds per year, except the sportfishing sectors, which are in number of angler-trips per year, and ornamentals (except black coral), which are in number of pieces or organisms per year.

Table 6. Main Hawaiian Islands Fisheries by Area: Annual Volume and Ex-vessel Value

	Annual Total		% of harvest from proposed FMP area	FMP portion	
	Volume (lbs)	Value ($1,000)		Volume (lbs)	Value ($1,000)
Coral reef:					
Food	1,004,900	9,391		540,001	1,076
Finfish:					
live					
dead	443,900	7,571	10	439,000	750
Crustaceans:					
lobster	10,000	128	0	0	0
other crustaceans	100,000	417	41	41,000	173
Echinoderms	1,000	11	3	0	0
Molluscs:					
mother-of-pearl					
other molluscs	369,000	925	16	60,000	150
Other invertebrates					
Seaweeds	81,000	339	1	1	3
Sport	500	71	10	50	7
Ornamentals					
Fishes and other	430,000	937	0	0	0
Hermatypic coral/live	min	min	0	0	0
Black coral	3,000	66	0	0	0
Marine natural products	unknown	unknown	unknown	unknown	unknown
Mariculture	unknown	unknown	0	0	0
Total coral reef		**10,465**			**1,082**
Deep bottom:					
Food	418,000	1,455	0	0	0
Sport	5,000	707	0	0	0
Ornamentals	0	0		0	0
Total deep bottom		**2,162**			**0**
Pelagic:					
Food	22,000,00	48,200	0	0	0
Sport	99,000	14,000	0	0	0
Total pelagic		**62,200**			**0**
Total all fisheries		**74,827**			**1,082**

All volume figures are in pounds per year, except the sportfishing sectors, which are in number of angler-trips per year, and ornamentals (except black coral), which are in number of pieces or organisms per year.

Table 7. Northwestern Hawaiian Islands Fisheries by Area: Volume and Ex-vessel Value

	Annual Total		% of harvest from proposed FMP area	FMP portion	
	Volume (lbs)	Value ($1,000)		Volume (lbs)	Value ($1,000)
Food					
Finfish:					
live	0	0		0	0
dead	19,000	14	82	16,000	11
Crustaceans:					
lobster	246,000	1,280	0	0	0
other crustaceans	min	1	51	min	min
Echinoderms	0	0		0	0
Molluscs:					
mother-of-pearl					
other molluscs	0	0		0	0
Other invertebrates	0	0		0	0
Seaweeds	0	0		0	0
Sport	375	159	100	375	159
Ornamentals					
Fishes and other inverts	0	0		0	0
Hermatypic coral/live	0	0		0	0
Black coral	0	0		0	0
Marine natural products	0	0		0	0
Mariculture	0	0		0	0
Total coral reef		**1,454**			**171**
Deep bottom:					
Food	371,000	1,161	0	0	0
Sport	min	min	0	0	0
Ornamentals	0	0		0	0
Total deep bottom		**1,161**			**0**
Pelagic:					
Food	4,000,00	8,764	0	0	0
Sport	375	159	0	0	0
Total pelagic		**8,923**			**0**
Total all fisheries		**11,538**			**171**

All volume figures are in pounds per year, except the sportfishing sectors, which are in number of angler-trips per year, and ornamentals (except black coral), which are in number of pieces or organisms per year.

Table 8. Other Islands Fisheries by Area: Annual Volume and Ex-vessel Value

	Annual Total		% of harvest from proposed FMP area	FMP portion	
	Volume (lbs)	Value ($1,000)		Volume (lbs)	Value ($1,000)
Coral reef:					
Food					
Finfish:					
live	0	0		0	0
dead	10,000	20	100	10,000	20
Crustaceans:					
lobster	200	1	0	0	0
other crustaceans	200	min	100	200	min
Echinoderms	0	0		0	0
Molluscs:					
mother-of-pearl					
other molluscs	100	min	100	100	min
Other invertebrates	0	0		0	0
Seaweeds	0	0		0	0
Sport	0	0		0	0
Ornamentals					
Fishes and other inverts	min	min	100	min	min
Hermatypic coral/live	min	min	100	min	min
Black coral	0	0		0	0
Marine natural products	0	0		0	0
Mariculture	0	0		0	0
Total coral reef		**22**			**21**
Deep bottom:					
Food	min	min	0	0	0
Sport	0	0		0	0
Ornamentals	0	0		0	0
Total deep bottom		**0**			**0**
Pelagic:					
Food	5,000	10	0	0	0
Sport	0	0		0	0
Total pelagic		**10**			**0**
Total all fisheries		**32**			**21**

All volume figures are in pounds per year, except the sportfishing sectors, which are in number of angler-trips per year, and ornamentals (except black coral), which are in number of pieces or organisms per year.

Based on the estimates in the preceding tables, the total annual ex-vessel value of the region's fisheries for coral reef resources (coral reef MUS taken from 0-50 fathoms) in recent years was about $15 million, $14 million of which was in food fisheries (mostly bottomfish and lobsters) $1 million in ornamentals (from 0.5 million pieces), and $0.6 million in sport fisheries (from 12,000 angler-trips). The deep bottom fisheries (mostly bottomfish, harvested from greater than fifty fathoms, and lobsters, harvested between ten and twenty fathoms) realized an approximate ex-vessel value of $4 million annually. The value of the natural products and mariculture sectors were assumed to be minimal, but more in-depth investigation might reveal otherwise.

Hawaii's share of total coral reef resource harvests was about 77 percent, or $12 million, of which 88 percent was in the main islands and 12 percent in the Northwestern Hawaiian Islands. The ex-vessel value of Guam's harvested coral reef resources was about $1.6 million, the CNMI's about $1.3 million, and American Samoa's about $0.7 million.

Overall, it was very roughly estimated that 10 percent of the total ex-vessel value of harvested coral reef resources was taken in federal waters (or the "management zone" of the CNMI). The estimated percentages of total ex-vessel value caught in the proposed FMP area (federal waters between 0-50 fathoms) were 1 percent in American Samoa, 4 percent in the CNMI, 8 percent in Guam, and 11 percent in Hawaii.

1.6 Economic Analysis of Existing Coral Reef Ecosystem Resources and Processes

1.6.1 Analytical Approach

Fishery and Non-fishery Values:

The management measures of the FMP will, as recognized in the plan's ecosystem-based approach, affect not just the value of the federal coral reef fisheries directly being managed, but also adjacent coral reef fisheries (e.g., in state and territorial waters), other types of fisheries (e.g., pelagic and deep bottom), and reef-dependent non-fishery uses and values, such as tourism. A comprehensive benefit-cost analysis of the proposed measures would therefore require detailed determination of the physical processes connecting these aspects of the coral reef ecosystem and the effects of harvesting on these connections and processes, as well as assessments of the value of all these sectors and the changes that might be caused by harvesting and/or regulation. In concept that has been done here, but because of deficiencies in available data and methods, the assessment is only qualitative for many sectors, with specification of some quantitative ranges of plausible values derived from available data and studies in other parts of the world.

Notwithstanding the limitations of this assessment in providing accurate measures of the net value of the affected sectors, the valuation estimates should be useful in making comparisons among alternatives as well as between fishery and non-fishery uses of the coral reef ecosystem. Most importantly, they will give an idea of how much value is potentially "on the line" under the various management measures being discussed.

National Versus Foreign Benefits:

In this analysis, we are interested only in how the proposed management measures affect the national account, i.e., the value to the United States as a whole. If the catch is exported and consumed outside the US, the consumer surplus is not accruing to the national account and should be omitted from the assessment. Similarly, if foreign visitors in the US are enjoying producer surplus (e.g., as commercial fishermen) or consumer surplus (e.g., as visiting anglers), those components should be omitted from the assessment.

It should be kept in mind that while the generation of producer or consumer surplus outside the national account is not relevant in terms of assessing net economic value, it can be very important in terms of indirect economic impacts. The expenditures of foreign tourists that hire charter fishing services in Hawaii, for example, may bring great indirect economic benefits to the local economy, and the consumer surplus these anglers enjoy through fishing is, of course, an important motivation for them to visit the US and make those expenditures.

Net Present Value:

Impacts to net economic value are generally described in terms of how the total future stream of net benefits is affected. Net present value (NPV) is the measure of that stream of future net benefits (time-discounted benefits minus costs over time). It is the time-discounted (through use of a standard discount rate) sum of all future benefits less the discounted sum of all future costs. The alternative that yields the greatest NPV would be the preferred one, subject to other considerations such as indirect economic and social impacts and conflicting national standards (e.g., application of the Endangered Species Act). Estimates of NPV require projections of how the fishery and other harvesting activities will evolve. In most of the sectors affected by this FMP – and in particular for the non-fishery sectors, many of which are undeveloped or even unknown – this is difficult, requiring in a number of cases reasonable conjecture. The task is further confounded by the lack of information about even the current (annual) net value of some affected sectors, and by limitations in valuation methodologies. In short, it will not be possible to quantitatively estimate the NPV of most affected sectors under either the with- or without-action alternatives. Therefore, the analysis instead focuses on whether the impacts to the total NPV under a given alternative are likely to be positive or negative. The impacts of various alternatives will then be qualitatively compared in terms of direction and relative magnitude of impacts to provide a simple benefit-cost analysis of alternate management regimes.

In order to provide points of reference – for example, to roughly compare values among affected economic sectors, some measures of the possible bounds of net benefits will be made. Net economic benefit is the sum of producer surplus and consumer surplus, less any public inputs such as management costs. In the case of a commercial fishery, producer surplus is equal to net returns from the fishery: ex-vessel value less all input costs (all harvesting costs, including labor). Consumer surplus in a commercial fishery is the net benefit of the product to consumers, i.e., their demand for the product less the purchase cost, summed across all consumers. In the case of a recreational fishery, consumer surplus is the net benefit to anglers, i.e., their willingness-to-pay to fish less the costs incurred in angling, summed across all anglers. If the angler is hiring charter services, the fishery may also generate producer surplus, equal to net charter revenues: charter fees less the costs

of operating the charter. There may also be consumer surplus in the charter boat case, i.e., the economic utility to the charter patron above the price he/she has to pay for the charter. In the case of subsistence fisheries, producer surplus and consumer surplus are one and the same, and they can be measured as willingness-to-pay less the cost of all fishery inputs.

In addition to these generally measurable benefits and costs, there are less direct and more difficult to measure values that should be accounted for. For example, just as purely recreational fishermen derive non-market values from fishing, many commercial fishermen do, as well. The social values of fisheries should also be accounted for in net value. Another important source of economic value is option value, which reflects the economic importance of keeping future options open – of not making irreversible commitments or changes to the resource. There is also what might be termed reverse-option value, the foreclosing of investment and other use opportunities in the near-term through overly-restrictive regulation. While options to engage in these types of activities may exist in the future (subject to natural changes in the environment, subsequent catastrophic natural or human events, etc.), the net present value of those options is reduced to the extent that they are pushed into the future.

Another type of value derived from fish populations, reef systems, etc. is existence value–the value derived by people who do not fish and do not consume fish, but who benefit from knowing that they have the opportunity to do so, or from the vicarious enjoyment of other peoples' fishing and consumption. For example, few people fish at the remote island of Midway, but many more anglers benefit from the fishery, as evidenced by the number of fishing magazines that feature articles on Midway. Existence value can clearly be affected by the management measures (e.g., negatively through direct closure of a fishery or positively through prevention of stock depletion that leads to the loss of harvesting opportunities). It should therefore be assessed as part of the net value of the fishery.

Furthermore, it is not just the value of traditional or developing fisheries that need to be assessed, but also other types of commercial exploitation of the coral reef ecosystem (e.g., aquarium fish collection, mariculture, and bio-prospecting), as well as reef-dependent non-fishery uses and values. Because this FMP addresses a range of effects on coral reef systems that have not been systematically analyzed in the fisheries literature or have only begun to be considered (either analytically or commercially), such as bio-prospecting, some of the discussion of economic impacts is hypothetical.

Finally, economic analysis usually requires a clear delineation of the physical and operational impact of an activity on the subsequent flow of economic resources from the affected natural resource asset (in this case, the coral reef ecosystem). Unfortunately the natural inter-relationships between particular components of the coral reef ecosystem are not well determined, at least quantitatively. As a result, it is frequently difficult or impossible to indicate to what extent the removal of a particular amount of a particular species will have on the surrounding ecosystem, and what effect, if any, that impact will have on economic values. It is relatively easy to identify the impact of regulation on the operation of existing harvesters, but less so on future operations. As a result, much of the regulatory impact review (and subsequent regulatory flexibility analysis) must take place at the level of principles, rather than quantities. This qualitative description of effects, or potential

effects, nonetheless should provide decision-makers with insights into the economic effects of the proposed management measures and their alternatives.

Time Scales:

Some non-fishery values are highly dependent on coral reefs being alive, diverse, and/or productive, while others rely more on the reef's fundamental structure – the reef as a well-placed mass of limestone. For example, in terms of protecting coastal property and providing calm waters for recreational water craft and shore-side activities, as long as the structure of the reef deflects waves and provides sandy beaches and lagoon bottoms, the values from these uses will remain high. A reef would have to be highly degraded before these values are affected – its physical structure would have to be substantially reduced. However, fishing-out a spawning aggregation of groupers or killing large areas of coral with cyanide can occur in just a year or two, and the consequent impacts to the value of scuba diving, for example, can be immediate and substantial. Thus, in terms of assessing the impacts of the fishery management measures proposed in the FMP, the time scales over which biological and ecological impacts are likely to occur are therefore very important.

Given that we as a society discount future benefits and costs substantially, any impacts that occur more than 20 to 50 years in the future are practically inconsequential in terms of present value. Society's annual discount rate is generally considered to be between 5 and 20 percent (this analysis has used a 7 percent rate). Even at a conservative discount rate of 5 percent, the difference in the present value of an activity over a 50 year time period versus a 100 year time period is only 9 percent. At a 10 percent discount rate, the difference is less than 1 percent. Clearly, assessments of NPV are sensitive to assumptions concerning the rates at which impacts occur.

Discount Rate, Time Horizon, and Inflation:

Where NPV is estimated, it is done by applying an annual discount rate of seven percent, following US government guidance (OMB 1992), and a time horizon of 25 years. Where there is reference in this analysis to NPV estimates from other studies, those estimates have been adjusted using seven percent and 25 years in order to facilitate comparison.

Except where otherwise noted, dollar figures have been inflation-adjusted to 1999 dollars using consumer price indices (CPI). Hawaii, American Samoa, and Pacific-wide values have been adjusted with the urban CPI for Honolulu (DBEDT, no date). Guam and the CNMI values have been adjusted with the Guam CPI (GDC, 1999). All others will be adjusted with the US city average CPI (BLS, 1999).

Measuring Producer and Consumer Surplus in Fisheries:

Pooley (1993b:93) notes that "...the distinction between 'commercial,' and 'recreational and subsistence' fishing in Hawaii is a weak [one]," and the same is true throughout the US Pacific Islands. The coastal fisheries of the region are dominated, at least in terms of numbers of fishermen, by small-scale, part-time fishermen that have variously mixed motivations to fish. They derive benefits as both producers and consumers–that is, consumers of both seafood and enjoyment. Even purely commercial fishermen may derive some enjoyment, or consumer surplus, from fishing, above

and beyond that reflected in their net revenues. In fact, for the purposes of this analysis there is no need to categorize fisheries as being commercial, recreational, or subsistence, as long as all aspects of both producer and consumer surplus in each fishery are accounted for. Such comprehensive accounting is a difficult challenge in any fishery, let alone the fisheries of the US Pacific Islands. Data from the region on landings alone are often incomplete, unreliable, and/or not sufficiently disaggregated by species, area, or harvesting sector. Data on prices and gross revenues are available for many fisheries, but data on harvesting costs are rare, as are assessments of non-market values (e.g., willingness-to-pay to fish or to consume seafood).

For two reasons–the mixed and highly variable motivations among participants in the fishery and the lack of economic data–the net economic value of the affected fisheries is not rigorously assessed here. Instead, quantified assessments have been done only on the elements of net economic value for which data are available–the ex-vessel value of the catch, and management costs. Both commercial and non-commercial catches are valued using prevailing ex-vessel prices. Charter fee revenues are considered the ex-vessel value of charter sport fisheries (the value of charter landings is assessed separately within the "food" fisheries).

Ex-vessel value can be viewed as the absolute upper bound to producer surplus. Producer surplus, however, is often less than zero. For example, the small-boat fishermen in Hawaii called "expense fishermen" by Hamilton and Huffman (1997) sell part of their catch to offset fishing expenses, but their expenses still outweigh their revenues. Their motivations are clearly a mix of recreation and commerce, and probably subsistence, as well. However, these fishermen are undoubtedly receiving enough consumer surplus (e.g., enjoyment) to offset that negative, and the net value of such a fishery can reasonably be assumed to be greater than zero.

The consumer surplus that accrues to fishermen is not estimated here, but because of the obvious problems with relying on ex-vessel value as an indicator of net value, the estimates of ex-vessel value will be supplemented with descriptions of possible ranges of fishermen's consumer surplus. Reviews of non-market valuations of consumer surplus from other fisheries are provided where possible, but extrapolation from one socio-economic and natural setting to another is in general not advised.

Allocation of Costs and Benefits:

A distinction must be made between the coral reef fisheries (resources) that would fall under this FMP's primary jurisdiction and those that would not–that is, those in territorial waters and those managed under other FMPs, including lobsters, precious corals, and most commercial bottomfish species. Most harvesting of coral reef resources takes place in territorial waters which would not be subject to the management measures, but the federal/state boundary (much less the 50 fathom contour line), is not a practical one for most fishermen nor for the various government agencies that monitor fisheries. Existing catch and effort data are therefore not easy to sort by federal versus state waters, and dividing the economic values of the fisheries between the two components is not easy. This analysis includes estimates of the total landings and value for each coral reef fishery sector and for the "FMP portion" of the total, the latter being that portion of the total coral reef resources that are derived from federal waters and that would be subject to the FMP.

1.6.2 Net Present Value of Coral Reef Fishery Sectors

Concepts and techniques for valuing coral reefs and other ecosystems have developed greatly in the last decade. The main application of valuation techniques has been for the purpose of measuring the actual (e.g., in the case of a vessel grounding) or projected (e.g., in the case of this FMP) impacts to the net value of a specific area of coral reef. Most approaches have involved identification of all the values associated with coral reefs, and to the extent possible, quantification of them. Direct uses that have markets, such as fisheries, can be assessed using market values. Indirect uses and values that have no markets can be assessed using contingent valuation techniques that measure consumer surplus–basically polling people to determine what they would be willing to pay to not lose a given resource. This method is very dependent on which and how many people are polled, and what questions they are asked. It is also dependent on the information people have–if they do not have an understanding of the actual or potential values that can be derived from the genetic material of coral reefs, for example, they cannot be expected to place a reasonable value on those resources. The calculation of replacement cost is another method which can also be used to estimate the value of a particular product, function, or service provided by reefs.

Discussed below are the many products, functions, and services provided by coral reef ecosystems, including the extractive fisheries to be managed by this FMP. It should be kept in mind that some values of coral reefs are partially or wholly mutually exclusive, so the values identified below are not necessarily additive. Mining of corals, for example, is likely to detrimentally impact other values of the reef.

Over-valuation can also occur through double-counting particular values–once inside the "coral reef" sector and again, at least implicitly, outside the sector (Costanza *et al.* 1997). Spurgeon (1992), for example, suggested that the value of coral reefs includes the mineral and pelagic fisheries values associated with increased property rights to coastal states afforded by the UN Convention on the Law of the Sea. The convention allows coastal states to make certain claims to marine resources 200 miles not just from shore, but from exposed reefs up to 12 miles from shore. "By increasing the extent of coastal zones, these reefs can be responsible for significant economic benefits" (*ibid*:533). Clearly these provisions affect the distribution of benefits among countries, and they may in fact increase total available benefits if they lead to more effective management. To attribute any such increase in benefits to the coral reefs themselves is a bit dangerous. It would be equally justifiable to attribute any increased value to the negotiators of the convention as to the reefs.

In an assessment of the world's natural capital and ecosystem services, Costanza *et al.* (1997) emphasized the interdependence of ecosystems and their services, and suggested that the next logical step in valuing ecosystem services would be the development of "general equilibrium" models to replace the typical approach of treating each ecosystem and each service independently and then summing their values. In other words, although this analysis is based on an ecosystem-based approach to valuation (as the entire FMP is based on an ecosystem-based approach to management), it may run into the same types of problems as a species-based approach, only at a more general level.

Another problem in valuing the total value of ecosystems is that ecological services tend to have much different supply and demand curves than products and services with markets. As described in Costanza *et al.* (1997), essential ecosystem services, such as clean air, are substitutable only up

to a point. Demand will approach infinity as supply approaches zero, so consumer surplus and total value approach infinity, as well.

In sum, assessment of the values of coral reef ecosystems is complex and problematic. This analysis is mostly limited to a qualitative discussion of the various types of values associated with coral reefs, supplemented with examples of valuations made elsewhere. Certain reef-associated sectors, primarily the fishery and tourism sectors, are treated more thoroughly, with quantitative assessments based on market values and contingent valuation studies.

Producer and Consumer Surplus to Fishermen:

Meyer (1987) examined in 1986 the motivations, revenues, costs, and non-market values associated with part-time resident boat fishermen of Hawaii (fishermen who did not make their primary living from commercial fishing). He estimated that the state-wide ex-vessel revenues from fish sales by this fleet of about $35 million (all values have been updated to 1999 dollars) were almost equal to estimated fishing inputs (about $38 million). The non-market benefits that accrued to the boat fishermen in addition to their sale revenues, however, were estimated through interviews with members of various fishing clubs to reach about $378 million. This estimate was based on the fishermen's assessment of the "fair" value, over costs, of an hour of fishing, and they were prompted to compare that value with the value of their time when working–their wage rate. The resulting average hourly non-market value of fishing ($31/hour) was about equal to the average wage rate of the fishermen ($32/hour). In other words, the fishermen were willing to pay to fish at a rate about equal to what they received to work at their regular jobs. This figure may be unrealistically high, in part because of the small time scale over which it was assessed (one hour rather than one day, month, or year), and because of the prompting to compare it with the value of their labor.

These estimates are not equivalent to the willingness-to-pay (WTP) approach discussed earlier concerning the estimation of consumer surplus in non-market circumstances. It perhaps represents a "willingness-to-accept compensation" for the loss of their fishing opportunities, which for a variety of economic and theoretical psychological reasons might deviate rather considerably from the WTP approach. Still, it is clear that the ex-vessel reported commercial value of the catch–estimated in Meyer (1987) to be equivalent to about 10 percent of the non-market value–is a poor indicator of the net economic value of the fishery–at least for Hawaii's "recreational" fleet.

Charter fisheries have also been assessed for the surplus values they generate for anglers. Samples and Schug (1985) estimated the consumer surplus of Hawaii's charter fishing patrons to be $95 per angler-trip (again, all values have been updated to 1999 dollars), equal to about half the charter fees paid. The study focused on the troll charter fishery that dominates the industry, and found that willingness-to-pay was strongly influenced by the probability of landing a blue marlin. It is doubtful the results are applicable to coral reef charter fisheries. Charter fisheries for coral reef species are generally of two types. In Guam and Saipan, the larger market is for generally inexperienced anglers making short trips on large party boats, fishing shallow bottoms with baited hooks. The still-developing charter fishery on Midway, in contrast, attracts experienced anglers that fish for several days with various methods, including spin-casting on the reef and sand flats and trolling for big game fish. Charter fees in the latter type of fishery are much greater than in the party boat fishery, and the potential for generating large consumer surpluses is probably also greater.

In order to generate a plausible range of fishermen's consumer surplus of the region's current coral reef fisheries, some simple assumptions have been applied. It should be emphasized that these assumptions are quite speculative, and when combined with the already tenuous assumptions used in estimating the volume of landings and charter trips, the results are useful for little more than illustrative purposes. The assumptions follow and the results are shown in Table 9.

Assumptions:

All coral reef food and ornamental fisheries generate some non-market value to fishermen–they all have a recreational aspect.

Recent average annual fisheries volumes are as estimated in Tables 2 through 9.

The average catch rate in the food fisheries is five pounds per hour fished (derived from data in Dalzell *et al.* 1996), and in the ornamental fisheries, five pieces per hour fished.

The non-market value to fishermen in the food and ornamental fisheries, measured as a surplus (i.e., willingness to pay above and beyond actual costs), is assessed under "low" and "high" scenarios, with fishermen's consumer surplus estimated as a percentage of the prevailing average wage rate:

1) in the low scenario, 20% of the wage rate;
2) in the high scenario, 100% of the wage rate.

The prevailing average private sector wage rates are $5/hr in American Samoa, $7/hr in the CNMI (citizens only), $9/hr in Guam (Bank of Hawaii 1997 a, b, and c), and $10/hr in Hawaii and the unincorporated islands (the recreational fishermen studied by Meyer (1987) had much higher-than-average wage rates).

Angler's consumer surplus in the charter coral reef fisheries is assessed under low and high scenarios:

1) in the low scenario, $25/angler-trip in Hawaii (including Midway) and $5/angler-trip in the other islands (about 1/6 the charter fees);
2) in the high scenario, $100/angler-trip in Hawaii and $20/angler-trip in the other islands (about 2/3 the charter fees).

Table 9. Consumer Surplus to Coral Reef Fishermen ($1,000/year)

	Am. Samoa	CNMI	Guam	MHI	NWHI	Other islands	All islands
Food	68 to 342	139 to 693	149 to 743	2,000 to 10,000	106 to 530	4 to 21	**2,466 to 12,329**
Sport	min	8 to 32	51 to 204	10 to 50	8 to 38	0	**77 to 324**
Ornamentals	1 to 5	min	9 to 43	173 to 866	0	0	**183 to 914**
TOTAL	**69 to 347**	**147 to 725**	**209 to 990**	**2,183 to 10,916**	**114 to 568**	**4 to 21**	**2,726 to 13,567**

Based on the assumptions made above, a plausible range of the total consumer surplus that accrues to coral reef fishermen in the US Pacific Islands is $3 to $14 million per year. Assuming no change in the future, this implies a present value of $32 to $158 million (7% discount rate over 25 years).

Management Costs:

The annual management costs for the coral reef fisheries of each of the island groups are presented in Table 10. The estimates are based on data for the years 1997-1999. They include funds spent through the Sportfish Restoration Program administered by the US Fish and Wildlife Service, the Western Pacific Fishery Information Network, administered by the National Marine Fisheries Service, and funds administered by state and territorial fisheries agencies. The estimates are necessarily rough for several reasons. First, it was difficult to distinguish some management costs by fishery–that is, separating the coral reef, pelagic, deep bottom, and freshwater components of management costs. Second, it was difficult to obtain information on state and territorial spending. Third, it was difficult to distinguish spending on fisheries "management" from spending on fisheries "development." In general, funds spent on surveys and monitoring, research, rule-making, and enforcement, and a portion of funds spent on education and outreach, were considered management costs.

Table 10. Current Annual Coral Reef Fishery Management Costs ($1,000/year)

American Samoa	CNMI	Guam	MHI	NWHI	Other islands	All islands
500	330	500	1,520	230	0	**3,080**

Estimates are derived from 1997-1999 grant data from the US Fish and Wildlife Service (Sportfish Restoration Program), 1997-1999 grant and budget data from the National Marine Fisheries Service (Western Pacific Fisheries Information Network), and estimates of spending by local sources. The division in costs between the Main and Northwestern Hawaiian islands is not an actual division in spending; it is simply the total costs in Hawaii divided according to the ex-vessel value of the fishery, as estimated above.

The estimated total of $3.1 million in management costs is conservative because there are additional federal funding sources for fisheries management that were not accounted for. Funds spent by coastal management and environmental agencies, some of which contribute to coral reef fisheries management, were not included. Funds spent by the US Fish and Wildlife Service in managing the Wildlife Refuges were not included. Funds spent by the WPRFMC on the crustacean, bottom fish, and precious coral fisheries were not included. Funds spent through other grant programs administered by the National Marine Fisheries Service (mostly for fisheries development) were not included.

Based on Table 10, more than half the spending on management was in or for Hawaii, and the rest fairly evenly distributed among American Samoa, the CNMI, and Guam. Using the ex-vessel value estimates from Table 2, management costs in Hawaii were equal to about 15 percent of the ex-vessel value of coral reef fisheries. In American Samoa, they were equal to about 73 percent of ex-vessel value, in Guam, about 32 percent, in the CNMI, about 25 percent, and overall, about 20 percent.

Net Present Value Given Current Conditions:

The annual ex-vessel value of the region's coral reef fisheries was estimated at $15 million. If these fisheries are like most, those revenues were almost, or more than, offset by fishing costs, which were not directly assessed here. A plausible range of the non-market value, or consumer surplus, that accrued to fishermen was estimated at $3 to $14 million per year. Public inputs into management were estimated to be about $3 million per year. If ex-vessel value is assumed to be completely offset by fishing costs, and the surplus to seafood consumers is assumed to be relatively small (e.g., $1 to $3 million per year), these figures suggest a net value of $0 to $15 million per year. If unchanged in the future, this would imply a net present value of $0 to $175 million (assuming a 7 percent discount rate over a 25 year horizon).

Net Present Value Given Likely Future Developments:

It is not possible to accurately project how the region's coral reef fisheries would develop in the no-action scenario. However, some general discussion about possible courses of fishery development is necessary in order to better characterize the no-action alternative and to compare the likely cost-effectiveness of the various management alternatives.

Most current harvesting of coral reef resources is for food; the biological yields and per-unit values of ornamentals, sport catches (which can be released), and marine natural products are less well known and more variable. More importantly, net value, not gross value, is generally the parameter of interest. One of the most important fishing cost items is travel to and from the fishing grounds. Fishing pressure is close to zero at many of the region's reefs because travel costs are prohibitive. Relatively high gross values would have to be available to justify travel to the more remote reefs. Lobster and deep bottom fishing in the

Northwestern Hawaiian Islands and sportfishing at Midway are good examples of such high value (and high cost) fisheries. The per-unit gross values of lobster and deep bottom fish are relatively high. The relatively high angler surplus available from fishing the relatively pristine reefs of Midway, combined with the availability of a landing strip and shore-side support facilities, make the generation of net benefits from sportfishing feasible.

Government restrictions are also important determinants of where and what type of harvesting is likely to develop. Inshore sportfishing at Midway, for example, could not have developed without the US Fish and Wildlife Service relaxing its restrictions on harvesting in the wildlife refuge. Tighter restrictions in territorial waters, technological innovations that would reduce costs for long distance harvesting, or decreased productivity in territorial waters would also tend to increase the feasibility of harvesting in more distant federal waters.

Following are profiles of several possible scenarios of future developments. It is emphasized that the main purpose of the FMP is to anticipate and control such changes. The scenarios include development of a live reef fish fishery, which would most likely occur in the remote islands of the CNMI, expansion of the ornamentals fishery, most likely in the Northwestern Hawaiian Islands or the remote islands and reefs of the CNMI, and development of bioprospecting activities. Another possibility is development of coral reef sportfishing at Palmyra, Wake, or Kingman, where access by air is possible, as at Midway.

Distant Finfish and Live Finfish:

The remote northern islands of the CNMI have been intermittently exploited for reef fish and deep bottom fish. Growth in the CNMI's resident and tourism populations will influence the attractiveness of those fishing grounds to supply product for the local market. The high value Asian market for live reef fish may also drive development of fisheries into areas within reasonable reach by ship or with cost-effective air freight costs. Well-financed harvesting and transport operations based in Asia have conducted profitable harvesting in many remote areas of the Pacific, many of them apparently only cost-effective because they are able to move on to new and more productive fishing grounds at any time.

Ornamentals:

Ornamentals are currently being collected only on reefs within easy reach of ports and shorelines. The Northwestern Hawaiian Islands may have a relatively great abundance of high-value species, but so far their collection does not appear cost-effective relative to working in the main islands. Increases in prices of increasingly regulated species and products, such as live rock, could increase the motivation to fish in federal waters and on remote reefs.

Sportfishing:

Palmyra, Wake, and Kingman (via Palmyra) may have the potential for tourism development, including sportfishing similar to what is done at Midway (see EIS). After three years of opening to the public, Midway is attracting about 250 fishermen and divers per year. The potential for growth of these types of operations, either on Midway or other islands, is not known.

Natural Products:

Bioprospecting could develop almost anywhere that locally endemic species are found. Given the 16,000 km^2 of coral reef in the region (Hunter 1995), the estimate of food fish landings made here (6.5 million pounds) implies a per-unit-area yield of about 430 lb/km^2-yr, or about 0.2 mt/km^2-yr. Yields were, of course, much higher in localized areas, and the 0-3 mile zone had higher yields than the reefs in federal waters. Dalzell and Adams (1997), for example, reported about the same level of annual landings for American Samoa (176mt) as estimated here (155mt), but identified the catch as coming from only 25 km^2, implying a yield of 7 mt/km^2-yr. When measured against the 270 km^2 of the whole of Tutuila (Hunter 1995), the yield would be only 0.7 mt/km^2-yr.

Munro and Williams (1985) suggested an average worldwide maximum sustainable yield of coral reef organisms of 15 mt/km^2-yr. This is in good agreement with a tentative estimate by Dalzell and Adams (1997), who applied what they emphasized to be an overly simple surplus production model. The model was fitted with yield estimates from various Pacific Islands (ranging from 0.3 to 64 mt/km^2-yr) and with human population per unit area of reef (ranging from 3 to 3,000 $people/km^2$) as a proxy for fishing effort. The model predicted a maximum sustainable yield of 16 mt/km^2-yr. The current yield from the US Pacific Island coral reefs is only about one percent of these estimates. Even in localized areas of relatively heavy fishing, such as around Guam and Tutuila, the yields appear to be well below these levels, consistent with the general belief that they are overfished (see body of FMP, and Green 1997). Dalzell and Adams (1997) reported recent yields from Guam and Tutuila to be 0.8 and 7.0 mt/km^2-yr, respectively, although a 1982 estimate from Tutuila that was based on only 3.6 km^2 of reef estimated a yield of 17.0 mt/km^2-yr (Wass 1982).

1.6.3 Net Present Value of Coral Reef Non-fishery Sectors

Tourism:

Coral reef-based tourism is very important in many countries. In the US Pacific Islands, it is especially important in Hawaii, Guam, and the CNMI. Scuba diving and snorkeling are two of the most obvious reef-dependent tourism activities. Others include underwater observatories, such as in Guam and glass-bottom boat tours. Activities that are partially

dependent on the protected lagoons formed by reefs include swimming, jet skiing, other small water craft activities, and all the beach and shoreline activities that coral reef ecosystems attract. The aesthetic qualities of coral reefs and lagoons as viewed from the shore are also important to tourists.

Some of these uses compete with and compromise other values. Scuba divers and snorkelers, for example can degrade reefs through physical contact. Jet skis have caused dramatic changes to localized areas of substrate in Guam.

There is a varying degree of dependence on coral reefs among these uses. The attraction of a reef to scuba divers and snorkelers, for example, depends on its aesthetic qualities, which are determined in large part by the complexity, diversity, vivacity, and density of its corals, fishes, and other organisms, as well as the degree of human congestion in the water. In general, the less degraded the reef, the higher the value, although proximity to tourist centers is critical. Other uses and values, such as personal water craft activities, shore-side tourism and recreation activities, and breakwater values, are much less dependent on the quality of the reef ecosystem per se (unless a degraded reef leads to increased siltage, intrusive sea grasses, etc.).

Net economic value from tourism includes the producer surplus that accrues to providers of tourism services (e.g., dive boat operators) and the consumer surplus that accrues to tourists. Some of what would otherwise be consumer surplus is often transferred to the public's producer surplus through the imposition of fees, such as entrance fees for parks.

An economic assessment of the value of Bonaire, in the Caribbean Sea, was done in 1991 (Dixon *et al.* 1994). The entire marine area surrounding Bonaire, to a depth of 60 meters, is a marine park, managed primarily for diving. The island economy is almost entirely dependent on tourism, which is centered around diving. A survey of visiting scuba divers revealed an average willingness-to-pay to visit the park of about $33 (all values have been updated to 1999 dollars), above and beyond actual costs. Applying a per capita consumer surplus of $33 to the approximately 17,000 divers visiting each year yields a total annual consumer surplus of about $561,000 (in fact, $207,000 was transferred to producer surplus through a visitor fee). Most diving, of course, takes place in a relatively small portion of the island's reefs. But an appropriate measure of value per unit area can be estimated by dividing the total consumer surplus by the island's total reef area. With roughly 100 km of coastline, and assuming an average reef width of 1 km, annual divers' consumer surplus totaled roughly $5,600/km^2 of coral reef. Based again on a 7 percent discount rate over a 25 year time period, this yields a net present value of about $0.07/m^2 .

In an assessment of a small developed coastal tourism area in Sri Lanka (with a fringing reef of about 0.25 km^2), the producer surplus from tourism was estimated at $156,000/km^2-yr, and

the consumer surplus of tourists at $223,000/km^2-yr (1999$) (Berg, *et al.,* 1998). Discounted at 7 percent over 25 years, this yields a net present value of $4.40/m^2.

In a study of dive and snorkel-based tourism in West Lombok, Indonesia, Riopelle (1995) estimated the net present value (producer surplus only) of diving and snorkeling on the local reefs to total about $33 million (adjusted from the author's 10 percent to a 7 percent discount rate), or about $760,000 per km of coastline. Derived from the profits on expenditures by 19,000 visiting divers and 50,000 snorkelers, this is equivalent to a producer surplus of $41 per visitor. West Lombok was described as having "major tourism potential," but still considerably less than other Indonesian locales, including Bali. It was suggested that a linear km of coastline is roughly equivalent to about one square km of coral reef, so the range of net present value from coral reef-related tourism in Indonesia, encompassing the "no tourism" and "major tourism" situations, was $0 to $1.40/m^2 (1999$; adjusted from a discount rate of 10% to 7%; over a 25 year time period; derived from Cesar, 1996).

In the U.S. Pacific Islands, dive and snorkel-based tourism is a small percentage of overall tourism activity. As a result, the economic values given above should not be extrapolated to the reef coastlines adjacent to the major tourist areas (e.g., Waikiki on Oahu or Tumon Bay in Agana), and even less so should they be extrapolated to distant reef areas (e.g., the Northwestern Hawaiian Islands or the northern part of CNMI). Indeed, there are legitimate questions about the extent to which under-water tourism can be expanded in any of the heavily inhabited areas given already high levels of shoreline and near-shore recreation by residents. Unfortunately no adequate metric exists of the under-water tourism values in the Western Pacific Region.

Turning to the US Pacific Islands specifically, Table 11 summarizes the tourism activity in each of the island groups.

Table 11. Marine Tourism and Scuba Diving: Annual Economic Activity by Island Group

	American Samoa	CNMI	Guam	Hawai'i	Total
Number of tourists	6,000	600,000	1,300,000	6,800,000	**8,800,000**
No. of tourists primarily "marine"	600	500,000	850,000	4,400,000	**5,750,000**
No. of tourists scuba divers	100	30,000	130,000	75,000	**235,000**
% of tourists American	80	12	5	54	**43**
Expenditures by tourists	$3m	$600m	$1,500m	$10,000m	**$12,100m**
Expenditures by "marine" tourists	$0.3m	$500m	$650m	$6,500m	**$7,650m**
Expenditures by scuba divers	$0.05m	$30m	$150m	$110m	**$290m**
Expenditures on marine recreation				$700m	
Expenditures on scuba diving		$16m		$28m	
Number of scuba dives	500	120,000	500,000	300,000	**920,000**
No. employed in tourism		8,000	20,000	170,000	**198,000**
No. employed in marine recreation				6,200	
No. employed in scuba diving		150		650	
Gov't. revenues from tourism			60% of tot	30% of tot	
Tourism as % of gross local prod.				26	

Data sources and assumptions are given in Section 4.
"m" means million; for example, "$3m" means $3 million.
Expenditures by tourists, by "marine" tourists, and by scuba divers include all local vacation expenditures.

The US Pacific Islands receive almost 9 million tourists each year, most of whom visit for reasons related to marine recreation and the marine environment. However, overall only about three percent of tourists scuba dive, varying between 1 percent in Hawaii and 10 percent in Guam. It is not possible to assess the net economic value of this tourism accurately, but some simple assumptions can be used to provide a plausible range of its net value.

Assumptions:

Producer surplus is between $50 and $200 per visitor-trip (i.e., profits of roughly 5 to 20% on visitor expenditures).

Consumer surplus is between $50 and $200 per visitor-trip (i.e., on average, each visitor would have been willing to pay an additional $50 to $200 for his or her vacation experience).

In Tables 12 and 13 are these assessments for all "marine" tourists, and for scuba divers only. These represent projections based on hypothetical values but they are the best available comprehensive estimates of these economic values at this time and would appear to provide order-of-magnitude estimates.

Table 12. Net Annual Value of Marine-based Tourism

	American Samoa	CNMI	Guam	Hawaii	Total
No. "marine" tourists/year	600	500,000	850,000	4,400,000	**5,751,000**
No. Amer. marine tourists/yr	480	60,000	42,500	2,376,000	**2,479,000**
Total Am. tourists' surplus ($1,000/year)	24 to 96	3,000 to 12,000	2,125 to 8,500	118,800 to 475,200	**123,949 to 495,796**
Total producer surplus ($1,000/year)	30 to 120	25,000 to 100,000	42,500 to 170,000	220,000 to 880,000	**287,530 to 1,150,120**
Net value ($1,000/year)	**54 to 216**	**28,000 to 112,000**	**44,625 to 178,500**	**338,800 to 1,355,200**	**411,479 to 1,645,916**

Table 13. Net Annual Value of Scuba Dive-based Tourism

	American Samoa	CNMI	Guam	Hawaii	Total
No. of scuba divers/year	100	30,000	130,000	75,000	**235,000**
No. of American divers/year	80	3,600	7,000	41,000	**51,600**
Total Am. divers' surplus ($1,000/year)	4 to 16	180 to 720	350 to 1,400	2,050 to 8,200	**2,584 to 10,336**
Total producer surplus ($1,000/year)	5 to 20	1,500 to 6,000	6,500 to 26,000	3,750 to 15,000	**11,755 to 47,020**
Net value ($1,000/year)	**9 to 36**	**1,680 to 6,720**	**6,850 to 27,400**	**5,800 to 23,200**	**14,339 to 57,356**

These rough assessments of the value of marine-based tourism suggest that the annual net value of marine-based tourism is $0.4 to $1.6 billion, and that scuba diving-based tourism contributes 3 to 4 percent of the total, i.e., $14-58 million. Assuming no change in the future, this implies a net present value of $5 to $19 billion for the discounted value of marine-related tourism in these islands, or $179,000 to $715,000 for scuba and diving-based tourism. Obviously the latter is the most relevant value for determining coral reef ecosystem-related net benefits, although some benefits accrue to the non-diving part of marine tourism.

Most tourism activities, including scuba diving, take place in territorial waters (or in the CNMI, in the "inshore management zone"). Exceptions are in Guam, where divers sometimes visit 11-Mile Bank, and at Midway, where all waters are federal waters. Between 100 and 150 scuba divers are estimated to have visited Midway in each of the last several years (Glover, pers. comm.).

Although tourism in federal waters is currently very limited, there appears to be some likelihood of growth. The tourism enterprise at Midway is only three years old, and will probably grow. Palmyra, Wake, and to a lesser extent, Kingman, may offer similar opportunities. The potential for tourism development in these remote islands, however, is very small compared to current and potential tourism use of the populated islands. Midway receives less than 1,000 visitors each year. However, such tourism can also lead to improved public awareness of these unique natural resources and consequently to improved protection of those resources.

Recreation:

"Recreation" as used here refers to uses by island residents rather than by tourists. The activities and values that bring recreation benefits are more or less the same as those in the tourism category. One difference, as defined here, is that recreation benefits to residents also include the quality of life, cultural, and heritage values associated with living near and in association with the coral reef ecosystem, and any values associated with having a tradition of doing so. Also, even when coral-reef

activities are not directly undertaken, having the option to do so is an important value to many island residents.

In Hawaii in the early 1990s, it was estimated that on a typical busy day, at least 170,000 people (including tourists) were swimming or visiting beaches and shorelines, 23,000 were surfing, 25,000 were fishing, 3,000 were paddling, 18,000 were boating, and others were diving (Clark, 1991).

These activities are clearly very important in the US Pacific Island communities, and participation in reef-associated recreation must be close to 100 percent of resident populations.

It would be very difficult to accurately assess recreation values, and a rigorous assessment will not be made here. But the following scenarios can illustrate a way to think about the value of recreation. The resident population of the US Pacific Islands is about 1.5 million. If every person was willing to pay $10 per year to maintain their reef-related recreation opportunities (in addition to costs already incurred), it would imply a total consumer surplus of reef-associated recreation of $15 million per year. At $1,000 per person, it would be $1.5 billion.

Reef-associated recreation also generates producer surplus. MacDonald *et al.* (1996) estimated expenditures in Hawaii's ocean recreation industry (including expenditures by tourists–already accounted for above) to be $700 to $800 million per year. If profits were 10 percent of expenditures, for example, producer surplus would be $70 to $80 million per year.

However, most reef-associated recreation occurs in territorial rather than federal waters. The economic value of off-shore coral reefs may depend on the "ecological services" provided by these components of the ecosystem, but this contribution is not well known. Exceptions to the off-shore element of this recreational activity include Johnston, Wake, and Midway, where there are small resident populations, and Rose atoll in American Samoa, the northern islands of the CNMI, and the Northwestern Islands of Hawaii, where some visitation by residents occurs. Recreational fishing for tourists is also being developed at Palmyra. There is a modest potential for growth of recreation in these federal waters.

Because recreation values are likely to respond to a given management alternative in a similar way as tourism values, the two sectors will be grouped together in the discussion of impacts in Section 1.7.

Breakwater:

Coral reefs serve as natural breakwaters, deflecting the energy of waves and inhibiting shoreline erosion. Shoreline damage from typhoons has been observed to be less where reefs are broad (Birkeland 1997a). They also provide sheltered waters for navigation, mooring of vessels, and port facilities. They form calm embayments that are valuable for swimmers, snorkelers, and beach-goers, they make surf breaks, and they produce beach sand, all bringing tourism and recreation benefits (but these latter values should not be double-counted with the tourism and recreation values already addressed).

Some of these values can be quantified, such as in localities where reef degradation leads to shoreline erosion and the loss of property with known value. In an assessment of the value of Indonesia's coral reefs, the protective net present value of coral reefs was estimated at $1,110 per km of sparsely populated coastline (about 0.001/m^2 of reef), $0.07/$m^2$ along coastlines with some development (roads and houses), and $1.36/$m^2$ along coastlines with major tourism infrastructure (in 1999 dollars, adjusted from 10% to 7% discount rate, over 25 years) (from Cesar, 1996). Using the same approach in Sri Lanka, the cost of coastal erosion was estimated to be between $0.002/$m^2$ and $2.00/$m^2$, depending on the land use (1999$, 7% discount rate applied over 25 years) (from Berg, *et al.,* 1998).

The cost of replacing the reef with an artificial breakwater could also be used to assess these values. In Sri Lanka, where coral mining has apparently led to coastal erosion, the costs of building preventative revetments, groins, and other breakwaters was estimated to cost between $248,000 and $844,000 per kilometer of shoreline (1999$) (Berg, *et al.*, 1998). Assuming a reef width of one kilometer, these replacement costs would translate to coral reef net present values of $0.25 to $0.84/$m^2$.

The reefs located in federal waters do not, generally, serve as breakwaters for coastlines that are highly developed. They are either on isolated banks or they surround generally undeveloped islands, including Palmyra, Kingman, Baker, Howland, and Jarvis, as well as the more developed islands of Johnston, Wake, and Midway. The value of these reefs as breakwaters, therefore, is derived more from protecting relatively pristine and valuable natural resources rather than protecting recreation areas and developed properties with easily assessed market values. Many of the remote atolls and emergent lands under federal jurisdiction, for example, are important as habitat for seabirds, sea turtles, and the Hawaiian monk seal. Assessing these aspects of the breakwater values of coral reefs would be more difficult than assessments based on market values of developed coastline properties, and it will not be attempted here.

While these breakwater values are clearly very high, it is not clear that any of the FMP management measures would have an impact on them. Impacts to the structure of the reef stemming from overfishing or damage from anchors, gears, and vessels may occur too slowly to be of any consequence in terms of impacts to NPV (see "time scales," above).

Wilkinson *et al.* (1999) assessed the economic impacts of the 1998 coral bleaching event in the Indian Ocean, using an "optimistic scenario" and a "pessimistic scenario." In the latter, damage was assumed to be severe and recovery slow or nonexistent. It was further estimated or assumed that the annual fisheries value would decline by 25 percent after 5 years, and the annual value of coastal protection, tourism, and other services would decline by 50 percent after 10 years. In other words, it was estimated that within 10 years of a near complete die-off of coral, without any direct physical disturbance, the reef would become susceptible to physical and bio-erosion and lose its ability to break waves to the point that half the value of the coastal lands that it protects would be lost.

In an assessment of the value of Sri Lanka's reefs, it was estimated or assumed that the breakwater value of the reef would decrease to zero and the fisheries value would decrease to one fifth after five years of coral mining (for lime production) (Berg *et al.* 1998).

On the scale of thousands of years, the balance between the rates of subsidence, accretion, erosion, and sea level change will determine whether the reef remains near sea level and serves to break waves. But on the scale of tens of years, subsidence is inconsequential and sea level change is perhaps marginally important. Although waves can cause erosion of a reef, they can also cause accretion; which effect will dominate when a reef dies depends on the orientation of the reef and its wave environment, and again, the time scale. In short, it is unclear how quickly the breakwater function of coral reefs can decline, especially for the types of impacts under the control of this FMP–overfishing and damage from vessels, fishing and other harvesting gear, and anchors. For the purposes of this analysis, the impacts of the FMP measures on breakwater values are assumed to be nil, and the breakwater sector is omitted from the discussion of economic impacts in Section 1.7.

Mining:

Many island communities, especially those lacking in terrestrial resources, such as atolls, are dependent on their reefs for construction materials, including blocks, aggregate, and sand. Even before the introduction of heavy machinery, island communities had been for thousands of years removing limestone and live and dead coral heads from their reefs to build jetties, breakwaters, building foundations, and paths. These are, of course, extractive uses, so they may compete with and compromise other values–both fishery and non-fishery. Several measures proposed in the FMP treat the coral reef substrate as either a non-renewable resource or too essential for other values to be worth harvesting or mining.

It is not known how much reef material is being mined from each of the US Pacific Islands.

None of the FMP management measures are projected to have any impact on the value of coral reefs for mining. This sector is therefore omitted from the discussion of economic impacts in Section 1.7.

Ecological Support:

As emphasized above, the coral reef ecosystem is not separable from other ecosystems in terms of function or value. For example, there are important physical and trophic connections between coral reef, mangrove, and pelagic ecosystems. The larvae of many coral reef organisms are pelagic and contribute to the diets of pelagic species like tunas. Many deep bottom fish, including snappers, emperors, and groupers, use coral reef habitat as juveniles.

Coral reefs also play important roles in the global balances of calcium and carbon (Spurgeon, 1992). The global climate affects coral reefs and coral reefs affect the global climate.

It would be very speculative to put a value on these types of roles of coral reefs, and as noted above, there is the problem of determining what portion of the value of, for example, the pelagic ecosystem, is attributable to coral reefs, rather than to the pelagic ecosystem itself, as well as vice versa.

No quantitative estimates of these values will be made here, but likely impacts to these roles of coral reefs are provided in the summary table of impacts.

Information:

This category refers to the benefits to be derived from discovering (research) and sharing (education) information gleaned from coral reefs. Some information leads to applications that are useful for managing the ecosystem itself, including fisheries management. Since those values must be subtracted as costs in the fishery sectors, the more important values to consider here are those that are beneficial beyond understanding and managing coral reefs themselves. The value of using coral reefs to monitor global climate change would be one example. Discoveries that lead to the development of marine natural products, such as pharmaceuticals, are perhaps the most valuable "information" use of coral reefs. Value in this category is largely a function of biodiversity–the greater the diversity, the greater the chance of discovering valuable information.

Most bioprospecting attention is being paid to those organisms that rely on chemical defense mechanisms, including sponges and ascidians, because they are more likely to have novel or complex chemistries. Several coral reef species have been found to have chemistries that led to the development of useful pharmaceutical products, including a gorgonian, a red alga, and an ascidian (Birkeland, 1997a).

The extent of current bioprospecting activities in the US Pacific Islands is not clear. It is difficult to monitor, in part because the people doing the collecting in the water are not bioprospecting, per se, but often doing basic biological research. Specimens or information derived from specimens can pass through several hands before the research has anything to do with the development of marine natural products, although increasingly universities and other research centers are developing entrepreneurial off-shoots to capitalize on their faculty's research efforts.

One example of a well-monitored bioprospecting operation is the one carried out by the US National Institutes of Health. The agency contracts researchers to collect a wide variety of coral reef and other marine species in order to screen their chemistries for possible activity against cancer and AIDS. The Coral Reef Research Foundation, based in Palau, is currently doing the collecting in many areas of the world, primarily in the Indo-Pacific, where marine biodiversity is highest. For any of these agreements, as with other agreements for developing conservation zones or establishing toxic waste dumps, a considerable valuation problem exists for deriving the economic value to the people of the "host" site, both in the present and in the long-term.

It is important to note that the costs associated with research, development, and production of marine natural products can be quite high, leaving relatively little left as net value. Mendohlson and Balick (1995), for example, estimated the potential net value of all yet-to-be discovered rainforest drugs to be $160 billion (1999$), far less than previous estimates that looked only at gross value.

The conventional approach to fisheries net valuation is to assess only the net benefits generated during first phase of the fishery–the harvest phase. All subsequent phases–such as processing–that add value to the product are considered indirect benefits. In the case of marine natural products, very little net value is associated with the harvest, or even research and development phases. Most comes in the ultimate phases–the profits stemming from product sales and consumer surplus. In a study of Korup National Rainforest in Cameroon, it was determined that Cameroon–the owner and supplier of the forest-derived information–would stand to gain only $6,700 per patent for drugs derived from

indigenous plants (1999 dollars) (Ruitenbeck, 1989). Just what portion of the ultimate net benefits stemming from these types of products can be attributed to the information provided by coral reefs is an open question.

It is generally believed that the potential for coral reefs to provide valuable information has barely begun to be tapped. Both the current and potential information values of the coral reefs in the US Pacific Islands are difficult to assess and it will not be attempted here. The likely impacts of the FMP measures to those values, however, are provided in the summary table of impacts.

Biodiversity:

With their great number of species and their variety and complexity of habitats, coral reefs have a high diversity of chemistries and high evolutionary potentials. Rainforests have a greater number of species, but coral reefs have a greater diversity at higher taxonomic levels and a greater diversity of basic body plans and chemistry (Birkeland, 1997a).

Biodiversity on coral reefs is quite variable around the globe and there is a great range among the US Pacific Islands. Coral reef biodiversity among the island groups is compared in the FMP.

There are a range of benefits that are derived from the many forms and species that coral reef ecosystems support (e.g., the value of harvesting, which exploits many species). Even the aesthetic diversity of coral reefs is important, as it provides part of the appeal to divers. The "information" values addressed above include the benefits to be gained from discovering information that leads to the development of valuable products, and it was pointed out that the potential value of that information is a function of biodiversity. All of those values have been addressed in the previous paragraphs. The concept of biodiversity, per se, as having value is really just the maintenance of future options that such diversity provides. These are options that might lead to new extractive fisheries, to the development of marine natural products, or to what are now inconceivable uses or values. The value of biodiversity itself is really just part of option value, discussed below, and will not be considered a separate sector in the analysis of impacts.

Existence Value:

Existence value and option value are very difficult to quantify, but they are undoubtedly important with regard to the impacts of the FMP. Existence value is derived from the knowledge that a particular resource or opportunity to use that resource exists and is available to provide a range of benefits, regardless of whether it is actually used. Impacts to existence value are difficult to assess, in part because different groups are affected differently. For example, regulatory closure of a fishery could negatively impact the existence value enjoyed by anglers while positively impacting the existence value enjoyed by certain conservationists, researchers, or naturalists. While there is a literature on the measurement of existence values, we are aware of none for areas in the Western Pacific Region.

Option Value:

Option value, is, according to Krutilla and Fisher (1995) is, "the value, in addition to consumer surplus, that arises from retaining an option to a good or service for which future demand is uncertain." Retention of that option is lost if a management action (or no action) results in irreversible changes–in this case, to the coral reef ecosystem. For example, if biodiversity on a reef decreases, option value is almost certain to decrease.

A type of value related to, or a subset of, option value is "quasi-option value." This refers to the "benefits of delaying a decision when one of the alternatives involves an irreversible choice and uncertainty exists about the benefits of the alternatives" (Dixon, *et al.*, 1994:109). It can be viewed as the expected value of the information that can be gained by delaying a decision (Conrad, 1980). Both option and quasi-option value are relevant in this analysis because they provide the means to recognize, if not quantify, the values associated with applying the precautionary approach to the management of coral reef fisheries. The rationale for using conservative biological reference points is reflected in option value. The rationale for conservatively controlling entry into a fishery until more information is gathered (e.g., through the permitting measures) is reflected in quasi-option value.

Existence value and option value do not necessarily track together. However, for the sake of simplicity, and because there is not enough information to accurately assess the impact on either one (as will be seen, virtually any management alternative could impact existence and option values either positively or negatively), the two values will be grouped together in the summary table of impacts. In both cases, because the future value of such options would be discounted by the net valuation process, and because the future value is unknown, uncertain, and likely distant into the future, the net present value of these options may be very small.

Holistic Valuations of Coral Reefs:

There have been numerous attempts to assess the total value associated with the many uses and functions that coral reefs provide, many of them done as a result of lawsuits claiming damages to reefs. CFMC (1999) reported that recent court settlements involving ship groundings on Florida's coral reefs averaged $921 per square meter ($m^2$) of damaged or destroyed reef. One assessment of the damage from a ship grounding off the Florida Keys estimated a lost present value of $4,363/$m^2$ (1999$) (Mattson and DeFoor, 1985). A court case in Egypt led to a similar assessment–the government was paid $2,083/$m^2$ (1999$) of damaged coral reef (Spurgeon, 1992). In both cases, the damaged areas were small and in areas important for tourism, so the figures are not necessarily applicable to larger and different areas. Further, the assessments may have been based on potential gross value, so they may exceed net present value. On the other hand, the assessments assumed some degree of regeneration of the reefs and their value during the ensuing years, which would underestimate full present value.

An assessment on a much larger scale was carried out by Cesar (1996), and predictably, the estimated per-unit-area values were much smaller than those in the small-scale assessments described above. The assessment examined Indonesia's coral reefs as a whole, and focused on the values that could most easily be quantified–reef fisheries, coastal protection, and reef-associated

tourism. The quantifiable net present values (actually the "net present loss to society due to destruction...") in those sectors ranged from about \$0.19 to \$1.57/m^2 (1999\$) of coral reef, depending on the level of tourism potential and the degree of coastal construction (i.e., the value of coastal property) (these figures have been adjusted from the study's 10 % discount rate to the 7 % rate used throughout this analysis, over a 25 year time period). Fisheries value was assumed to be the same in both the low and high scenarios. At the low end of the range, fisheries contributed about 80 percent of the value. At the high end of the range, fisheries contributed only about 9 percent, while coastal protection and tourism contributed 47 and 43 percent, respectively (Cesar, 1996).

Costanza *et al.* (1997) assessed the value of all the earth's natural capital and ecosystem services. They identified and assessed the value of each of 17 ecosystem services for each of 16 biomes, of which coral reefs were one. The results were qualified as being tentative and conservative. The total annual value of world's coral reefs was estimated at \$0.68 per m^2 per year (1999\$). The present value would be \$7.47/m^2 (1999\$). Fully half the value was contributed by "recreation" (including tourism) services, followed closely by "disturbance regulation." "Food production" contributed about 4 percent of the total. Values in the authors' categories of "gas regulation," "climate regulation," "nutrient cycling," and "genetic resources" were not assessed or included because of a lack of information. Of eleven biomes for which total values were (tentatively) estimated, coral reefs ranked sixth in terms of per-unit-area value, and tenth in terms of total global value (ahead of cropland).

The range among the assessments described above, \$0.19/m^2 for undeveloped areas of Indonesia to \$4,363/m^2 for a small area in the Florida Keys, covers four orders of magnitude. For assessing the value of large areas, such as the entirety of the coral reefs under the jurisdiction of this FMP, the high end of the range is probably not applicable (at \$4,363/m^2, the 16,000 km^2 of coral reefs in the US Pacific Islands would be worth \$70 trillion). For localized areas where the value of coastal property and tourism are high, however, such figures may be applicable, and may even underestimate NPV.

Summary:

In this analysis, the only quantitative valuations made of the coral reefs of the US Pacific Islands were for fisheries and tourism, and they were very tentative. A first-order estimate of the annual net value of the fisheries was \$0 to \$15 million, which, if unchanged in the future, would imply a net present value of \$0 to \$175 million. A first-order estimate of the annual net value of marine-based tourism was \$400 to \$1,600 million, which, if unchanged in the future, would imply a net present value of \$5 to \$19 billion.

Other reef-dependent sectors, including recreation, the value of reefs as breakwaters, ecological services and information, and existence value and option value, are clearly very important, but they are not quantifiable. These sectors are interconnected (e.g., the reef as a breakwater provides tourism and recreational opportunities) and coral reef ecosystems are interconnected with other ecosystems.

Tables 14 and 15 present a summary of the coral reef valuations of other studies described in the preceding sections, along with the fishery and tourism values assessed here. The findings are described in terms of value per-unit-area. The tables do not include all the types of coral reef values recognized here and in the cited studies. The terms used in the table for value types are not

necessarily the same as those used in the cited studies, and the fits may not be exact (e.g., "breakwater" used for "coastline protection;" "fisheries" used for "food").

A high degree of variability in the assessments is apparent, much of which can be explained by the various scales on which the assessments were done. The smallest assessments had by far the highest values. The results of this study illustrate the correlation, as well. Both the fishery and tourism values were divided by the total area of coral reef in the US Pacific Islands (16,000 km^2), yielding relatively small NPVs of \$0 to \$0.01/m^2 for fisheries and \$0.30 to \$1.20/m^2 for tourism. The values of fisheries, tourism, and recreation are, of course, generated from only small portions of the total reef area of the US Pacific.

Table 14. Summary of Coral Reef Valuations: Net Present Value, in 1999 Dollars per Square Meter

Source	Fisheries	Tourism	Breakwater	Total value
Mattson and DeFoor (1985)				4,363.00
Spurgeon (1992)				2,083.00
CFMC (1999)				921.00
Berg *et al.* (1998)		4.40	0.002 to 2.00	
Dixon *et al.* (1994)		0.07		
This study	0 to 0.01	0.30 to 1.20		
Cesar (1996)	0.15	0 to 1.36	0.001 to 1.36	0.19 to 1.57
Costanza *et al.* (1997)	0.27	3.68		7.37

The values from this study are only very tentative figures used for illustrative purposes–see text for limitations.

The tourism and breakwater ranges of Cesar (1996) are his extreme ranges; the "total value" range is a more moderate range under "low" and "high" scenarios; thus the components do not sum to the "total value."

The "tourism" value from Costanza *et al.* (1997) is actually called "recreation" by the authors, and presumably includes both tourism and recreation, as the terms are used here.

Table 15. Details of Valuation Studies

Source	Location	Scale	Methods
Mattson and DeFoor (1985)	Florida Keys	very small (ship grounding)	court case (unknown method)
Spurgeon (1992)	Egypt	very small (ship grounding)	court case (unknown method)
CFMC (1999)	Florida Keys	very small (ship groundings)	average of court cases (unknown methods)
Berg *et al.* (1998)	Sri Lanka	tourism: village specific (0.25 km^2) breakwater: country-wide	tourism: PS (profits), CS (WTP) breakwater: property values
Dixon *et al.* (1994)	Bonaire, Antilles	island-wide (100 km^2)	consumer surplus (WTP)
This study	US Pacific Islands	region-wide (16,000 km^2)	see text
Cesar (1996)	Indonesia	country-wide (75,000 km^2)	fisheries and tourism: PS (profits) breakwater: property values
Costanza *et al.* (1997)	World	global (620,000 km^2)	various

"PS" means producer surplus; "CS" means consumer surplus; "WTP" means willingness-to-pay.
It was here, not in the original study by Dixon *et al.*, that the net value was divided by the island's entire reef area.

1.7 Economic Analysis of FMP Alternatives

Alternatives:

The economic impacts of each of the four types of alternative measures (marine protected areas; permit and reporting requirements; allowable harvesting gear; and various miscellaneous requirements) are assessed relative to the no-action alternative. As explained in the preceding sections, the current value and future expected trajectory of the no-action alternative are not well known. A primary motivation of the FMP, in fact, is to address the largely unpredictable future course of fishery development and its potential problems.

Since the FMP considers a range of management (control) measures contained in four alternatives ranging from No Action through Maximum Additional Protection, the following analysis discusses the implications of each of the management measures in some detail. The section concludes with a summary of the overall implications of the suite of management measures in each of the four alternatives.

Factors Affecting Fishery Sector Values:

Projections of a harvesting sector's NPV under a given measure relative to the no-action NPV will be based primarily on the following four factors: 1) whether harvesting effort will increase or decrease relative to the no-action scenario, 2) whether the impact to harvesting effort will bring the fishery greater or fewer gross returns relative to the no-action scenario, 3) whether private costs will be greater than in the no-action scenario and whether they will outweigh any impact to gross returns,

and 4) whether public costs will be greater than in the no-action scenario and whether they will outweigh any impact to net private returns.

An additional factor is whether the composition of the "fleet" will shift towards more efficient or less efficient participants. Measures that bring increased costs to fishermen, for example, will disproportionately reduce the participation or effort of those less willing or able to pay those costs. This choice depends on whether the costs are fixed or variable, the level of investment in the harvesting operation, the returns of the operation, and the underlying asset basis of the harvesting operation. For example, if the increased costs are on a fixed, flat rate basis (e.g., the cost of acquiring an annual permit), large full-time commercial food or sport operations are probably more likely to bear the costs than part-time recreational and mixed-motivation fishermen, assuming similar wealth levels, while wealthier participants (whatever their motivations) may have greater flexibility and willingness to absorb the costs than less wealthy participants. If a burdensome measure is not applied equally across the fleet, such as if subsistence fishermen are exempt, the fleet would shift accordingly.

Federal Versus State and Territorial Waters:

An important factor with respect to the economic and social impacts of these management measures is that they will apply only in federal waters.

The decision of where to fish (e.g., in territorial versus federal waters) is a function, among other things, of the costs and risks of getting to the fishing grounds or harvesting area (a function of distance and exposure), the costs of harvesting (including any restrictions that hinder harvesting efficiency and any costs associated with permitting and reporting), and expected returns (a function of fish abundance and related factors).

Some of the proposed management measures are restrictive and burdensome to fishermen. At least in the short term, they will reduce the incentive to fish in federal waters. Any resulting decrease in participation or harvesting effort in federal waters could result in shifts to other fisheries or other economic sectors. The impacts of shifts into other areas and fisheries will depend on the biological and economic state of those fisheries (e.g., whether they are already overfished). It is assumed in this analysis that:

1. Fishing effort which shifts out of coral reef fisheries in the EEZs will result in greater effort in both territorial coral reef fisheries and non-coral reef fisheries (e.g., deep bottom and pelagic),

2. Greater fishing and harvesting effort in territorial coral reef fisheries will, given the general assessment of their already being overfished in most nearshore areas (see Green 1997), result in smaller net returns relative to the no-action NPV, and

3. Increased effort in pelagic fisheries will result in greater net returns for the pelagic sector relative to the no-action NPV, but not necessarily an increase in overall net returns, and increased effort in non-coral reef fisheries (e.g., deep bottom fish) is likely to result in lesser net returns relative to the no-action NPV.

The "balance" between federal and territorial/state regulations is clearly an important consideration. Increasing costs to fishermen could also push them out of fisheries altogether and into other economic sectors. It should be noted that these other sectors might include reef-dependent industries such as marine tourism, which, applying the concept of ecosystem management, could be considered part of the "fishery" being managed by this FMP.

Impacts to Non-fishery Sectors:

It is assumed that the value of each of the non-fishery sectors is purely a negative function of reef degradation, and that reef degradation is a positive function of harvesting effort and the degree of usage of destructive gears and practices. The extent of these relationships is of course the ultimate issue in the relationship between the management of harvesting sectors and the preservation of coral reef ecosystem values.

1.7. 1 General Effects of Management (Control) Measures

As indicated in the FMP, the potential for fishing and non-fishing activities to have fishery, environmental, and economic effects depends on how they are managed through one or more of the following management (control) measures:

- marine protected areas
- permit and reporting requirements
- allowable harvesting gear
- other (miscellaneous) requirements

Each of the four alternatives analyzed in the FMP contains these four management measures to a varying degree. In this section, the effects of each management measure under the Western Pacific Coral Reef Ecosystem FMP are described, focusing on how fishery participants and the fishery as a whole are likely to respond. Descriptions of compliance, management, fishery monitoring, and enforcement costs are also presented.

This is followed by a summary table of the likely effects outside the FMP regulated fishery itself, particularly in: 1) coral reef fisheries in territorial waters, 2) non-coral reef fisheries, and 3) non-fishery sectors. In addition, the impacts of each measure on net present value are assessed relative to the no-action alternative, with comparisons made among alternatives within a given type of management measure. The notations "zero," "negative," or "positive" in parentheses always refer to the impact relative to the No-Action alternative, not relative to any of the other alternatives.

Measure: Marine Protected Areas

The FMP includes two types of MPAs: "no take" and "low use." As with all natural resource harvesting restrictions, the economic issue is the extent to which these MPAs preserve the natural productivity of the ecosystem for social and/or economic values and to what extent they displace effort to open areas. The natural factors are not well known, nor is the recovery period (which in the case of snappers and groupers, for example, is likely to exceed the economic time-scale for value recovery). To the extent that MPAs are close to inhabited areas (e.g., in the EEZ of Guam) or

accessible transportation (e.g., near Midway), then potential for use (and thus potential costs of restrictions) increases. To the extent that the areas are isolated (e.g., the Northwestern Hawaiian Islands except Midway), the costs of exploration and harvest increase. This reduces the profitability of harvest and reduces the social cost of regulation. Regarding insurance requirements for all fishing vessels operating in or transiting MPAs, several fishermen have indicated that pollution insurance is a standard part of their operations. As a result, although it would increase costs to existing fishermen who do not have such insurance, and to future fishermen and harvesters and similar operators (e.g., ecotourism purveyors), it would reduce asset risks to vessel operators and appear to provide substantial social value (as indicated by recent controversies concerning wreck removal).

The following summarizes the extent to which each alternative implements these management measures and the extent to which net economic values are affected:

No Action Alternative (Alternative 1):

In the absence of additional management measures, the bottomfish, lobster, and precious corals FMPs will still regulate those fisheries and through the Essential Fish Habitat portions of those FMPs, will serve to protect the general coral reef ecosystem. However, in the absence of the CRE MPAs, potential development of other fisheries (e.g., aquarium, live rock, bio-prospecting, etc.) will occur under open access conditions. While the lack of regulation usually fosters short-term investment and growth in nascent natural resource settings, in the long-term the lack of management controls tends to encourage over-exploitation and creates an unstable investment climate. The effect in high-cost coral reef fisheries, such as the NWHI, would be to preclude sustainable development and potentially harm the bottomfish, lobster, and precious coral fisheries as well.

Minimal Additional Protection (Alternative 2):

The restricted level of MPA protection identified in this alternative would be expected to offer extensive general ecosystem protection and preclude unsustainable development while allowing broad areas for exploratory development.

Substantial Additional Protection (Alternative 3, Preferred Alternative):

The broad levels of MPA protection identified in this alternative would be expected to offer extensive general ecosystem protection but would increase the costs of exploratory development. Low cost exploratory options would still be possible but high cost options might not. Where eco-tourism and other low-use activities would be possible, these should not be substantially affected by this alternative.

Maximum Additional Protection (Alternative 4):

The effect of these MPAs (to 100 fathoms) would be to preclude all development of marine resources from EEZ coral reef habitats except for research functions and high-cost deep-water exploration (perhaps in conjunction with the precious corals fishery). Whether eco-tourism and other low-use activities would be permitted would depend on the drafting of the management measures.

Measure: Harvesting Permits and Reporting Requirements

The impact on coral reef harvesting and on less regulated fisheries (e.g., territorial) depends on a variety of factors including the degree of discretion given to NMFS concerning Special Permits in determining participation, effort, catch, compliance costs, and management costs. Outside the FMP fishery, such factors include the magnitude of the positive and negative impacts on habitat and ecosystem services and value caused by reduced participation in the FMP fishery and greater participation in other fisheries. The impact within the coral reef ecosystem fishery of various permit alternatives would be primarily determined by their severity and by the public costs of enforcement, permit processing, and data analysis (negative), the effects of compliance costs on individual net returns (negative), and the indirect effects of reduced participation on the FMP fishery's total private net returns (positive or negative). The impacts outside the fishery would be determined by any displacement of harvesting activity to (greater participation) territorial fisheries and in non-coral reef fisheries.

Participation in the fishery, and probably effort, would likely be least under the Special Permit requirements. Per-vessel compliance costs would be substantially greater under the Special Permit than under the General Permit, as would public permit processing and data analysis costs. Reliance on local data collection systems may instill greater trust and compliance by fishers. As these systems have a long history in the islands, the cost of continuing these programs would likely be of much lower cost than a new system. For this reason, the Council and NMFS continue to provide support and guidance to these programs. Enforcement costs would likely be greatest for harvesting under the Special Permit and lower under both the General Permit and the No Action Alternative.

The subsistence harvesting exemption would likely result in greater net private returns in the fishery relative to any of the other permits, with the degree of the impact depending on how it is interpreted and applied. The benefits would be offset by enforcement being less effective and slightly more costly. The extent of these overall benefits is unknown.

The following summarizes the extent to which each alternative implements these management measures and the extent to which net economic values are affected:

No Action Alternative (Alternative 1):

The reliance on local data collection systems may lead to gaps in information for future resource management decisions, although compliance to a locally-run and familiar system is likely higher. Nevertheless, inadequate data collection over time may cause drastic management measures to occur in the face of a real or perceived future problem.

Minimal Additional Protection (Alternative 2):

The costs of permitting and reporting under this alternative are relatively minimal and therefore are likely to have a small effect on economic activity. To the extent that Alternative 2 encourages higher levels of development, however, it may increase the administrative burden to the government and subsequently the scientific research and analysis burden.

Substantial Additional Protection (Alternative 3, Preferred Alternative):

The costs of permitting and reporting under this alternative are limited to the low-use MPAs at this time and are likely to have a small effect on economic activity.

Maximum Additional Protection (Alternative 4):

Given the extensive nature of the MPAs in this alternative, and the requirement for permitting and reporting in most coral reef areas, reporting and permitting may have substantial costs to small-boat fishermen as well as to larger harvesters seeking permission to access more remote areas. Similar costs are likely to the government. With permits required for research and management activities, this may also place burdens on science.

Measure: Gear Restrictions

Gear restrictions are likely to have three primary effects: first, the reduction in efficiency in harvest; second, the (positive) biological effect of this reduced harvest; and third, the cost of enforcement. One alternative is to restrict gears consistent with rules in adjacent territorial waters. This would reduce enforcement problems significantly and would otherwise have the same effect of the current status quo (no action alternative) in terms of effect on participation and ecosystem. However, since the EEZ areas are more distant than the territorial areas, the costs of harvesting would be greater, as would the costs of compliance. It can also be anticipated that the density of participation would be lower.

The following summarizes the extent to which each alternative implements these management measures and the extent to which net economic values are affected:

No Action Alternative (Alternative 1):

In the absence of gear restrictions under the CRE FMP, protection of habitat from inappropriate gears would be limited to that provided by the bottomfish, lobster, and precious coral FMPs. This also suggests habitat dangers similar to those of over-fishing identified under Alternative 1 in the MPA category.

Minimal Additional Protection (Alternative 2):

This alternative is unlikely to impose substantial economic costs on any type of sustainable development and harvesting activities.

Substantial Additional Protection (Alternative 3, Preferred Alternative):

This alternative, through the prohibition of night-time spear-fishing with scuba or hookah may have some impact on recreational fishing but that effect is expected to be small. Otherwise its effects would be minimal (similar to those of Alternative 2).

Maximum Additional Protection (Alternative 4):

This alternative's prohibition of spear-fishing with scuba or hookah is likely to have a deleterious effect on recreational fishing.

Compliance Requirements and Costs

The permitting options are the only ones with direct costs of compliance. Although the details of the permitting measures have yet to be fully determined, the following assumptions regarding the measures will be made in order to estimate compliance costs, as shown in Table 16:

1. Permit applications are estimated to require 1 hour of labor for the General Permit and 2 hours for the Special Permit. These permits will be required to be renewed annually, however the renewal form should require no more than 0.5 hours of labor to complete.

2. A fee would be charged for each application, this fee would be calculated in accordance with the procedures of the NOAA Finance Handbook for determining the administrative costs of processing each application.

3. Reports on catch and effort would be required after every trip, requiring 0.5 hour per fishing day for fishing under the General Permit, and 1 hour per fishing day for the Special Permit.

4. If vessel observers are required, the public, and not the permit holder, would pay the entire cost, estimated at $5,000 per month.

5. No conditions beyond catch reporting requirements may be attached to a General Permit. Any conditions may be attached to a Special Permit.

Table 16. Compliance Costs of Permitting and Reporting Measure

	Fixed ($/permit-year)			Variable ($/vessel-day)		
	Cash	**Labor**	**Total**	**Cash**	**Labor**	**Total**
General Permit:						
Permit application	0	20	**20**			**0**
Reporting			**0**	0	10	**10**
General Permit total	**0**	**20**	**20**	**0**	**10**	**10**
Special Permit:						
Permit application	0	40	**40**			**0**
Reporting			**0**	0	20	**20**
Special Permit total	**0**	**40**	**40**	**0**	**20**	**20**

Costs are estimated on a per-vessel basis; multi-vessel operations would probably incur lower per-vessel costs.
The value of labor is assumed to be $20 per hour.
A Special Permit could include any number of additional conditions, with associated costs.

Management Costs

Plan Development:

It is estimated that the Western Pacific Regional Management Council will spend $500,000 to $700,000 on the development of this FMP. Costs include staff time, public scoping meetings and hearings, meetings of the Plan Team, Habitat and Ecosystem Advisory Panel, Scientific and Statistical Committee, and the Council itself, contractors that contributed to plan development, and administrative costs, including printing. The NMFS will also have made expenditures towards plan development in the form of staff time and administrative costs, estimated at $50,000 to $100,000.

Plan Review:

Monitoring and reviewing the plan, including routine meetings, data analysis and reporting by the Plan Team, making occasional adjustments such as framework measures and amendments, and implementing management actions that would require coordination among different plan teams, will bring running costs to both the WPRFMC and the NMFS. Staff time, administrative costs, meetings of the Council and relevant teams and committees, and public hearings can be expected to cost the WPRFMC $200,000 to $400,000 per year. Staff time and administrative costs can be expected to cost the NMFS $50,000 to $100,000 per year. These figures are based in part on estimates made in other Council documents for similar services (e.g., WPRFMC 1994).

Permits:

The General permit would only require assessment of whether the applicant meets basic eligibility requirements, and would be the least costly of the permits on a per-permit basis.

The Special permit would require case-by-case scientific and administrative review of fairly sophisticated applications that include demonstration of how the proposed harvesting would be sustainable at the ecosystem level. The Regional Administrator of the NMFS would review applications in consultation with the WPRFMC.

The two-tiered permit systems also requires the additional task of maintaining the list of the two categories of target organisms–those subject to General Permits and those subject to Special Permits. Given the Council's mandate under that option to determine needed biological reference points for species as information becomes available, the analytical requirements of the Council's and NMFS' staffs might be greater than under either the General Permit or the Special Permit options. The costs involved in creating and maintaining the two lists of species and determining the biological reference points are addressed under "fishery monitoring, analysis, and reporting."

The per-application processing costs of each of the three options are roughly estimated at:

General:	$50	to	$100	per application
Special:	$400	to	$2,000	per application

The total annual cost of each option would depend on the number of applicants. The Special Permit option, because of its costly application requirements and relative uncertainty of outcome, would probably yield the fewest applicants. Very rough estimates of the number of expected annual applicants, at least during the first few years, are:

General:	10	to	20	applicants
Special:	0	to	10	applicants

Under those assumptions, total annual permit processing costs would be:

General:	$500	to	$2,000 total cost
Special:	$0	to	$20,000 total cost

Fishery Monitoring, Analysis, and Reporting:

The Western Pacific Fisheries Information Network is already monitoring components of the coral reef fisheries in the region. The system might be expected to be expanded or improved in response to the needs of the FMP. Roughly estimated additional costs of the network are $0 to $200,000 per year.

The FMP Special Permit would allow NMFS to require, at its discretion, vessel observers, at a cost of about $5,000 per vessel per month. Ten vessels harvesting half the year, for example, would cost $300,000, and that is treated here as the maximum possible cost (how the cost would be divided between the public and the harvesting participant has not been determined; in estimating compliance costs, above, it was assumed the public would pay, so the cost is included here).

The data reporting requirements of fishermen would be roughly the same under all permitting options, but less detailed reports would be required under General Permits than under Special Permits. The data in these reports would presumably be processed and analyzed by NMFS, which would report the results to the WPRFMC. The number of reports would depend on the number of permit holders, which would depend on the number of applicants (estimated for each permit system above) and the percent of applicants that are granted permits. Under the two-tiered permit system, NMFS would also have the task of devising and maintaining the two lists of species, and for Non-Target species, determining biological reference points. If vessel observers are used, analyzing their data would require additional costs. The total costs of these tasks are roughly estimated at $50,000 to $200,000 per year (based on estimates for similar services in WPRFMC 1994).

Enforcement:

Enforcement costs of NMFS and the Coast Guard for the region's federally managed pelagic fisheries were estimated in 1994 at $1.5 million per year (WPRFMC 1994). Enforcement costs are largely discretionary and are increased greatly by the proposed MPAs which would require some amount of distant patrolling by air and by sea. A large portion of the enforcement needs of the FMP could presumably be met through existing levels of patrolling and other services for other fisheries. Additional patrols would cost as much as $100,000 per air patrol and $250,000 per surface patrol from Honolulu to distant islands (not to all islands at once–just in one direction or another). Dock-

side enforcement would require additional personnel, at a cost of about $100,000 per agent per year. Prosecution costs would increase according to the level of patrolling. In sum, the enforcement costs for the plan could run anywhere from about $0.3 million to as much as $3.0 million or more per year.

The estimated costs of implementing the FMP are summarized in Table 17.

Table 17. Summary of Expected Implementation Costs of FMP ($1,000/year)

	Low	High
Management plan	250	500
Permits	0	20
Fishery monitoring and analysis	50	700
Enforcement	300	3,000
TOTAL	**600**	**4220**

The one-time costs of developing the FMP, $0.55 to $0.80 million, are not included here.

Summary

The likely impacts of each management measure on the net present value of each of the fishery and non-fishery sectors are summarized in Table 18. For each sector and each measure, the likely impact is described as being either less than, the same as, or more than the likely no-action net present value. The coral reef resources under the jurisdiction of the FMP are termed "FMP fisheries." Coral reef fisheries not in federal waters are termed "local coral reef fisheries," and all other domestic fisheries are termed "non coral reef fisheries." The No Action Alternative is omitted from the table. Included are analyses of implementation of a framework procedure for future management actions, as well as a non-regulatory method for the integration of FMPs to allow for consideration of the ecosystem effects of the harvesting of coral reef resources which are primarily managed under the Bottomfish, Crustaceans, and Precious Corals FMPs.

Table 18. Impacts of FMP Management Measures to Net Present Value – Relative to the No Action Alternative

	FMP fisheries	Local coral reef fisheries	Non coral reef fisheries	Tourism and recrea-tion	Support for other ecosys-tems	Informa-tion	Existence and option values	Overall
Marine protected areas established								
Remote Areas	–	O	O	–	+	+	+	– +
Accessible Areas	– +	O	– +	O	+	+	+	– +
Guam's southern banks–no large harvesting vessel anchoring	– +	O	– +	O	+	+	+	– +
Harvesting permit and reporting requirements								
General Permit	– +	– O	– +	– O	– +	– +	– +	– +
Special Permit	– +	– O	– +	– O	– +	– +	– +	– +
Permit exemption for subsistence harvesting	– +	– O	– +	– O	– +	– +	– +	– +
Gear restrictions								
Allow only certain gears	– +	O	O	O	O +	O +	O +	– +
Restrict gears to be consistent with rules in local waters	– +	O	O	O	O +	O +	O +	– +

"– +" means less than or greater than, i.e., indeterminate; "– O" means less than or the same as; and "O" means the same as the NPV under the no-action alternative.

As can be seen in Table 18, little can be said definitively about the likely impacts of the management measures on net value. The impact of most measures could be either positive or negative in most sectors, with the exception of the locally managed coral reef fisheries, in which positive impacts are relatively unlikely. The following summarizes the extent to which each alternative implements these management measures and the extent to which net economic values are affected:

No Action Alternative (Alternative 1):

Alternative 1 would implement no new management measures, leaving protection of the coral reef ecosystem to those measures implemented under the bottomfish, lobster, and precious corals FMPs and the essential fish habitat provisions of those FMPs. The absence of MPAs would open areas of the coral reef ecosystem to over-harvesting due to open access harvesting conditions. The absence of permitting and reporting requirements would mean that adequate information for scientific assessment of any such developments would be lacking. Without gear restrictions it is possible that coral reef habitat itself could be harmed. Altogether the Council determined that the No Action alternative was not viable in an era of increased potential for harvesting pressure on the coral reef marine environment and increased concern worldwide for preserving coral reef ecosystems. Although there would be some costs in terms of economic developments potentially forestalled by the other three alternatives, the potential losses to the Western Pacific coral reef ecosystem of unfettered marine development and utilization would certainly offset any potential gains from such development.

Minimal Additional Protection (Alternative 2):

Alternative 2 would designate a range of precautionary management measures that would impose some controls on commercial and recreational use of the coral reef ecosystem in Federal waters in the Western Pacific. The implementation of low-take MPAs along with restrictions on taking live rock and coral and the prohibition of non-selective gear, as well as permitting and reporting requirements, should preclude any "mining" of the coral reef ecosystem by unfettered marine development. At the same time, the management measures under Alternative 2 impose minimal costs for marine development and utilization. However, the Council believes that this alternative does not provide adequate protection for particularly sensitive coral reef ecosystem areas, particularly those in shallow waters. As a result, although the measures in this alternative are precautionary, there is the potential for over-harvesting and habitat destruction in some circumstances. The potential costs of such activities would outweigh the potential benefits of harvesting in shallower waters and marine developers not being subject to stricter controls in sensitive areas.

Substantial Additional Protection (Alternative 3, Preferred Alternative):

Alternative 3 (which incorporates the management measures in Alternative 2) also provides a range of no-take MPAs in particularly sensitive regions of the Western Pacific coral reef ecosystem, requires additional permitting and reporting requirements, mandates the use of non-destructive gears, and implements some additional restrictions (vessel monitoring, anchoring controls, and night-time fishing regulations) which are intended to prevent not only unfettered marine development (as precluded by Alternative 2) but also to prevent or mitigate unintended harm to the coral reef ecosystem through reduction in vulnerability of certain coral reef fish to night-time fishing as well

as providing insurance and mitigation systems for fishing vessels operating in or transiting through areas designated as no-take or low-use MPAs. The additional costs of the insurance and mitigation systems are expected to be low, relative to their potential benefits, while the lost opportunities concerning night-time fishing may be significant to recreational fishers but the prevalence of this activity outside of three miles (i.e., in the EEZ) is thought to be low. As a result, the Council believed this alternative balanced the costs to current and future participants in the coral reef ecosystem with the benefits of increased protection.

Maximum Additional Protection (Alternative 4):

Finally, Alternative 4 provides much broader no-take MPAs (out to 100 fathoms) as well as incorporates the measures proposed in Alternatives 2 and 3. The result of the 100 fathom MPAs would be to effectively curtail any commercial and recreational use of the Western Pacific coral reef ecosystem within the EEZ. Although the benefits of such use in terms of aquarium fish collection, bio-prospecting, and other potential uses are not well known, it may be that some considerable value exists. The maximum protection provided by this alternative would impose future costs with unknown future benefits.

Summary of Impacts of the Preferred Alternative (Alternative 3):

The following is a further summary of impacts under the Preferred Alternative (Alternative 3). To the extent that Alternatives 2 and 4 (Minimal and Maximum Protection) mimic aspects of the Preferred Alternative, these impacts would accrue accordingly. To the extent that these other two alternatives contain different degrees of management (e.g., smaller or larger MPAs, less or more restrictive gear rules), then the impacts would be either smaller or greater, respectively.

1. The preferred management measures, primarily through the permitting and protected area measures, can be expected to result in a lower level of fishing, harvesting levels and participation on federal coral reefs than under the No-action Alternative.

2. Because they would bring greater restrictions and greater harvesting costs in federal waters, the preferred measures would encourage harvesting effort outside federal waters, and they could thereby negatively impact values of both fishery (if the greater effort leads to or exacerbates overfishing) and non-fishery sectors (if the greater effort degrades habitat or other ecological services) of coral reefs under local jurisdiction.

3. Because of the flexible nature of the Special Permit system, as well as the uncertainty of how it would evolve relative to the General Permit system, the impacts of the permitting measure are difficult to assess. To the extent that the Special Permit system requires expert knowledge in formulating and defending the proposed activity, it will increase costs to participation and set a higher wealth threshold for participation.

4. The expected implementation costs of the FMP and the preferred measures are $0.6 to $4.6 million per year, not including the one-time costs of developing the plan ($0.5 to 0.8 million), and not including the existing costs of managing coral reef fisheries in territorial waters (about $3 million/year).

5. Management inputs needed for effective implementation of the preferred measures are likely to be relatively large compared to the net value of the existing and potential fisheries (especially since the basic operations of the bottomfish, lobster, and precious coral fisheries are covered by separate FMPs), but small relative to the net value of non-fishery sectors.

6. It is unlikely the preferred measures would result in a greater net value of coral reef fisheries–even just in federal waters–than under the no-action scenario. The preferred management measures are likely to result in prevention of losses to the net values of non-harvesting sectors, but only in federal waters. Those benefits could be offset by negative impacts to both harvesting and non-harvesting sectors in locally managed waters. Because coral reef harvesting activities have a limited capacity to affect non-harvesting values of reefs, the potential impact of the FMP measures on non-harvesting values – positive or negative – would likely be small relative to total non-fishery values.

7. It is not possible to determine whether the impact of the preferred measures on the overall net value of the region's coral reefs would be positive or negative but given the nature of open access fisheries historically, it is likely that they will be more positive than the No-action Alternative.

8. The social and indirect economic impacts of the preferred measures would vary greatly from area to area. On remote reefs with little historical or current harvesting activity, few participants would be affected. One exception is Midway, where the preferred protected area measures would reduce the area the coral reef sportfishery could develop. On nearshore reefs close to population centers, such as the federal reefs off Saipan and Tutuila, and Penguin and Ka'ula Banks in Hawaii, more participants would be affected, including commercial, recreational, and sport fishermen, most of whom only occasionally fish in federal waters. Fishing activity on the isolated offshore banks of Guam, American Samoa, CNMI, and Hawaii, and around Farallon de Medinilla in the CNMI would also be substantially affected by the permit requirements, and participation and effort can be expected to be substantially reduced.

9. The preferred permitting measure would be restrictive and costly enough that, where there are adjacent fishing grounds under local jurisdiction, many affected participants would probably choose to stop fishing in federal waters rather than bear the increased costs of compliance. Similarly, future growth in coral reef fishery participation and effort in locally managed waters is likely to be greater than it would have been in the no-action scenario.

10. Relatively few of the region's coral reef fishery participants would be affected by the preferred measures, and only some of those affected would be significantly affected. Consequently, the preferred measures are unlikely to hinder the "sustained participation" of fishing communities, consistent with part (A) of National Standard 8 of the Magnuson-Stevens Act.

11. Although the preferred measures do not include any explicit allocation of harvesting privileges, the costs of complying with the preferred permitting measure would cause proportionately greater impacts to small-scale, part-time, recreational and mixed-motivation fishermen, with consequent shifts in the composition of participants.

12. The discretion in issuing Special Permits under the preferred permitting measure could result in preferences being given according to any number of criteria, some not intended, including time of application and the ability to express scientific ideas.

13. Implementation of the preferred measures on reefs in federal waters that are contiguous with reefs under local jurisdiction may be problematic and thus costly in terms of enforcement and effectiveness. The three-mile boundary is difficult for fishermen to determine and comply with, and the measures, being quite restrictive relative to local rules, may not be readily accepted by local fishing communities. To the extent that straight-line enforcement boundaries are imposed, given the bottom topography of the western Pacific island areas, it is possible that the proposed management measures would have either a substantially greater or potentially smaller effect than anticipated.

14. The portion of new federal management inputs that are funneled through local economies would bring positive indirect economic impacts to those economies.

2.0 INITIAL REGULATORY FLEXIBILITY ANALYSIS

2.1 Introduction

The Regulatory Flexibility Act (5 U.S.C. 601 et seq.)(RFA) requires that agencies assess and present the impacts of their proposed actions on small business entities. In accordance with the RFA, the following is set forth: (1) The need for, and objective of, the measures are outlined in the ~~draft~~ FMP which accompanies this document; (2) The proposed measures would apply to all individuals who wish to harvest domestic coral reef resources in the federal waters of the Western Pacific Region; (3) All affected individuals are expected to be small business entities; (4) The proposed measures include new reporting requirements; and (5) No Federal rules are known to duplicate, overlap, or conflict with the proposed measures.

An IRFA is needed to determine if a regulatory action is expected to have a "significant economic impact" on a "substantial number" of "small entities."

A "small entity" in this case would be a commercial fishing or marine harvesting company, a wholesaler dependent on products harvested from the coral reef ecosystem, a non-profit organization that is independently owned and not dominant in its field, or a small government jurisdiction.

2.2 Basis for Rule and Description of Alternatives

The basis for the rule, description of alternatives, etc. are described in the preceding RIR. The following provides information specific to the needs of the RFA.

2.3 Description and Number of Affected Small Entities

Virtually no participants in the fisheries of the US Pacific Islands can be considered large entities. The challenge in identifying small entities in this case is first, distinguishing "businesses" from fishing participants that sell their catch only occasionally, and second, identifying which fishing entities participate in, or rely on, coral reef fisheries.

Tables in the Fishery Impact Statement, reproduced on the following page as Table 19, shows the number of participants in the fisheries of the US Pacific Islands.

Table 19. Harvesting Community Descriptors

	Am. Samoa	CNMI	Guam	Hawaii	Other islands	All islands
Resident population	64,000	65,000	160,000	1,187,000	350	**1,476,350**
Number of regular commercial food fishermen	50 to 100	50 to 100	50 to 500	2,000 to 3,000	0	**2,150 to 3,700**
Number of sometime commercial food fishermen	200 to 500	200 to 1,000	1,000 to 10,000	50,000 to 200,000	0 to 20	**51,400 to 216,020**
Number of sometime food fishermen	10,000 to 30,000	10,000 to 30,000	20,000 to 60,000	150,000 to 415,000	100 to 300	**190,100 to 535,300**
No. of commercial reef ornamentals collectors	1	0 to 1	2 to 4	170 to 220	0	**173 to 226**
No. of permitted non-comm. reef ornamentals collectors	na	na	35 to 45	190 to 300	na	**na**
Number employed in reef ornamentals industry	1 to 2	0 to 2	4 to 10	200 to 300	0	**205 to 314**
Number of regular commercial fishing boats	40 to 60	150 to 160	100 to 400	1,200 to 1,700	0	**1,490 to 2,320**
Number of boats that charter sportfish	1 to 2	30 to 40	20 to 25	150 to 250	2 to 4	**203 to 321**
Number of other boats that fish	20 to 30	250 to 350	300 to 1,500	8,000 to 12,000	5 to 20	**8,575 to 13,900**
Total number of boats that fish	70 to 80	430 to 550	420 to 1,925	9,400 to 13,900	7 to 24	**10,337 to 16,474**
Total annual production of seafood (1,000 lb)	770	1,050	1,120	32,000	15	**34,955**
Total annual production of reef seafood (1,000 lb)	340	500	410	5,300	10	**6,560**
Per-capita annual production of local seafood (lb)	12	16	7	27	43	**24**
Per-capita annual production of reef seafood (lb)	5	8	3	4	29	**4**
Per-capita annual consumption of seafood (lb)		56		56		
Per-capita annual consump. of local seafood (lb)	12	16	6	23	43	**20**
Per-capita annual consump. of local reef seafood (lb)	5	8	3	4	29	**5**
No. of wholesalers dealing local seafood/ornamentals	0	0	0 to 2	5 to 30	0	**5 to 32**
No. of retailers dealing local seafood/ornamentals	30 to 40	50 to 60	50 to 200	200 to 1,000	2 to 4	**332 to 1,304**

See section 3 of FMP for additional details.

It is assumed that in terms of food fishing participants, only those identified as "regular commercial food fishermen" in Table 19 are members of "businesses," and all such businesses will be considered "small entities." All commercial ornamentals collecting participants and all charter sportfishing participants will also be considered members of "small entities."

In Table 20, numbers of fishery "participants" are converted to numbers of "entities," using the assumptions footnoted under the table. Research entities were not considered part of the "fishing communities" described in Table 19, but since they may be affected by the action, they are included here. Most research is undertaken by government organizations, such as universities, but universities and other governmental institutions contract research to small entities, and small entities may undertake independent research. With little information available on those small entities, the estimates here are rough.

In Table 21, the numbers of small entities in all fisheries are narrowed down to just those that would be subject to the regulatory action of the FMP–that is, to "affected entities."

As described throughout the RIR, the regulatory action will have economic impacts not just on participants in coral reef fisheries, but on participants in other fisheries and in non-fishery sectors, as well. This analysis, however, is limited to the impacts on "affected" small entities, where only those entities that are directly subject to the regulatory action are considered "affected." If the universe of affected small entities was expanded to include entities that are indirectly affected, or even just those that are *negatively* indirectly affected, the universe would be so large that none of the five IRFA triggering criteria would be met, and an IRFA would not be required. Use of the more restricted interpretation of "affected," as done here, leads to a more conservative analysis, with the triggering criteria more likely to be met.

The regulatory action would affect only fishermen, collectors, vessel operators, and vessel owners–that is, the harvesting sector. The processing, wholesaling, retailing, and exporting sectors would not be directly affected. Only entities that harvest coral reef ecosystem species in federal waters of the US Pacific Islands (or in the CNMI, in the offshore management zone) are affected entities, and all are "small" as defined by the RFA.

Table 20. Number of Small Entities in the Fisheries of the US Pacific Islands

	Am. Samoa	CNMI	Guam	Hawaii	Other islands	All islands
Number of food fishing businesses	25 to 60	25 to 160	25 to 400	1,000 to 1,700	0	**1,075 to 2,320**
Number of charter sportfishing businesses	1 to 2	15 to 20	10 to 13	75 to 125	1	**102 to 161**
No. of reef ornamentals collecting businesses	1	1	1	5 to 13	0	**8 to 16**
Number of research entities	0	0 to 5	0 to 10	5 to 50	0	**5 to 65**
No. of wholesalers dealing local seafood/ornamentals	0	0	0 to 2	5 to 30	0	**5 to 32**
No. of retailers dealing local seafood/ornamentals retailers–local product	30 to 40	50 to 60	50 to 200	200 to 1,000	2 to 4	**332 to 1,304**
Total number of affected small entities	**57 to 103**	**91 to 246**	**86 to 626**	**1,290 to 2,918**	**3 to 5**	**1,527 to 3,898**

"No. of food fishing businesses" derived from Table 19 by assuming 2 fishermen per business, and setting the maximum equal to the maximum estimate of "number of regulator commercial fishing boats" from Table
"Number of charter sportfishing businesses" estimated by assuming (with little basis) two charter boats per business, with the number of charter boats taken from Table 19 (the number is known for "other islands").
"No. of reef ornamentals collecting businesses" derived from Bartram (pers. comm.), Gourley (pers. comm.), Green (1997), and Miyasaka (1991 and 1997) for American Samoa, CNMI, Guam, and Hawaii, respectively.
"Number of research entities" roughly estimated with little basis.
Number of wholesalers and retailers taken directly from Table 19.

Table 21. Number of Affected Small Entities

	Am. Samoa	CNMI	Guam	Hawaii	Other islands	All islands
Number of food fishing businesses	1 to 3	2 to 16	2 to 40	100 to 170	0	**105 to 229**
Number of charter sportfishing businesses	0 to 1	3 to 4	1 to 2	7 to 13	1	**12 to 21**
No. of reef ornamentals collecting businesses	0	0	0	0	0	**0**
Number of research entities	0	0 to 5	0 to 10	5 to 50	0	**5 to 65**
Total number of affected small entities	**1 to 4**	**5 to 25**	**3 to 52**	**112 to 233**	**1**	**122 to 315**

It is estimated that in Am. Samoa, CNMI, Guam, and Hawaii, 5%, 10%, 10%, and 10%, respectively, of food fishing businesses fish for coral reef resources in federal waters (CNMI, the offshore management zone).
In is estimated that in Am. Samoa, CNMI, Guam, and Hawaii, 20%, 20%, 10%, and 10%, respectively, and on Midway, 100%, of charter sportfishing businesses catch coral reef species in federal waters.
It is believed that no reef ornamentals collecting businesses catch coral reef species in federal waters (there may be occasional commercial collecting of ornamentals on Palmyra, but it is assumed to be a rare activity).
It is assumed that all research entities in all island groups harvest coral reef species in federal waters.

2.4 Impacts on Affected Small Entities

The economic impacts of the management measures under the FMP alternatives are addressed in detail in both the RIR (in terms of the fishery as a whole) and in the FMP (in terms of fishing communities and participants). Those analyses are supplemented here with a discussion of how the action is likely to affect coral reef fishery participants as small entities.

There is some discussion of the possible differential impacts among entities–such as how smaller operations might bear relatively larger burdens than larger operations. It should be kept in mind, however, that all affected entities in the fishery are small entities, as defined by the RFA, so there will be no disproportionate effects between large and small entities–a central concern of the RFA.

It is difficult to determine the effects of the action on the risks, revenues, and costs of harvesting. It is also difficult to determine how entities will respond to a given change in risk, revenues, or costs. They may bear an increased burden by remaining in the fishery at the same level of harvesting effort, they may adjust to or mitigate the impact with innovations, they may shift to other areas or fisheries to avoid the impacts, they may put either less or more effort in the fishery in order to minimize the impacts (e.g., depending on whether they stem from changes in fixed or variable costs), or they may exit the fishery.

The most straightforward of the five IRFA-triggering mechanisms to examine is the second–the magnitude of compliance costs relative to total production costs.

The permitting requirements are the only part of the proposed action that would bring direct compliance costs. The requirement would apply to all entities that catch coral reef. The compliance requirements and costs of the proposed permit requirements were addressed in the RIR and for Special Permits were roughly estimated at a minimum of $600 per vessel per year (whether or not the permit is issued) plus $10 per trip. General Permits, if needed, would cost about $50 per year plus $5 per trip, but since all harvesting would initially require Special Permits, the General Permit will be ignored in this analysis.

The threshold annual production costs, below which the (minimum) compliance costs would constitute more than 5 percent of total costs are about $14,000. Not all affected entities would necessarily bear the compliance costs. With the exception of the sportfishing operation based at Midway, all affected entities are based on islands that have adjacent territorial waters that would not be subject to the action. Many of the affected entities, especially the smaller ones, could be expected to shift their effort to territorial waters in order to avoid the costs of fishing federal waters. They could also shift to fishing for non-coral reef species. Although such shifts might result in fewer gross receipts or poorer efficiency, there would be no increase in compliance costs.

It is not possible to determine how many entities would bear the compliance costs and continue fishing for coral reef species in federal waters, how many would shift into other areas or species, or how many would exit the fishery. For the purposes of this analysis, it is determined that it is possible that 20 percent or more of the affected food, charter, and research fishing and harvesting entities would be significantly affected by the increase in compliance costs.

2.4.1 Compliance Requirements and Costs

The compliance requirements and costs of the permitting measure would be applicable to all affected small entities except lobster and bottomfish permit holders that target lobster and bottomfish.

The actual costs of compliance would vary among entities, depending on the number and sizes of vessels and the number of trips made. The compliance costs would include flat rate annual per-vessel annual costs (permits) and more or less flat rate per-vessel trip costs (data collection and reporting). Because most compliance costs are fixed costs, the smaller, less capital-intensive and less profitable operations would bear a greater burden than larger operations relative to total production costs.

The permit application and reporting requirements would require a certain level of scientific expertise, which would bring a certain level of costs. Issuance of Special Permits would require the applicant to demonstrate the proposed activity would be sustainable and not detrimental to the ecosystem. It would require a similar level of expertise and effort as applying for a research or exempted fishing permit. It was estimated in the RIR that such an application would require labor valued at about $20 per hour, and approximately two hours would be required to prepare the application the first year. The time required would presumably decrease considerably in subsequent years, with an average of perhaps 0.5 hours per year, valued at $10.

Another cost associated with the Special Permit requirement is that there is no guarantee that the permit would be issued. Even if issued, the permit may have restrictions or conditions that would make the enterprise cost-ineffective. In these cases, the permit application investment would be sunk and lost.

The Special Permit reporting requirements could be fulfilled with the expertise of a typical fisherman. It was estimated in the RIR that the labor requirements would be about one hour per fishing day, valued at $20. Because reporting costs are variable costs, the differential effects among entities would be small.

2.4.2 Other Economic Impacts

The restricted gears and methods provision could lead to decreased efficiency, less effort, and less return for some entities. Commercial fishing with tangle nets for Kona crab in the Main Hawaiian Islands, for example, would be allowed, but with yet-to-be-determined restrictions. Almost half the commercial catch of Kona crab is from federal waters, most of that from Penguin Bank (from Friedlander, 1996). If strongly affected, fishing effort for Kona crab could presumably shift to territorial waters. Spearfishing on compressed air at night, which would be prohibited, may have been done by one business in the northern islands of the CNMI, but not since 1995 (MES 1997). It may also currently be done by one or more small entities on the bank to the west of Saipan, in the offshore management zone.

The requirement for fishing vessels operating in or transiting through MPAs to carry varying amounts of insurance to cover the cost of vessel removal and pollution liability in the event of a grounding represents a potential additional cost to vessel owners. The amount and cost of this required insurance is expected to vary with vessel category, size, permit type and fishing area and has yet to be determined. However, it is not anticipated that large numbers of individuals or small business entities will be affected by this measure as most of the MPAs are far from inhabited areas.

The prohibition on the harvest of hard corals and wild live rock would not impact any small entities.

The Special Permit requirement–with its capacity to deny access and to attach any number of conditions on harvesting–may effectively exclude small entities from certain activities, areas, or the entire fishery. Because of the large degree of discretion given to NMFS in reviewing and issuing permits, it is not possible to estimate how many or to what degree small entities would be affected (this is in addition to the impacts of the compliance costs, addressed above).

The low degree of security, durability, and stability associated with the permits (e.g., their validity, conditions, and limitations may change at any time) provide permit holders with relatively little interest in the fishery and present a high level of risk associated with investment.

The substantial financial and technical requirements of the permit application process and the substantial costs needed to comply with permit conditions are likely to favor larger, full-time, capital intensive, high-profit operations, leading to effective allocation of fishing rights among different

categories of entities. Those costs, along with the vague criteria for permit issuance, could also lead to allocation according to any number of other factors, as well, including vessel size, scientific expertise, or market (e.g., fishing for sport versus food).

The no-take zones would affect a few small business entities. Existing fisheries operating in the NWHI would be prohibited from fishing at all depths 0-10 fm and 0-50 fm around Laysan, French Frigate Shoals the northern half of Midway. However, the small business entities are not likely to be significantly affected by restriction of these areas, as no-take zones represent approximately 14% of the available fishing grounds in federal waters in the NWHI. Similarly, the sportfisheries operating out of the Midway Atoll National Wildlife Refuge would not be significantly affected by the no-take MPAs. Shore-based fishing would be allowed to continue under special permits while pelagic fishing will be allowed to continue in the 0-50 fathoms in the southern half of Midway Atoll and with a special permit beyond 50 fm in both the southern and northern half of the Refuge. The developing ecotourism and sportfishing business at Palmyra will be able to develop under the Special permit regime. Permitting costs, as a percentage of total costs, would be minimal for this operation.

The no-anchoring restrictions for Guam's banks and other yet-to-be designated areas could reduce harvesting efficiency by vessels longer than 50 feet (of which there are apparently very few)–by how much is not known.

Whatever the impacts of the preferred measures, most affected entities do not rely totally on coral reef species in federal waters and have alternative activities and areas that they can fish.

2.5 Identification of Duplicating, Overlapping, and Conflicting Federal Rules

Two possibly duplicating, overlapping, or conflicting federal rules were identified:

1) The Special Permit system would be similar to the existing "exempted fishing permit" (EFP) system administered by the NMFS for otherwise closed fisheries (50CFR600.745). Like an EFP, a Special Permit may, at the discretion of NMFS, be conditioned with limits on catch, effort, periods, areas, gears and methods, and it would require reporting of catch and effort data. In both systems, the burden would be on the applicant to demonstrate the lack of detrimental effects, consistency with the objectives of the FMP, and to otherwise justify the need for a permit. The proposed Special Permit system could be viewed as closing the fishery, with exemptions provided through a permit system that is similar to the existing system for closed fisheries. The proposed system would use the same administrative infrastructure to provide what could be viewed as a second means, with slightly different requirements and conditions, of gaining access to the fishery. The substantive differences between the two systems are:

1. The EFP process requires publication in the *Federal Register* of receipt of any application determined by the NMFS Regional Administrator or Director to warrant consideration, as well as consideration of comments from the public and other agencies, including the USCG and local fishery agencies; the Special Permit process would not;

2. The fee for an EFP may be set as high as needed to cover the administrative expenses of issuance (currently set at zero); the fee for a Special Permit has not been determined; and

3. The Special Permit system would give the WPRFMC discretion to review the application and consult with NMFS, while the EFP system gives NMFS the discretion to consult with the WPRFMC over the application.

2) The proposed action would prohibit the harvest of hard corals and wild live rock, except for research or as aquaculture broodstock, subject to obtaining a Special Permit. The restriction would therefore apply to any dredging of reef material that contains coral or live rock. Dredging is governed by the Clean Water Act.

2.6 Alternatives to Minimize Impacts

The Environmental Impact Statement for the FMP identifies a range of alternative regulatory measures and how each of them would meet the objectives of the FMP relative to the preferred set of actions. Those and other options are discussed here in terms of how they might reduce the impact on small entities while still accomplishing the objectives of the FMP. For reference to how the alternatives would meet statutory objectives, and how the objectives and proposed measures are consistent with the national standards of the Magnuson-Stevens Act, see Consistency with National Standard Guidelines and Sustainable Fisheries Act Provisions in the FMP.

Marine Protected Areas:

Using alternative MPA configurations would shift the impacts among affected small entities and could reduce the impacts on them. For example, not closing the waters around Midway would allow the existing sportfishing entity to continue coral reef fishing. Alternatively, an exemption could be provided for certain activities, such as catch-and-release fishing or fishing for local use (i.e., no export from the NWHI). However, based on recent suggestive declines in *ulua* CPUE at Midway Sportfishing, the efficacy of catch-and-release as it is now practiced for *uluas* in the NWHI should be seriously evaluted before such activities are given automatic exemptions. An exemption of the latter type could also reduce the possible future impact on potential sportfishing entities at islands such as Palmyra, Wake, or Kingman (at which a Special Permit would be required).

There is no alternative to the anchoring limitation on Guam's southern banks that would meet the stated objectives (FMP Objective 4–minimize adverse human impacts), except possibly adjusting the affected vessel size (e.g., to larger than 50 feet). The relationships between vessel size, anchor damage, harvesting efficiency, and vessel safety are not known well enough to choose the optimal alternative.

The no-MPA option would bring smaller short-term direct impacts to small entities, but it would not serve FMP Objective 1 (foster sustainable use ... through the use of the precautionary approach and ecosystem-based resource management) or 4 (minimize adverse human impacts).

Fishing Permit and Reporting Alternatives:

Reducing the compliance costs and uncertainty of the permitting system would reduce the impacts on small entities. The compliance costs and uncertainty of General Permits are much less than for Special Permits. Classifying as many species as possible as Currently Harvested Coral Reef Taxa (General Permit) before implementation of the FMP could reduce impacts to some small entities.

Minimizing the degree of discretion in reviewing Special Permit applications, such as through the use of prescribed issuance guidelines, would improve the certainty of outcome and reduce the risk of small entities losing their investment in an application and in the fishery. The General Permit system would allow no discretion, but its utility would be limited to providing information (FMP Objective 3), without any effective controls on harvesting effort that might be needed to "foster sustainable use ... through the use of the precautionary approach and ecosystem-based resource management" (Objective 1) and to minimize adverse human impacts (Objective 4).

Setting limitations on the types and degrees of conditions that may be placed on a permit would decrease likely compliance costs and provide more certainty of outcome of the application process. Set permit durations would also provide greater certainty and decrease the risk of losing an investment in the fishery. The disadvantage of these more prescriptive permit options is that they would give fishery managers less flexibility and less ability to rapidly respond to changes in the environment, the fishery, and available information (FMP Objective 2).

The no-permit, no-reporting option would result in no impact to small entities, but it would not contribute to FMP Objectives 1, 2, 3, or 4, described above.

Less strict permit requirements (e.g., no permit requirement) might be appropriate on reefs that are contiguous with, or proximate to, locally-managed reefs, where permit requirements would be difficult to enforce in any case. The disadvantages to these alternatives are again, less control over harvesting effort (Objectives 1 and 4), less flexibility and responsiveness afforded to managers (Objective 2), and less ability to gather information (Objective 3).

A final option would be to close the fishery entirely. This would be, in a sense, a permitting alternative, since exempted fishing permits (EFP) may be applied for when a fishery is otherwise closed. The likelihood of obtaining an EFP is probably not as great as obtaining a Special Permit, because although they have the common mandate of being consistent with the objectives of the FMP (e.g., "foster sustainable use . . . "), the EFP is designed to only allow harvesting for "exploratory," "data collection," or other limited purposes. The Special Permit, in contrast, has the less restrictive purpose of ensuring sustainable harvest. An EFP is unlikely to offer any greater certainty, stability, or durability than a Special Permit, but the costs of application would be no more than for a Special Permit.

Gear Restrictions:

Allowance of night spearfishing on compressed air would reduce the impacts to commercial spearfishermen operating in the offshore management zone of the CNMI (if such activity actually occurs). This gear does not degrade habitat or result in bycatch, so the effect of allowing it would be to increase potential harvesting efficiency, along with an increased risk of overfishing.

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4.0 SOURCES AND ASSUMPTIONS FOR TABLES

Data Sources and Assumptions

The ex-vessel values given in Tables 1 through 7 are the product of volume and per-unit value (e.g., price per pound or price per charter trip). The prices reported below for Tables 2 through 7 are nominal for the year(s) indicated; values shown in the tables have been inflation-adjusted to 1999 dollars using consumer price indices for Honolulu (for Hawaii and American Samoa data) and Guam (for Guam and CNMI data). All prices and values are ex-vessel unless otherwise noted.

Sources and Assumptions for Table 3 (Fisheries, American Samoa):

Coral Reef:

Food:

- Finfish landings are 1991-1995 average from Green (1997:Table 52); value used 1996 price of $1.80/lb from Hamm *et al.* (1998:Table II.1.1); % FMP roughly estimated from information in Green (1997), Saucerman (pers. comm.), and Kinsolving (pers. comm.).
- Crustacean landings are 1991-1995 average from Green (1997:Table 52); value estimated at $3.50/lb with little basis; % FMP from information in Green (1997), and excludes lobsters.
- Echinoderm landings are 1991-1995 average from Green (1997:Table 52); value estimated at $2/lb with little basis; % FMP from information in Green (1997).
- Mollusc landings are 1991-1995 average from Green (1997:Table 52); value estimated at $2/lb with little basis; % FMP from information in Green (1997).
- Other invertebrate landings are palolo worms, rough recent average from Green (1997:115); value of $10/lb taken from range of $7 to $10/lb from Saucerman (pers. comm.); % FMP from information in Green (1997).
- Seaweed landings from Green (1997:116); value unknown; % FMP from information in Green (1997).

Sport: There is a very small charter sportfishing industry, and most activity is trolling (Saucerman pers. comm. and Kinsolving pers. comm.), so assume minimal coral reef trips and value.

Ornamentals: Landings are rough estimates based on there being one commercial collector (Bartram pers. comm.) and assuming mostly fish and shells are the targets (Bartram pers. comm. and Kinsolving pers. comm.); value of $2/piece estimated with little basis; coral collecting is banned in depths shallower than 60 feet (Hunter 1995), no knowledge of any black coral or hermatypic coral, but some known collection of live rock, assume it is minimal; % FMP assumed zero from information in Green (1997).

Marine natural products: No knowledge of any activity.

Mariculture: No knowledge of any activity except small giant clam farms (Kinsolving pers. comm.), so assume it is minimal.

Deep Bottom:

Food: Landings are 1993-97 average from WPRFMC (1998:1-3), multiplied by the 88% that were BMUS in 1997 (WPRFMC 1998:Table 1); value based on 1997 price of $2.35/lb from WPRFMC (1998:2).

Sport: There is a very small charter sportfishing industry, and most activity is trolling (Saucerman pers. comm. and Kinsolving pers. comm.), so assume minimal deep bottom trips and value.

Ornamentals: No knowledge of any activity.

Pelagic:

Food: Landings roughly estimated from Hamm *et al.* (1998:Figure II.3.1), which reported about 300,000 to 500,000 lb/year from 1994-1996 (note increase from 1991-1995 average of 180,800 lb/year reported in Green (1997:Table 52); value based on 1996 price, $1.10/lb, reported in Hamm *et al.* (1998:Table II.1.1) for albacore, which dominated landings in 1996.

Sport: There is a very small charter sportfishing industry, and most activity is trolling (Saucerman pers. comm. and Kinsolving pers. comm.); roughly estimated, with little basis, 2 active boats, each doing 20 trips/year and 3 anglers/trip; fees roughly estimated, with little basis, at $80/angler-trip.

Sources and Assumptions for Table 4 (Fisheries, CNMI):

Coral Reef:

Food:

- Finfish landings are rough 1983-1993 average from DFW (1994:Figure 3); note that Radtke and Davis (1995) reported only 307,500 lb for 1995, but may have been commercial only; value based on 1996 price of $2.40/lb from Hamm *et al.* (1998:Table .1.1), in agreement with Radtke and Davis (1995); % FMP roughly estimated based on information in MES (1997) and Green (1997), including the report in the former that 15 mt of reef fish were taken from the northern islands in 13 trips by one 110-ft vessel during 7 months of 1995.
- Lobster landings estimated from various sources in Green (1997:138); value based on 1996 price of $4.64/lb from Hamm *et al.* (1998:Table .1.1); % FMP excludes lobsters.
- Echinoderm landings are all sea cucumbers (wet weight), very roughly estimated from records of Oct 1995 to May 1997 landings as reported in Green (1997:137), of 168,235 lb, but qualified with evidence that such levels may not be sustainable; value based on $6,000/mt for Fiji, reported in Dalzell *et al.* (1996:App 1); % FMP estimated from information in MES (1997) and Green (1997).
- Mother-of-pearl mollusc landings are all trochus, very roughly estimated from information in MES (1997) about intermittent nature of fishery, potential harvests, and amount stockpiled by a local company; value based on 1996 price of $3.09/lb paid by one company for shell-with-meat (MES 1997); % FMP estimated from data in MES (1997) and Green (1997).

Sport: Miller (pers. comm.) reports 33 boats registered as charter in 1999; roughly estimated, with little basis, there were 2 active boats for reef fish, each taking 100 trips/year and 8 anglers/trip; fees roughly estimated, with little basis, at $50/angler-trip; % FMP estimated from information in MES (1997) and Green (1997), and the assumption that the bank off west coast of Saipan may be used for sportfishing.

Ornamentals: Finfishes, invertebrates, and live rock are taken, but rarely, for local use in homes and hotels, and shells and beach coral are taken for local use and by visitors (Gourley pers. comm.); corals are also taken to make lime, by permit; assume overall landings and value to be minimal; % FMP estimated from information in MES (1997) and Green (1997).

Marine Natural Products: No knowledge of any activity.

Mariculture: No knowledge of any activity.

Deep bottom:

Food: 1993-1997 average landings from WPRFMC (1998:4-6) was 33,494 lb (commercial only); Radtke and Davis (1995) reported about 72,000 lb in 1995; so roughly estimated 50,000 lb; value based on 1997 price of $3.32/lb from WPRFMC (1998:12).

Sport: Miller (pers. comm.) reports 33 boats registered as charter boats in 1999; roughly estimated, with little basis, there was 1 active boat for deep bottom, taking 100 trips/year and 3 anglers/trip; fees roughly estimated, with little basis, at $100/angler-trip.

Ornamentals: No knowledge of any activity.

Pelagic:

Food: Radtke and Davis (1995) reported about 360,000 lb in 1995; DFW (1994) implied about 700,000 lb/year, so roughly estimated 500,000 lb/year; value based on 1996 price of $1.90/lb, from Hamm *et al.* (1997:Table .1.1).

Sport: Miller (pers. comm.) reports 33 boats registered as charter boats in 1999; roughly estimated, with little basis, 20 active boats doing trolling, each taking 150 trips/year and 3 anglers/trip; fees roughly estimated, with little basis, at $100/angler-trip.

Sources and Assumptions for Table 5 (Fisheries, Guam):

Coral Reef:

Food:

- Finfish 1991-1994 average landings reported in Myers (1997:Table 5) as 250,271 lb, including shallow component of bottom fishing and *atulai*; but personnel of Department of Aquatic and Wildlife Resources are reported as believing annual value to be $1.5 to $2.0 million/yr (main body of this document), so made intermediate estimate of 400,000 lb; value based on 1996 price of $2.94/lb for "reef fish," from Hamm *et al.* (1998:Table IV.1.1); % FMP estimated from Myers (1997), which reports that "substantially less than 20%" of reef fish are taken in federal waters, so estimated 10%.
- Lobster landings are 1991-1994 average, derived from Myers (1997:Tables 3 and 5); value based on 1996 price of $3.66/lb, from Hamm *et al.* (1998:Table IV.1.1); % FMP excludes lobsters.
- Mother-of-pearl mollusc landings are trochus only, 1991-94 average, derived from Myers (1997:Tables 3 and 5); value based on $2.20/lb price for CNMI reported by Dalzell *et al.* (1996:App 1).
- Other mollusc landings are 1991-94 average, derived from Myers (1997:Tables 3 and 5), includes giant clam *(T. maxima)* and octopus; value based on 1996 price of $2.65/lb for octopus from Hamm *etal.* (1998:Table IV.1.1); % FMP estimated from data in Myers (1997).
- Other invertebrate landings are 1991-94 average, derived from Myers (1997:Tables 3 and 5); value estimated, with little basis, at $2.20/lb; % FMP estimated from data in Myers (1997).
- Seaweed landings discussed in Myers (1997) and Green (1997) but no indication of volume or value; % FMP estimated from information in Myers (1997).

Sport: Pitlik (pers. comm.) reported 1,733 "bottom fishing" boat-trips and 20,388 angler-trips; with little basis, estimated half were deep bottom and half coral reef fishing trips; value based on $30/pax for party boats (Pitlik, pers. comm.); % FMP estimated based on WPRFMC (1998:2-13), which reported charter boats made 23% of all bottom fishing trips in 1996, including some "reef fish"; but most trips were only 2-4 hours, so very few went to federal waters, and assumption that federal waters are visited proportionately less often by charter boats than by commercial and recreation boats.

Ornamentals: Green (1997) estimated landings of ornamental fishes at 1,000 to 2,000 fish per month/mo (most exported to US, 120 to 150 per month sold in local pet shop) and some local residents collect for both home use and sale to local pet shop; some invertebrates also collected, but not exported; value of $2 per fish estimated with little basis; % FMP estimated from information in Myers (1997).

Marine Natural Products: No knowledge of any activity.

Mariculture: No knowledge of any activity.

Deep Bottom:

Food: Landings are average annual landings of BMUS during 1993-1997 (WPRFMC 1998:Guam App:2-9); value based on 1996 price of $3.50/lb (WPRFMC 1998:7).

Sport: Pitlik (pers. comm.) reported estimated 1,733 "bottom fishing" boat-trips and 20,388 angler-trips; with little basis, estimated half were deep bottom and half coral reef fishing trips; WPRFMC (1998:2-13) reported that charter boats made 23% of all bottom fishing trips in 1996; value based on $30/pax for party boats (Pitlik, pers. comm.).

Ornamentals: No knowledge of any activity.

Pelagic:

Food: Landings derived from Myers (1993:Fig 1), which reported range of 168mt to 364mt from 1980 to 1991; so took 300 mt; historical commercial data in Hamm *et al.* (1998:Fig IV.3.1) indicate it is reasonable; value based on approximate 1996 price of $1.30/lb, from Hamm *et al.* (1998:Table IV.1.1).

Sport: Pitlik (pers. comm.) reported 3,537 troll boat-trips and 20,519 angler-trips; value based on $350/boat-trip (Pitlik pers. comm.).

Sources and Assumptions for Table 6 (Fisheries, Main Hawaiian Islands):

Coral Reef: DAR (no date) reported about 1.2 million lb of commercial coral reef species landings between 1993 and 1997; Friedlander (1996) reports that under-reporting of commercial is common and notes the large non-commercial component of the fishery. Meyer (1987a) reported 21m lbs landings just by recreational boaters, much of which must have been reef species; so very roughly estimate landings of coral reef species of 5 million lb/year.

Food:

- Finfish landings estimated as 5 million coral reef species total less all other species groups; value based on 1991-1995 average price, or $1.56/lb, from Friedlander (1996:Table 14); % FMP from % of commercial landings outside 2 mile statistical zone (Friedlander 1996:Table 14), less 10% to approximate the 3 mile federal boundary.
- Lobster landings roughly estimated as twice the reported commercial landings, from Friedlander (1996:Table 14); price of $11.74/lb was 1991-95 average, from Friedlander (1996:Table 14); % FMP excludes lobsters.
- Other crustaceans mostly kona crab, landings roughly estimated as twice reported commercial landings, from Friedlander (1996:Table 14); price of $3.83/lb was 1991-95 average, from Friedlander (1996:Table 14); although an MUS under the crustacean FMP, kona crabs included here under % FMP, which is from % of commercial landings outside 2 mile statistical zone (Friedlander 1996:Table 14), less 10% to approximate the 3 mile federal boundary.

- Echinoderms all sea cucumbers; landings estimated as average 1991-95 reported commercial landings (Friedlander 1996:Table 14) adjusted upwards proportionately with other species so that all coral reef species landings totaled 5 million lb; price of $7.16/lb was 1991-95 average, from Friedlander (1996:Table 14); % FMP from % of commercial landings outside 2 mile statistical zone (Friedlander 1996:Table 14), less 10% to approximate the 3 mile federal boundary.
- Mollusc landings estimated as average 1991-95 reported commercial landings (Friedlander 1996:Table 14) adjusted upwards proportionately with other species so that all coral reef species landings totaled 5 million lb; price of $2.30/lb was 1991-95 average, from Friedlander (1996:Table 14); % FMP from % of commercial landings outside 2 mile statistical zone (Friedlander 1996:Table 14), less 10% to approximate the 3 mile federal boundary.
- Seaweed landings estimated as average 1991-95 reported commercial landings (Friedlander 1996:Table 14) adjusted upwards proportionately with other species so that all coral reef species landings totaled 5 million lb; price of $3.84/lb was 1991-95 average, from Friedlander (1996:Table 14); % FMP from % of commercial landings outside 2 mile statistical zone (Friedlander 1996:Table 14), less 10% to approximate the 3 mile federal boundary.

Sport: Roughly estimated 500 angler-trips per year based on Hamilton (pers. comm.) estimating that less than 1% of charter trips are for reef fish, with 1-3 anglers/boat; value based on fee of $141/angler-trip estimated for pelagic charter fishery, as described below; % FMP estimated with little basis.

Ornamentals: Volume for fishes and other inverts is number of animals collected, 1991-95 average from Miyasaka (1997), fishes dominated but some inverts, particularly feather duster worm, note 99% are sold; value based on 1991-1995 average ex-collector prices from Miyasaka (1997); % FMP from information in Friedlander (1996). Volume and value for black coral are 1991-95 averages from Friedlander (1996:Table 14).

Marine Natural Products: No knowledge of any activity, but with Hawaii's large ocean research and development industry, it is possible.

Mariculture: No knowledge of any activity, but with Hawaii's large mariculture industry, it is possible.

Deep Bottom:

Food: Landings 1993-97 average from WPRFMC (1998:3-10); value based on 1993-96 average price of $3.48 from WPRFMC (1998:3-3).

Sport: Roughly estimated 5,000 angler-trips per year based on data in Hamilton (1998 and pers. comm.); value based on fee of $141/angler-trip estimated for pelagic charter fishery, as described below.

Ornamentals: No knowledge of any activity (see Grigg 1993).

Pelagic:

Food: First, assumed 32 million lb total food fish in Hawaii, derived from data in Pooley (1993a:Table 1) of 30.2 million lb for 1990, adjusted upwards by implied higher landings in Meyer (1987a), then subtracted 5 million lb of reef species and 1 million lb bottom fish species, leaving 26 million lb; then applied ratio of landings between main and northwestern islands of 85:15 (1991-95 average from Friedlander 1996:Table 13) to very roughly estimate pelagic landings in main islands; value based on 1991-95 average price of $2.01 from Friedlander (1996:Table 13) for all offshore gear.

Sport: Data in Hamilton (1998) on trips/boat and number of charter boats suggests about 33,000 charter boat trips/yr, assumed 3 anglers/trip; total revenues estimated from average annual fees per business in Hamilton (1998) of $73,195, multiplied by 200 boat fleet, estimated from data in Hamilton (1998).

Sources and Assumptions for Table 7 (Fisheries, Northwestern Hawaiian Islands):

Coral reef:

Food:

- Finfish volume and value from Friedlander (1996:Table 14), assume no additional non-commercial landings; note most of it is sharks, thus the low value; % FMP from % of commercial landings outside 2 mile statistical zone (Friedlander 1996:Table 14), less 10% to approximate the 3 mile federal boundary.
- Lobster volume and value are 1992-1997 averages from Pooley and Kawamoto (1998); note dramatic decrease since 1988-89, when 1.5 million lb landed; lobster excluded from % FMP.
- Other crustaceans volume and value from Friedlander (1996:Table 14), assume no additional non-commercial landings; % FMP from % of commercial landings outside 2 mile statistical zone (Friedlander 1996:Table 14), less 10% to approximate the 3 mile federal boundary.
- Other molluscs volume and value from Friedlander (1996:Table 14), assume no additional non-commercial landings; % FMP from % of commercial landings outside 2 mile statistical zone (Friedlander 1996:Table 14), less 10% to approximate the 3 mile federal boundary.
- No commercial sea cucumber, other invertebrate, or seaweed landings reported in Friedlander (1996).

Sport: About 150 anglers/yr recently visited Midway to fish (Glover pers. comm.); assumed 5 trips per angler (derived from MSF 1999), and half reef fishing (e.g., spin-casting) and half pelagic fishing (Glover (pers. comm.); value based on $2,125 per angler-visit (derived from MSF 1999); all Midway's waters federal, so 100% FMP fishery.

Ornamentals: No knowledge of any activity.

Marine Natural Products: No knowledge of any activity.

Mariculture: No knowledge of any activity.

Deep Bottom:

Food: Landings and value 1993-97 averages from WPRFMC (1998:3-10).

Sport: At Midway only pelagic and reef fishing noted by Glover (pers. comm.), but likely some minimal activity.

Ornamentals: No knowledge of any activity.

Pelagic: First, assumed 32 million lb total food fish in Hawaii, derived from data in Pooley (1993a:Table 1) of 30.2 million lb for 1990, adjusted upwards by implied higher landings in Meyer (1987a), then subtracted 5 million lb of reef species and 1 million lb bottom fish species, leaving 26 million lb; then applied ratio of landings between main and northwestern islands of 85:15 (1991-95 average from Friedlander 1996:Table 13) to very roughly estimate pelagic landings in northwestern islands; value based on 1991-95 average price of $2.01 from Friedlander (1996:Table 13) for all offshore gear.

Food: 1990 from Pooley (1993a:Table 1) for total for state, then used MHI:NWHI ratio of 85:15 to split it (Friedlander 1996:Table 13)

Sport: About 150 anglers/yr recently visited Midway to fish (Glover pers. comm.); assumed 5 trips per angler (derived from MSF 1999), and half reef fishing and half pelagic fishing (Glover (pers. comm.); value based on $2,125 per angler-visit (derived from MSF 1999).

Sources and assumptions for Table 8 (fisheries, other islands):

Coral Reef:

Food: Landings derived from Irons *et al.* (1990), who reported on harvest of reef species on Johnston in 1990; those figures were doubled to roughly account for the 110 people on Wake (Green 1997) presumably doing about the same amount of fishing as the 175 people on Johnston in 1990; per-unit values roughly estimated with little basis; lobsters excluded from % FMP.

Sport: No knowledge of any activity.

Ornamentals: Irons *et al.* (1990) noted that coral and shells were collected by residents of Johnston for personal use; some evidence of aquarium fish harvesting seen at Palmyra.

Marine Natural Products: No knowledge of any activity.

Mariculture: No knowledge of any activity.

Deep bottom:

Food: No knowledge of any activity.

Sport: No knowledge of any activity.

Ornamentals: No knowledge of any activity.

Pelagic:

Food: Estimated, with little basis, that about half as much pelagic landings were made as reef fish landings; value ($2/lb) roughly estimated with little basis.

Sport: No knowledge of any activity.

Sources and Assumptions for Table 10 (Tourism Activity):

American Samoa:

- Total number of tourists derived from NPS (1996) estimates for 1993: less than 5,000 tourists plus 5,000 cruise ship passengers, the latter of which spend only about 8 hours on land; these figures can be compared with industry's peak of about 34,000 visitors in 1974.
- Percent of tourists American roughly estimated at 80 percent from data in Green (1997).
- Number of tourists "marine" and scuba divers from Kinsolving (pers. comm.) and Saucerman (pers. comm.).
- Expenditures by tourists, marine tourists, by scuba divers estimated by assuming expenditures of $500 per visitor.
- Number of scuba dives estimated by assuming five dives per visiting diver.

CNMI:

- Number of tourists and expenditures by tourists from MES (1997) and unpublished data of Marianas Visitors Authority.
- Percent of tourists American from Bank of Hawaii (1997b) and Miller (pers. comm.).
- Number of tourists "marine" roughly estimated from Green (1997) and Miller (pers. comm.).
- Number of scuba dives roughly estimated from DEQ (in prep.), which reported 84,000 or more dives in Lau Lau Bay alone.
- Number of scuba divers roughly estimated from the number of scuba dives (above), divided by a roughly estimated four dives per tourist (derived from the typical stay of Japanese tourists being 3 nights–Miller, pers. comm.).

- Expenditures by marine tourists and by scuba divers estimated by multiplying total tourist expenditures by the percentages of total tourists that were "marine" and scuba divers, respectively.
- Expenditures on scuba diving from DEQ (in prep.).
- Number employed in tourism roughly derived from 1995 census data, as reported by Miller (pers. comm.).
- Number employed in scuba diving roughly derived from Miller (pers. comm.).

Guam:

- Number of tourists, number of tourists "marine," percent of tourists American, number employed in tourism, and government revenues from tourism from GEDA (1999).
- Number of tourists scuba divers, expenditures per tourist, and number of scuba dives from Birkeland (1997b).
- Expenditures by marine tourists and by scuba divers estimated by multiplying total tourist expenditures by the percentages of total tourists that were "marine" and scuba divers, respectively.

Hawaii:

- Number of tourists, percent of tourists American, expenditures by tourists (1997-1998 averages) from Bank of Hawaii (1998).
- Number of tourists "marine" estimated at 65% of total, derived from an estimate of 85% by Clark (1991) for tourists that engage in some ocean recreation.
- Expenditures by marine tourists and by scuba divers estimated by multiplying total tourist expenditures by the percentages of total tourists that were "marine" and scuba divers, respectively.
- Expenditures on marine recreation from Grigg (1997), but includes expenditures by residents.
- Expenditures on scuba diving for 1992 and includes only tours and sales, from Clark (pers. comm.), cited in Friedlander (1996).
- Number of scuba dives (all paid dives, including by residents) from Tabata (pers. comm.) for 1986, adjusted upwards by 120%, the increase in visitation since 1986.
- Number of scuba divers estimated from number of scuba dives, assuming four dives per diver.
- Employment in tourism (1994-1997), government revenues from tourism (1992), and tourism as percent of gross state product (1992) from WTTC (1997), which treated the "travel and tourism industry."
- Employment in marine recreation from MacDonald *et al.* (1996).
- Employment in scuba industry (including part-time and contract workers) from Tabata (pers. comm.) for 1986, adjusted upwards by 120%, the increase in visitation since 1986.

Endnotes

1. "Natural products" as a fishery and "information" as a non-fishery are related but treated separately here. The former refers to the harvest side of gathering information and novel products from coral reefs, which is directly under the control of fisheries management agencies and this FMP. The latter, "information," refers to all the values of knowledge gleaned from the reef that do not rely on extraction and that are therefore not under the control of the FMP.

For example, a sponge might be harvested and examined by an academic researcher interested solely in taxonomy. The specimen might then be passed on to an academic or commercial researcher who learns about the chemistry of the sponge, including the discovery of some unique chemical activity with commercial application. This chemical information, either with or without the original specimen, might then be passed on to another party interested in producing commercial quantities of some derivative for pharmaceutical or other purposes. This might lead to synthesization of the chemical derivatives of the sponge and/or further harvest of the sponge, and ultimately to the production of saleable products. These last few steps in the process are well beyond the jurisdiction of the FMP. They are, however, important in terms of valuing the genetic and other "informational" resources of the sponge and the coral reef ecosystems in general.

It is assumed here that under even the most restrictive management alternatives being considered, extraction of small amounts of coral reef resources for primary research purposes–for the "discovery" of information–would be allowed, if governed by permits, and the measures would have no impact on this aspect of "information" value. If and when discovery of a valuable resource leads to the demand for more intensive extraction of an organism from the coral reef, the controls of the FMP could then conceivably restrict the extent of extraction and consequently the value of the research and development–for example by limiting the rate of extraction to the extent that it affects the production rate of a commercial product. Any such intensive extraction for commercial purposes, along with the value of the products that come from it, will be considered here as part of the "coral reef fishery natural products" sector. These are activities that are directly dependent on coral reef resources and directly under the control of the FMP. Harvesting of stony corals for use as bone graft material would be one example. In fact, it appears that no such activities are currently taking place in the US Pacific Islands. Any academically, educationally, or commercially motivated research that does not involve such intensive extraction, including research that leads to the development of commercial products, as well as any subsequent commercial production that does not rely on continued extraction from the reef, is treated under the "non-fishery information" sector.

UNITED STATES DEPARTMENT OF COMMERCE
The Deputy Under Secretary for
Oceans and Atmosphere
Washington, D.C. 20230

MAY - 3 2002

Dear Reviewer,

In accordance with provisions of the National Environmental Policy Act of 1969 (NEPA), we enclose for your review the Final Environmental Impact Statement (FEIS)/Fishery Management Plan for Coral Reef Ecosystems of the Western Pacific Region (FMP), located in the Exclusive Economic Zone of the Western Pacific Region. This FEIS is prepared pursuant to NEPA to assess the environmental impacts associated with NOAA proceeding with implementation of the proposed FMP.

The FMP proposes to: (1) establish fishing permit and reporting requirements; (2) specify the use of selective, non-destructive gears and methods for harvesting management unit species; (3) designate marine protected areas, including no-take marine reserves and areas zoned for specific fishing activities allowed only with a special permit; and (4) establish a framework process to allow for future regulatory adjustments to the coral reef ecosystem management program. The FMP also would establish a formal process to allow the various fishery management plan teams, i.e., pelagics, crustaceans, bottomfish and seamount groundfish, precious coral, to coordinate their discussion of relevant fishery issues with the coral reef ecosystem plan team; facilitate consistent State and territorial level management of coral reef resources; create social, economic and political incentives for sustainable use and disincentives for non-sustainable use of coral reef resources; and foster education, public outreach and "coral reef management diplomacy." The FMP contains a definition of overfishing, designates management unit species divided into two groups: harvested coral reef taxa and non-targeted coral reef taxa; identifies essential fish habitat; describes fishing sectors; and addresses bycatch and other requirements of the Magnuson-Stevens Fishery Conservation and Management Act.

RESPONSIBLE OFFICIAL: Dr. Charles Karnella, Administrator
Pacific Islands Area Office, Southwest Region
National Marine Fisheries Service
1601 Kapiolani Blvd., Rm. 1110
Honolulu, Hawaii 96814
(808) 973-2937

Please note that this FEIS is dated for October 2001. The National Marine Fisheries Service (NMFS) headquarters received the Coral Reef Ecosystem FMP/FEIS for public review at that time but still had to resolve a few issues before formally reviewing. NMFS began its formal review of these documents on March 2002, and discovered that the essential fish habitat alternatives were not included in the FEIS. They are attached with this letter along with an errata sheet.

Any written comments or questions you may have should be submitted to the responsible official by June 10, 2002. Also, please send one copy of your comments to my staff in Room 6121, NOAA/SP, U.S. Department of Commerce, 14th and Constitution, N.W. Washington, D.C. 20230.

Sincerely,

for Scott B. Gudes,
Deputy Under Secretary for
Oceans and Atmosphere

Enclosures

Errata

Insert the following text after the "III: Maps of Coral Reef Habitat in the Western Pacific Region" heading and before the maps (p. 390) in Volume III of the "Final Fishery Management Plan for the Coral Reef Ecosystems of the Western Pacific Region":

For each of the maps listed in Chapter III of Volume III, EFH is bounded by, and displayed within, the 50 fm depth contour (the hashed area on each map). EFH may encompass all or some of the hashed area, based on the EFH text descriptions listed in Table 6.3 of Volume I, and repeated below:

For Currently Harvested Coral Reef Taxa, EFH for *Eggs and Larvae (all species)* is:

the water column from the shoreline to the outer boundary of the EEZ to a depth of 50 fm,

EXCEPT for the following species:

Carcharhinidae	(no EFH designation for egg and larval life stages)
Labridae	(EFH for eggs and larvae is designated as the water column *and all bottom habitat* from the shoreline to the outer boundary of the EEZ to a depth of 50 fm)
Octopodidae	(EFH for the egg life stage is all coral, rocky, and sand-bottom areas from 0 to 50 fm)

For Currently Harvested Coral Reef Taxa, EFH for *Adults and Juveniles (all species)* is:

all bottom habitat and the adjacent water column from 0 to 50 fm,

EXCEPT for the following species:

Holocentridae Muraenidae	(EFH for adults and juveniles is *all rocky and coral areas* and the adjacent water column from 0 to 50 fm)
Kuhliidae	(EFH for adults and juveniles is all bottom habitat and the adjacent water column *from 0 to 25 fm*)
Kyphosidae	(EFH for adults and juveniles is *all rocky and coral bottom* and the adjacent water column from *0 to 15 fm*)
Mullidae Octopodidae Polynemidae Priacanthidae	(EFH for adults and juveniles is *all rocky/coral bottom and sand-bottom habitat* and the adjacent water column from 0 to 50 fm)

Mugilidae (EFH for adults and juveniles is *all sand and mud bottom* and the adjacent water column from *0 to 25 fm*)

Scombridae
Sphyraenidae (EFH for adults and juveniles is *only* the water column from the shoreline to the outer boundary of the EEZ to a depth of 50 fm)

Aquarium Species/Taxa (EFH for adults and juveniles is the coral, rubble, and other hard-bottom features and the adjacent water column from 0 to 50 fm)

For Potentially Harvested Coral Reef Taxa, EFH for *all life stages and species* is:

the water column and all bottom habitat from the shoreline to the outer boundary of the EEZ to a depth of 50 fm

ESSENTIAL FISH HABITAT

EFH Designations for MUS

Due to the large gaps in scientific knowledge about the life histories and habitat requirements of many species living the coral reef ecosystem, the Council has adopted a precautionary approach in designating EFH for the Coral Reef Ecosystem MUS. Several alternative approaches for EFH designation for MUS were considered and are listed as follows (1) no action; (2) species-by-species; (3) family-by-family; (4) habitat/behavioral group; (5) reef obligate species/reef-associated species; (6) designate MUS at a higher taxonomic order; (7) representative species; (8) indicator species; (9) habitat composites; (10) designate the sessile benthos MUS (e.g., reef-building corals) as EFH for those organisms themselves and for associated species.

The Council endorses an approach to designating EFH similar to one previously used by the South Atlantic and Pacific Fishery Management Councils. MUS are linked to specific habitat "composites" (i.e., sand, live coral, seagrass beds, mangrove, etc.) for each life history stage, consistent with the depth of the ecosystem to 50 fathoms and to the limit of the EEZ. The proposed EFH may also protect the habitats of species managed under other FMPs in the Western Pacific. The habitat composite approach is described in depth as alternative 9.

Alternatives Considered in EFH Designation for MUS

Alternative 1: No action/status quo

Alternative 1 would continue the status quo. No new EFH would be designated for the Coral Reef Ecosystem and associated species in addition to those already designated for species covered under the existing Bottomfish FMP and the Crustacean FMP. This is not a viable alternative as the Magnuson-Stevens Act mandates that any FMP shall describe and identify essential fish habitat for the fishery based on the guidelines established under section 305(b)(1)(A); minimize to the extent practicable adverse effects on such habitats caused by both fishing and non-fishing activities and; identify other actions to encourage the conservation and enhancement of such habitat.

Alternative 2: Designate EFH species-by-species

Alternative 2 would attempt to identify and describe EFH for each of the thousands of MUS associated with the coral reef ecosystem. This would assume that there has been systematic sampling conducted in the Western Pacific Region to adequately identify species and their habitat requirements, densities, productivity and temporal and spacial distribution of each major life history stage. However, a great number of coral reef organisms are not yet described by science and therefore, cannot be assessed even at the level 1 guideline. In addition, those species that are known to exist are sometimes too cryptic to be noticed when macro fauna and flora are monitored. Monitoring does not presently nor is it practicable to cover more than a small percentage of total reef area and organisms. Therefore, the quality of available data necessary to

identify EFH for all coral reef associated MUS is virtually non-existent even at the level 1 guideline. Furthermore, information for the majority of MUS extant in the coral reef ecosystem cannot be assessed beyond the level 2 rating.

Alternative 3: Designate EFH family-by-family

Alternative 3 would designate EFH by family groups. Grouping MUS by families allows for broader designation of EFH and thus strengthens protection of EFH for the coral reef ecosystem, as family groups frequently utilize common habitat and exhibit similar life history characteristics. However, diversity of habitat use and dependance may be greater within some families than between families. For example, the family Lutjanidae include 16 genera and nearly 100 species in the Western Pacific Region. The range of some species in the subfamily Lutjanus are known to occur from the shoreline and have also been observed at depths below 50 fathoms (Ota and Parrish 1981). On the other hand, the range of some species in the subfamily Etelinae, such as the genus *Pristipomoides*, are believed to occur on bottom habitat from 40 meters down to a depth of 400+ meters. Based on a level 1 rating, EFH for the family Lutjanidae could arguably encompass the entire water column down to 400+ meters and to the extent of the EEZ. Consequently, a broad designation of EFH at the family level could compromise the justification of the EFH designation when information is not available beyond a Level 2 rating.

Alternative 4: Designate EFH by trophic level feeding guild associations with habitat (habitat/behavioral group)

Various studies have been conducted to analyze trophic linkages and their relationship to the function of the ecosystem as a whole. Such studies have focused on predator /prey interactions and their effects upon ecosystem dynamics. For example, Norris 1985 conducted a study of the trophic relationships of piscivorus coral reef fishes in the NWHI. He concluded that certain trophic linkages are quantitatively important to the function of the ecosystem, although there are others that are not. This uncertainty has the potential to have deleterious effects if EFH is identified and described for MUS arbitrarily. Correspondingly, this approach would present great difficulties when attempting to determine linkages that exist between kingdoms such as those shared between algae and herbivorous fish species.

Alternative 5: Designate EFH for the coral reef biological community (reef obligate/associated species)

Coral reef ecosystems are characterized not only by diversity, but gradients and subtle transitions which defy precise classification. Hence, not all resource management decisions require the same level of resolution. Some of the subtleties and details may be ignored to resolve problems of a widespread or more general nature. Such problems limit the immediate practical application of ecosystem-based management for coral reefs. Competition, recruitment limitation, and predation have all been proposed as processes that govern the distribution of fishes. Presumably the distribution of invertebrates and seaweeds in coral reef biological communities are subject to

the similar processes. Presently, the most widely accepted view is that many fishes exist as spatially divided populations in a patchy environment where local subpopulations maintain interconnection by exporting larvae to and receiving larvae from other subpopulations (Sale 1991). A pluralistic view has recently emerged where multiple processes are acknowledge as being important in structuring the fish.

Alternative 5 proposes to designate EFH for species that are known to play an important role in the ecology and dynamics within the coral reef ecosystem. Scientists recognize that reef ecosystems are organized largely by internal processes, including predator-prey trophic guilds, keystone species, indicator species, symbiotic and other biological inter-relationships that are subject to periodic natural disturbance (e.g., storm waves, floods). Identification and description for these MUS can provide a broad range of protection as this alternative would encompass a great number of fish species, invertebrates, corals and algae. However, Alternative 5 is insufficient in implementing the EFH mandate as only "important" species/ families are addressed. It may also fail to capture those species that have an important role in the ecology of the coral reef ecosystem, but have not been adequately studied by scientists.

Alternative 6: Designate EFH for MUS at higher taxonomic groups

Alternative 6 is similar to Alternative 3 (designating EFH family-by-family), except that it would designate EFH by higher taxonomic levels. Like Alternative 3, a higher taxonomic grouping of closely related species allows for broader designation of EFH and thus strengthens protection of EFH for the coral reef ecosystem, as these groups frequently utilize common habitat and exhibit similar life history characteristics. However, diversity of habitat use and dependance may be greater within some some taxonomic groups than between these taxonomic group. Consequently, a broad designation of EFH at higher taxonomic levels could compromise the justification of the EFH designation when information is not available beyond a Level 2 rating.

Alternative 7: Designate EFH based on representative (keystone) species

Keystone species are species that play a role in the food web so significant that if they are removed from the ecosystem in significant numbers, existing trophic relationships may be upset, affecting other species' stock size or viability. In coral reef ecosystems of the western Pacific, apex predators, including coastal sharks and jacks (ulua), qualify as keystone predators. For example, a study at French Frigate Shoals (FFS) in the NWHI estimated that the combined populations of two carangids (jacks or ulua) eat at least a few thousand metric tons of prey annually in a 500 km^2 of coral reef. From an ecological perspective, this must represent one of the most important top-level trophic paths in this system (Sudekum et al. 1991). The estimated combined predation pressure by these two jacks exceeds the combined estimate for the three dominant coastal shark species in the same system by a factor of about 40. Other studies and observations have shown that predation by jacks at FFS dwarfs the amount of fish removed by bottomfish hook-and-line fishing around the same atoll. When compared to the annual removal of fish at FFS, fish consumption by two jack species removed approximately 5000 times more

tons of biomass than the Bottomfish Fishery in the NWHI (Sudekum et al. 1991 and Council 2000). However, similar to Alternative 5, this alternative is insufficient in implementing the EFH mandate as only representative species/ families are addressed. It may fail to capture those species that have an important role in the ecology of the coral reef ecosystem, but have not been adequately studied by scientists.

Alternative 8: Designate EFH for environmental indicator species/families

Indicator species are species that are sensitive to changes in the environment and respond to those changes respectively. Indicator species such as *Chaetodon spp.*, are useful in the assessment of ecological conditions and have been used in monitoring the health of coral reef ecosystems where baseline data does not exist. Unfortunately, the efficacy of indicator species themselves are not solely indicative of the virility or demise of the coral reef ecosystem. Storm events, recruitment processes and other factors weigh heavily on the condition of coral reef ecosystems and are known to naturally expedite the displacement of species. Studies have further shown that marine algae out competes coral species with changes in herbivory pressures and nutrient influx. The designation of EFH based on this criteria is not scientifically sound as it would arbitrarily designate EFH for only a select number of species in the coral reef ecosystem. The lack of understanding of such interactions such as trophic level feeding guilds and predator/prey interactions frustrates efforts to define reef ecosystems, and also places constraints on monitoring and evaluation of changes caused by natural and human forces. Even when significant changes in coral reef resource abundance, size distribution and species composition attract the attention of resource managers, they are subject to varied interpretation because of the difficulty of differentiating natural from man-induced effects. There is also a lack of consensus on what constitutes "preferred" ecosystem outcomes that are clearly desirable and recognizable by managers, scientists and resource users.

Alternative 9: Designate EFH by habitat composites (Preferred Alternative)

Except for several major coral reef associated species, very little is known about the life histories, habitat utilization patterns, food habits or spawning behavior of most coral reef associated species. It is completely unrealistic and inefficient to give every small unit of coral reef an equal amount of management attention. To avoid directing the limited management resources available toward inconsequential problems, the Council needs to be able to make distinctions and to recognize the occurrence of patterns (i.e., the repetition in space and/or in time, of similar conditions and events). Classification of the reef environment according to habitat types is a logical first step toward pattern recognition. With the inclusion of factors that account for biological community structure and function, a classification system could evolve toward an ecosystem form of resource management. The most practical approach is to utilize physical attributes, and, conceptually at least, arrive at a community approach as subcategories once the latter become evident through closer scrutiny.

Three co-ordinate and interlocking factors are important in the distribution of shore and reef invertebrates: a) the degree of wave shock; b) the type of bottom; and c) the tidal exposure. These characteristics are recognized as the basis of at least one classification scheme developed for coastal water ecosystems in the Hawaiian Islands. The narrow tidal range and high wave action characteristic of nearshore environments in Hawaii render classification schemes developed for higher latitude, continental coasts inappropriate. The strong modifying influence of coral reefs on shoreline environments further reduces the applicability of such schemes. The primary effect of the presence of a reef structure is to nullify, or at least seriously modify, the concepts of open and protected coasts. The importance of wave energy in the determination of organism distribution remains unchanged but the presence and form of the reef itself determines the nature of the wave regime at and near the shore. Reef form, therefore, must be a primary category in any classification scheme for tropical coastal zones.

Physical factors affecting the distribution and abundance of coral reef species vary both spatially and temporally. Spatial factors include substratum type, and complexity and proximity to adjacent habitats (Friedlander and Parrish 1998). Physical habitat plays an important role in structuring ecological communities but its contribution has seldom been documented in the literature because of the difficulty of separating effects of habitat from other influences in the environment. Structural features of habitat may: 1) provide shelter from physical and chemical stress; 2) restrain foraging predators and interfering competitors; and 3) modify availability of resources and their rate of acquisition. Habitat complexity provides refuges and barriers that fragment the area, resulting in more heterogenous assemblages. Temporal physical factors include changes in temperature, salinity, turbidity, terrestrial runoff and wave energy. Biological characteristics include the availability of the appropriate food organisms, both in species composition and abundance and the ability of the food production system in providing a continuous level of appropriate food items.

For most Coral Reef MUS, EFH was identified based upon the Level 1 data rating, and linked with specific habitat composites (i.e. sand, live coral, seagrass beds, mangrove ect.) for each life history stage, consistent with the depth of the ecosystem to 50 fathoms and to the limit of the EEZ. This alternative would also protect the habitats of other species managed under other FMP in the Western Pacific Region and possibly achieve ecosystem management through an incremental approach.

To implement the habitat composite alternative for MUS of the Coral Reef Ecosystem FMP, Council used a two-tiered approach in designating EFH consistent with the use of habitat composites.

Currently Harvested MUS

EFH has been identified for species which are (1) currently being harvested in federal waters or (2) likely to be harvested in the near future, or (3) species of particular concern are designated as harvested MUS.

To reduce the complexity and the number of EFH identifications required for individual species and life stages, the Council has designated EFH for species assemblages pursuant to §600.320 National Standard 3- Management Unit(d)(2). The designation of these complexes is based upon the ecological relationships among species and their preferred habitat. These species complexes are grouped by the known depth distributions of individual MUS. For a broader description of the life history and habitat utilization patterns of individual Harvested MUS, see Volume III.

Potentially Harvested MUS

Table 6.4 (Volume I) summarizes the habitat types utilized by the individual species that comprise the higher taxonomic orders that have been designated as Potentially Harvested MUS. Based upon this analysis the Council has designated EFH for the Potentially Harvested MUS as all habitat composites occupied by the MUS to the extent of the coral reef ecosystem as defined in the FMP (50 fm) (see Table 6.5 in Volume I). These taxa include literally thousands of species that encompasses virtually the entire range of coral reef fauna and flora. There are large gaps in scientific knowledge about the life histories and habitat requirements of the thousands of species of organisms that comprise these taxa. In fact, a large percentage of these biota have not been described by science. Therefore, the Council has adopted a precautionary approach in designating EFH to ensure that enough habitat is protected to sustain managed species.

To reduce the complexity and the number of EFH identifications required for individual species and life stages, the Council has designated EFH for species assemblages pursuant to §600.320 National Standard 3- Management Unit(d)(2). The designation of these complexes is based upon the ecological relationships among species and their preferred habitat. These species complexes are grouped by the known depth distributions of individual MUS. For a broader description of the life history and habitat utilization patterns of Potentially Harvested MUS, see Volume III.

Alternative 10: Designate the sessile benthos MUS (e.g., reef-building corals) as EFH for those organisms themselves and for associated species

In their adult life history stage, sessile benthos (described in Volume III) generally lack mobility and form much of the habitat upon which other species depend. These organisms, such as reef building corals, algae and sponges, are instrumental in the coral reef ecosystem's primary production and are largely responsible for supporting the higher trophic levels, many with predator-prey relationships. The high degree of symbiosis begins with the zooxanthellate associations and encompass a wide degree of associations, including trophic relationships of piscivorus coral reef fishes. These linkages are believed to be quantitatively important to the function of the ecosystem as they have certain measureable effects to the function of the ecosystem as a whole. Due to these considerations, sessile benthos and their fundamental role in the ecosystem could be defined as EFH themselves. However, this is not a viable alternative as this approach would fail to identify and describe EFH for the great majority of coral reef MUS, many of which are not primarily associated with the sessile benthos MUS.

HABITAT AREAS OF PARTICULAR CONCERN

In addition to EFH, the Council also identified potential areas for designation as habitat areas of particular concern (HAPCs) within EFH. HAPCs are specific areas within EFH that are essential to the life cycle of important coral reef species. In determining whether a type of area should be designated as a HAPC, one or more of the following criteria must be met: (1) ecological function provided by the habitat is important to MUS; (2) habitat is sensitive to human-induced environmental degradation; (3) development activities are, or will be stressing the habitat or; (4) the habitat is rare.

Alternatives Considered in HAPC Designations for MUS

As mentioned earlier, large gaps in scientific knowledge about the life histories and habitat requirements of many coral reef ecosystem species places constraints in accurately designating EFH for MUS. The Council considered several alternatives to implement the EFH provision in the Coral Reef FMP which included: (1) no action; (2) Designate HAPC by habitat type based on a coral reef classification system and; (3) Designate HAPC by habitat composites based on the criteria for selection.

Alternative 1: No action/status quo

Under this alternative, no HAPC would be designated for any Coral Reef FMP MUS. This is not a viable alternative as there are many habitat types in the Western Pacific Region that meet the HAPC criteria for MUS.

Alternative 2: Designate HAPC by habitat type based on a coral reef classification system

Benthic marine habitats in the Western Pacific Region are generally divided into three major zones: littoral, sublittoral and the deep sea. Each of these zones are further divided into distinct habitats types based upon physical attributes, exposure to wave action, and terrestrial influences. Coral reef ecosystem in the Western Pacific Region contains numerous habitat types ranging from estuaries to barrier reefs and atolls. During the 1980s, a classification system for categorizing coral reef habitats was developed by AECOS Inc. (AECOS). The classification system categorized coral reef habitat based on a 4-digit numeric key which represents one of 14 specific habitat descriptions. The key is not strictly dichotomous, rather it represents a "web" which leads the user through the assignment of numbers in order, to reach each digit position. The orders or digit positions represent progressively finer scale descriptions of classification, leading ultimately to a particular habitat type and is illustrated below. A similar classification scheme is the developmental stages and will soon be implemented as a tool in the Coral Reef Assessment and Monitoring Program (CRAMP) in Hawaii (Jokiel, pers. comm. 1998).

Once habitat types are identified, they can be linked to MUS they support and then compared to the HAPC designation criteria to determine the justification of its inclusion. Unfortunately, this

classification scheme was intended exclusively for Hawaii and is presently inadequate for classifying habitat in other regions in the Pacific. As more information is gathered from other regions and incorporated into this classification scheme, this alternative may be revisited by the Council for possible inclusion as a framework measure.

Alternative 3: Designate HAPC by habitat composites based upon the criteria for selection (Preferred Alternative)

The Council considered locations to designate as potential HAPC based upon recommendations submitted by the Plan Team. The Plan Team selected certain areas that meet the NMFS criteria for HAPC and are known to support populations of MUS. The Plan Team further noted that existing protected areas in state/territorial/commonwealth waters should be considered for possible HAPC designation by virtue of their existing protected status. The Plan Team recommended that further research be conducted in the region, and that a framework provision be developed to modify and update EFH/HAPC as more information is gained. For a list of the areas that have been designated as HAPC, and the criteria met by each area, see Table 6.6 (Volume I).

FINAL ENVIRONMENTAL IMPACT STATEMENT
FOR THE
FISHERY MANAGEMENT PLAN
FOR
CORAL REEF ECOSYSTEMS
OF THE
WESTERN PACIFIC REGION

Volume II

Western Pacific Regional Fishery Management Council

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COVER SHEET

[x] Final Environmental Impact Statement (Separate EIS)

Responsible Agencies (Contacts for further information):

Western Pacific Fishery Management Council
1164 Bishop Street
Suite 1400
Honolulu, HI 96813
Contact:

Kitty M. Simonds
Executive Director
Telephone: (808) 522-8220

NMFS Southwest Region
Pacific Islands Area Office
1601 Kapiolani Blvd., Suite 1110,
Honolulu, HI 96814-4700
Contact:

Charles Karnella
Administrator
Telephone: (808) 973-2935

PROPOSED ACTION: Approval and implementation of the fishery management plan for Coral Reef Ecosystems of the Western Pacific Region.

Abstract:

The proposed action is to implement a fishery management plan for Coral Reef Ecosystems (CRE) in the western Pacific under the provisions of the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA). The plan proposes to (1) establish specific and comprehensive regulations -- fishing permit and reporting requirements, allowable fishing gear, "no-take" and "low-use" marine protected areas – for the EEZ to anticipate and avoid adverse impacts on coral reef resources and ecosystems from potentially damaging fishing activities; (2) create a framework procedure for timely regulatory action to adapt to new information and changes in fisheries; (3) encourage coherent and coordinated management, monitoring and enforcement across jurisdictional boundaries to address impacts such as illegal foreign fishing of coral reef resources in remote areas of the U.S. Pacific Islands; degradation of essential fish habitat in nearshore (non-EEZ) coral reef areas; damage to reefs from derelict gear originating from outside of the Western Pacific Region; (4) establish a procedure to assess and control possible ecosystem effects of fishing activities under the existing FMPs for bottomfish, crustacean and precious coral fisheries in the western Pacific; and, (5) amendments through four existing FMPs to prohibit fishing (biological removal) in no-take marine protected areas (MPAs) and require insurance for operation/transit of MPAs.

EXECUTIVE SUMMARY

This final environmental impact statement (FEIS) was prepared to examine impacts of implementing the proposed Fishery Management Plan (FMP) for Coral Reef Ecosystems of the Western Pacific Region. An environmental impact statement is required under the National Environmental Policy Act (NEPA) for federal actions that may significantly affect the quality of the human environment. The FEIS also incorporates the relevant environmental impact analyses for FMP amendments for crustaceans, bottomfish and seamount groundfish, precious corals, and pelagic fisheries.

The Coral Reef Ecosystems FMP (CRE-FMP) was developed by the Western Pacific Regional Fishery Management Council (the Council), based on the ecosystem approach. A recent report to Congress in 1999, by the Ecosystem Principals Advisory Panel (EPAP) recommends that FMPs be developed as "Fisheries Ecosystem Plans" covering the ecosystems under Council jurisdiction. This FMP represents the first fishery ecosystem plan developed in the United States.

The FMP would address current and emerging problems due to interactions of humans and coral reefs in the western Pacific exclusive economic zone (EEZ). Although local regulations control many of the impacts of resource exploitation on nearshore coral reefs in settled areas, exploitation of coral reef ecosystems remains relatively uncontrolled in federal waters of the EEZ. Although these areas have been minimally exploited to date, fishermen are interested in expanding into these areas. Fishery sectors that could expand into the EEZ include current nearshore fisheries for coral reef species, new fisheries for the live fish markets in Southeast Asia, expanded fisheries for coral and "live rock" for the U.S. aquarium trade, and developing fisheries for pharmaceutical applications. In addition, CRE-FMP measures would help managers to better understand impacts due to natural environmental changes, other FMP-managed fisheries, and non-fishing related impacts, such as dredging.

Description of the Alternatives Considered in this EIS

To address these problems, four alternatives, including the status quo (No-action alternative), were examined. Alternative 2 would establish low-use marine protected areas from 0-50 fathoms in the Northwestern Hawaiian Islands (NWHI) and Pacific Remote Island Areas (PRIAs). Alternatives 3 (the Preferred Alternative) and 4 (substantial and maximum additional protection to coral reef resources) contain four primary management measures: (1) marine protected areas; (2) permits and reporting requirements; (3) fishing gear and methods; and, (4) other ecosystem-based management measures. Each alternative has different components and options nested within it. (For a summary of the management measures in each alternative see the table at the end of this Executive Summary.) The environmental effects of each of the alternatives, management measures, components, and options have been analyzed in this EIS. In June 2000, the Council tentatively adopted a preferred alternative and management options. In June 2001,

the Council finalized its preferred alternative with several modifications. The alternatives and options considered are listed below.

Alternative 1: *No Action* - under this alternative no new MPAs of any type would be implemented.

Alternative 2: *Minimal Additional Protection to Coral Reef Resources* - under this alternative low-use MPAs would be established for EEZ waters from 0-50 fathoms around each of the NWHI and each of the PRIAs. In addition, no anchoring by large vessels would be allowed on Guam's offshore southern banks. Midway Atoll, which is physically located in the NWHI, would be exempted from these MPAs.

Alternative 3: *Substantial Additional Protection to Coral Reef Resources* (**Preferred Alternative**) - under this alternative no-take MPAs would be established for all EEZ waters from 0-10 fathoms in the NWHI as well as EEZ waters from 0-50 fathoms around French Frigate Shoals, Laysan Island, and the northern half of Midway Island. No-take MPAs would also be established for EEZ waters from 0-50 fathoms around American Samoa's Rose Atoll, and Jarvis, Howland, Baker and Kingman in the PRIAs. In addition, low-use MPAs would be established in EEZ waters from 10-50 fathoms around the remaining NWHI (0-50 fm in the southern half of Midway Atoll), as well as EEZ waters from 0-50 fathoms around Palmyra, Johnston, and Wake Islands. Sustainable use of coral reef resources for customary and traditional purposes will be permitted in the low-use MPAs of the NWHI. Anchoring of large vessels (greater than 50 ft in length) would be prohibited on Guam's offshore southern banks. Insurance would be required for all fishing vessels operating in MPAs.

Alternative 4: *Maximum Additional Protection to Coral Reef Resources* - under this alternative no-take MPAs would be established for EEZ waters from 0-100 fathoms around all of the region's islands and atolls. Due to the broad extent of these areas, there would be no low-use MPAs under this alternative.

Measures Incorporated into the Alternatives

Measure 1. Marine Protected Areas: MPAs are areas where some or all activities are prohibited. MPAs holistically protect ecosystems and multi-species resources that cannot be addressed by a species-by-species approach. Options considered were the location of these areas (off all the Pacific islands, or only in remote areas), how much of the MPAs would be no-take areas versus low-use areas for resource extraction, and what separate types of activities would be allowed or prohibited in these areas.

Measure 2. Permits and Reporting Requirements: Permits are used to identify participation in a fishery. They provide base data for fishery monitoring, catch reporting, and management. The options for permit requirements include type of permits, who is required to have a permit to harvest reef resources, prohibitions on harvest of certain reef resources, and other conditions of the permit.

Measure 3. Fishing Gear/Methods: Gear restrictions are used to prevent overfishing, protect habitat from direct impacts, and limit bycatch. Options considered include defining legal gear types so as to prohibit other gear types, and special restrictions for SCUBA spearfishing.

Measure 4. Other Ecosystem-Based Management Measures: The other measures proposed in the plan include a framework for adaptive management, a process to identify and address possible impacts of existing FMP fisheries on coral reef ecosystems, and other non-regulatory measures such as education. None of these constitute "action" in terms of NEPA.

Summary of Impacts of the Alternatives and Options

Environmental Impacts

- Because there is currently low fishing effort for coral reef taxa in remote areas of the EEZ, there are essentially no immediate impacts of implementing any alternative in these remote areas, except in bottomfish and lobster fisheries operating in NWHI under existing FMPs and low levels of recreational and subsistence fishing at Johnston, Wake, Palmyra and Midway Atolls.

- For less remote areas, the preferred options under Alternatives 2, 3, and 4 would provide additional conservation than the status quo because gear types would be regulated, commercial harvest of live rock and corals would be prohibited, and resource removals would be monitored. If monitoring indicates that resource conditions warrant conservation action, these can more quickly be brought about through the framework process outlined in Section 2.4.

- Compared to the status quo and Alternative 2, Alternatives 3 and 4 reduce the potential for overfishing of reef resources in the future by implementing the preferred options for setting aside marine protected areas, establishing permit and reporting requirements for monitoring, and gear restrictions. Spawning adults of the more valuable food fishes would be better protected by prohibiting spearfishing with scuba gear at night, when they are most vulnerable.

- Compared with the status quo, Alternatives 3 and 4 provide for improved habitat protection and reduced discarding. Only specified gears would be allowed; unattended nets would be specifically prohibited for these reasons. In no-take MPA zones, all fishing gear including lobster traps and bottomfish hook-and-line fishing would be prohibited

under Alternatives 3 and 4. The option to prohibit harvest of coral and live rock under Alternatives 3 and 4 would be expected to result in habitat conservation. Lastly, the FMP requires consultations for federal activities to minimize effects from fishing and non-fishing activities on essential fish habitat.

- Compared to the status quo, Alternatives 3 and 4 could slow the introduction of exotic species through conditions on passage of all fishing vessels in MPAs.

- Alternatives 3 and 4, and the options to set aside some no-take MPA zones, would be expected to result in positive impacts for conserving reef ecosystems and marine diversity. No-take MPAs may conserve a large reservoir of spawning biomass and genetic material for multi-resource coral reef resources, including endemic and rare species.

- The MPAs proposed under Alternatives 3 and 4 may reduce impacts of fishing on protected species. Existing marine protected areas surrounding national wildlife refuges would be expanded in sensitive areas, in particular, French Frigate Shoals, and Laysan Island. Vessel groundings, which pose some of the most serious human threats to these protected species habitats, would be expected to be reduced under Alternatives 3 and 4 provisions for MPA designations and permit and vessel passage controls.

Social and Economic Impacts

- The status quo, Alternative 2, and the Preferred Alternative (3) do not restrict collection of coral reef resources for customary and traditional indigenous uses in the EEZ around the main inhabited islands and provides incentives through preferential access to indigenous use sub-zones of MPAs, which could be implemented through framework action. Alternative 4 would prohibit all types of fishing shallower than 100 fathoms throughout the EEZ.

- The Preferred Alternative (3) and options would mitigate most of the potential impacts on existing fisheries, but existing fishing effort could be displaced or become more costly to conduct around some of the NWHI, Palmyra, Johnston, and Wake islands. Alternative 4 would displace all coral reef fisheries and other fisheries operating in the coral reef ecosystem.

- The Preferred Alternative (3) and options for no-take zones would allow recreational fishing activities for tourists to continue at Midway Atoll, but it would deter future development of most PRIAs as sportfishing destinations. Alternative 4 could displace recreational activities at Midway.

- The Preferred Alternative (3) and options for locations of no-take MPAs are likely to cause some displacement from familiar grounds in the NWHI bottomfish fishery and, to a far lesser extent, NWHI lobster fishery. Alternative 4 would displace all fishing effort for

these fisheries. For Alternative 3, fishing effort is likely to be redirected to other islands and banks in the NWHI. This could increase the cost of fishing and prevent the harvest of underutilized target resources, but it is not expected to cause a major displacement of participants. Under Alternative 4, fishing effort would likely be displaced to state and territorial waters. The number of permits in both fisheries is fixed under limited access plans, so opportunities for new participants are already limited.

- Although NWHI bottomfish permit holders would lose access to a few familiar and productive fishing grounds as a result of the Preferred Alternative (3) and options, closure of French Frigate Shoals and Laysan Island would likely have less effect than closure of more productive areas of the NWHI. The preferred option for no-take areas have accounted for 10 % of the recent total bottomfish harvest in the NWHI fishery. Applied to recent (1994-1998) landings data, this percentage represents about 36,047 lbs. of bottomfish with an ex-vessel value of $115,350. Alternative 4 would cause a complete shutdown of this fishery.

- The Preferred Alternative (3) and options for no-take zones would incur only minimal costs to lobster fishing activities in the waters around French Frigate Shoals and Laysan Island. These areas have historically accounted for about 1.2% of the total lobster harvest in the NWHI fishery. Applied to recent (1996-1999) landings data, this percentage represents about 3,075 lbs. of spiny and slipper lobsters with an ex-vessel value of $16,308. It is likely that fishery participants could recover this loss in revenue by moving to other fishing grounds. Alternative 4 would cause a complete shutdown of this fishery.

- Closure of some or all fishing grounds in the NWHI would also have a negative economic impact on local businesses that directly or indirectly support and are supported by the fishery.

- In addition to potential economic losses associated with closure of some fishing grounds in the NWHI, there would be the loss of lifestyle, assuming that displaced fishermen cannot find an equally satisfactory alternative way of life.

- Closure of some or all fishing grounds in the NWHI would also likely have a negative impact on those who value the continued existence of Hawaii's maritime tradition and culture.

- Closure of some or all NWHI bottomfish fishing grounds would have an impact on seafood consumers by reducing the amount of fresh bottomfish available for sale.

- Technically complex and customized permits to be issued under Alternative 3 would significantly increase cost of administration and enforcement.

Justification for the Preferred Alternative

While a minimal amount of fishing pressure currently exists in the coral reef ecosystem management area for the proposed management unit species, this Fishery Management Plan has been developed as a framework upon which to address potential management needs. The Plan has been drafted to immediately protect large portions of coral reef and associated resources, while allowing flexibility to adapt to a wide variety of potential management issues as resource utilization develops. Thus, this FMP should be viewed as a preemptive management regime as well as a work in progress. The preferred alternative comprises the following four management measures. The rationale for these measures is as follows:

No-Take Marine Protected Areas: No-take MPAs are delineated by the 10 fm isobath, except for certain ecologically sensitive areas where the boundary is extended to the 50 fm isobath. These areas are French Frigate Shoals, Laysan Island, the north half of Midway Atyoll, and Jarvis, Howland and Baker Islands, Kingman Reef, and Rose Atolls. These no-take MPAs apply to the existing FMPs of the Council. The Council felt that no-take should apply for all activities save limited research and management activities which could not occur elsewhere.

The ecological significance of these areas as remote and near-pristine reefs were driving factors in choosing these areas as the initial MPAs for this FMP. Their proximity to important Hawaiian monk seal colonies was another reason for choosing these areas. Seaward boundaries are delineated by following the relevant depth contours around the indicated areas. Basing these seaward boundaries on either the closest State of Hawaii commercial catch reporting grid square, inclusive of the relevant contours, or on circles drawn around islands or banks that are inclusive of these areas was considered, but rejected due to the significantly larger closed area that would result. Most of this additional closed area would be beyond the depth of coral reefs and would result in a major impact on existing fisheries.

Low-use Marine Protected Areas: The Council proposes a zone-based management approach to designate geographic areas for prescribed uses. Zone-based management allows for unique regulations for areas of varying ecological and socio-cultural importance, which has been successfully employed in other coral reef ecosystems and was preferred by the Council. All EEZ coral reefs around the NWHI not designated for no-take areas are designated as low-use MPAs. Other low-use MPAs are designated for coral reefs in the EEZ around Palmyra, Johnston and Wake atolls. The seaward boundaries preferred for all low-use MPAs would extend to a uniform depth of 50 fm. These locations were chosen for reasons similar to those used to choose those of no-take MPAs, but they allow existing fisheries to continue and also permit closely monitored new fisheries in ecologically and socio-culturally important areas. The offshore banks south of the island of Guam will be designated as a no-anchor zone to prevent coral reef habitat damage from anchoring of vessels larger than 50 feet.

Permits and Reporting: Special permits and reporting are required for the harvest of coral reef resources in the low-use marine protected areas. Vessels regulated and targeting species managed by other FMPs would be exempt from this requirement. Special permits and reporting

will also be required for potentially (but not previously) harvested coral reef taxa throughout the region's EEZ. Regional permit and reporting requirements for the remaining EEZ waters would continue for currently harvested coral reef taxa where reef resources are actively fished and managed under local laws and regulations. The Council preferred to retain local jurisdictions' reporting requirements for current practices in the populated regions, enacting general or special permit requirements under a framework provision at a later date if deemed necessary.

Due to their ecological vulnerability, the preferred alternative would prohibit the of collection of live stony coral or live rock for commercial purposes, except small amounts that could be collected under a special permit for use as seed stock for aquaculture or for customary and traditional indigenous purposes.

Allowable Gears and Methods: The list of allowable gears is based primarily on these gear types potential for minimizing damage to essential fish habitat (EFH). Adverse impacts from fishing gear may include physical, chemical, or biological alterations of the substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other components of the ecosystem. Catch selectivity is a second criterion for allowable gear; gears which produce a minimum of bycatch would be allowed.

Summing Up: The Preferred Alternative's combination of management measures should better protect the coral reef environment and allow the region's coral reef ecosystem resources to be better managed. Management measures in the Coral Reef Ecosystem FMP combine harvest controls with careful monitoring in a manner that allows the controlled and ecologically sensitive use of these vital resources.

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CHAPTER 1

PURPOSE AND NEED FOR ACTION

The National Environmental Policy Act (NEPA) was signed into law in 1970, in response to an overwhelming national sentiment that federal agencies should take the lead in providing greater protection for the environment. It established environmental policy for the nation, provided an interdisciplinary framework for federal agencies, and established procedures and a public process to ensure that federal agency decision-makers take environmental factors into account. NEPA requires preparation of Environmental Impact Statements for major federal actions significantly affecting the quality of the human environment.

In accordance with NEPA, an Environmental Impact Statement (EIS) is required because the implementation of the Coral Reef Ecosystems Fishery Management Plan (CRE-FMP) is a "major federal action significantly affecting the quality of the human environment." Its purpose is to disclose to decision-makers and the public alternative ways to manage coral reef resources in the U.S. Exclusive Economic Zone (EEZ) around the U.S. Pacific Islands and to aid the decision-makers in selecting a course of action. This EIS describes four alternatives, including a Preferred Alternative, for the future management of coral reef resources in the EEZ, and the affected environment and the environmental consequences of implementing the proposed action and alternatives.

This EIS also incorporates the environmental impact statement required for amending the existing Fishery Management Plans (FMPs) for crustaceans, bottomfish, precious corals, and pelagic fisheries. These four fisheries will continue to operate under their respective FMPs. However, they will also be required to comply with the no-take marine protected areas outlined in the CRE-FMP. Each of the four FMPs will be amended to ensure the no-take status of these areas. These include Amendment 7 to the Bottomfish and Seamount Groundfish FMP, Amendment 11 to the Crustaceans FMP, Amendment 10 to the Pelagics FMP and Amendment 5 to the Precious Corals FMP. These amendments specify where the no-take marine protected areas are located, and what management unit species are currently included in the existing FMPs. A summary description of the FMP fisheries and their FMPs is included in Section 3.3.2 of this EIS. An analysis of the impacts of these area closures on the four existing FMPs is included in section 5.9 of this document, describing the environmental consequences for existing fisheries and communities.

A related action that may affect the measures of the CRE-FMP is the recent establishment of the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve (CRE Reserve). In December 2000, President Clinton issued Executive Order (EO) 13178, establishing the Reserve. The EO

sets forth a number of conservation measures and creates specific Reserve Preservation Areas (RPAs), which were made permanent by EO 13196 on January 18, 2001. The conservation measures and locations of RPAs are detailed in Section 9.2 of the FMP.

Pursuant to this EO and the National Marine Sanctuaries Act (NMSA), National Oceanic and Atmospheric Administration (NOAA) is initiating the process to designate the Reserve as a National Marine Sanctuary. NOAA will prepare an environmental impact statement and management plan, which will examine the management, boundary, and regulatory alternatives associated with sanctuary designation (66 FR 5509, January 19, 2001). Because the final rules for the Reserve have not yet been published, and an EIS will be prepared for the marine sanctuary, a comprehensive analysis of the impact of the Reserve cannot be completed at this time. A preliminary assessment of the potential impacts to the human environment is included in Chapter 5 of this EIS. However, two alternatives considered by this EIS (3 and 4, described in Chapter 2) are consistent with the concept of establishing marine reserves in the NWHI, as described in the CRE-FMP.

The Coral Reef Ecosystems FMP was developed by the Western Pacific Regional Fishery Management Council (hereafter, the Council or WPRFMC), based on the ecosystem approach. A recent report to Congress by the Ecosystem Principals Advisory Panel (EPAP) recommends that FMPs be developed as "Fisheries Ecosystem Plans" covering the ecosystems under Council jurisdiction. This FMP represents the first fishery ecosystem plan developed in the United States.

In accordance with the policies recommended by EPAP in developing Fisheries Ecosystem Plans, the Council formulated eight objectives for the CRE-FMP. These objectives promote sustainable use of coral reef resources, especially by fishing communities and indigenous fishermen in the region; an adaptive management approach based on fishery-dependent and fishery-independent research; marine protected areas and habitat conservation; cooperative and coordinated management by the various agencies concerned with conservation of coral reef resources; and education to foster public support for management.

The FMP will address potential human impacts on coral reefs in the Western Pacific Region's EEZ. Although local regulations control many of the impacts of resource exploitation on nearshore coral reefs in settled areas, exploitation of coral reef ecosystems remains relatively uncontrolled in the federally-managed EEZ. Although these areas have been minimally exploited to date, there has been interest expressed for fisheries to expand in these areas. Adverse impacts to coral reef habitats may arise from expansion of current nearshore fisheries for coral reef species, new fisheries for the live fish markets in Southeast Asia, expanded fisheries for coral and "live rock" for the U.S. aquarium trade, and developing fisheries for pharmaceutical applications. In addition, the CRE-FMP will improve understanding of the impacts caused by natural environmental changes, other FMP managed fisheries, and non-fishing related impacts, such as dredging.

Certain gear types, or the ways in which they are used, can cause adverse impacts to habitat. For instance, a new method of reef fishing with tangle nets was recently introduced to Hawaii. When retrieved by hydraulically-powered reels from depths of 10 to 100 m, the nets snag and damage the bottom. Lobster tangle nets—used in nearshore areas around some of the main inhabited island groups—have a similar impact, breaking coral when they are retrieved. The State of Hawaii has taken action to control destructive gillnetting in state waters around the main Hawaiian Islands, and consistent measures are proposed for the EEZ by the CRE-FMP. The FMP will limit fishing gears and methods that will be allowed in the EEZ, and will exclude those which have the potential to significantly damage coral reef habitat. New underwater technologies (mixed gas scuba, rebreather, manned and unmanned submersibles) capable of greatly extending the depth at which reef habitats can be impacted were considered in determining allowable gear.

Destructive fisheries in Southeast Asia are known to target remote areas isolated from fishing communities and government patrols. Coral reefs in the Northwestern Hawaiian Islands (NWHI) generally lack the species most desired for the live reef fish trade and they are probably far enough from the major Asian markets so that live transport by boat would be uneconomical. The remote U.S. Pacific Island possessions (Palmyra Atoll, Howland, Baker, Johnston, and Wake Islands, and Kingman Reef; PRIAs hereafter) and the remote portions of the Commonwealth of the Northern Mariana Islands (CNMI) seem at the most risk from the live reef fish trade because some of the target species are present. The CNMI grounds are close enough to the Hong Kong live fish market so that the catch could be transported economically. Island government and National Wildlife Refuge regulations prohibit the use of poisons, explosives, and breaking of coral when fishing in nearshore areas, but there are no comparable regulations that would protect EEZ reef habitats. Furthermore, long-range surveillance and enforcement capabilities are inadequate to police remote coral reef areas. Hence, this threat is not adequately controlled under existing management systems. CRE-FMP management measures would control the use of destructive fishing methods in the EEZ around U.S. Pacific Islands.

Few marine ornamental products are collected from reef areas in the EEZ around U.S. Pacific Islands. The aquarium trade is trying to develop several education and conservation plans in order to improve fish survivability. These plans include captive breeding of fishes, propagation of corals, and education about advanced husbandry techniques; the goal is to significantly lower the number of species harvested from the wild. Nevertheless, the rapidly expanding reef ornamentals industry has the potential to expand into the EEZ in some areas of the U.S. Pacific Islands. The marine ornamentals trade involves numerous species of reef fish—especially angelfish, butterflyfish, and damselfish—and also a widening spectrum of invertebrates—including corals, anemones, crustaceans, molluscs, polychaetes, echinoderms, and sponges. The removal of "live rock" substratum unavoidably includes an incidental harvest of commensal and infaunal organisms, which are removed with the rock. Other coral reef resources that are highly endemic could be made locally extinct if heavily collected in their limited range of distribution. The FMP, therefore, would manage this activity from an ecosystem perspective.

Coral reef ecosystems in the EEZ around U.S. Pacific Islands are likely targets for the emerging industries for pharmaceutical and natural products. These emerging "fisheries" have the potential to harvest organisms about which little or nothing is known, whether of their particular life cycle, their place in the food web or their abundance and distribution. The most interesting chemicals are usually species-specific; these species may be rare or patchily distributed and the natural production of the active chemical may vary in time and space (Birkeland 1997a).

Pharmaceutical companies make their profit from synthesis of the active ingredients in their laboratories. Initial collections would involve small quantities of a broad spectrum of organisms for initial screening. Virtually any coral reef resource could become a target for bioprospecting, including species that are presently undescribed by science and for which there is no understanding of sustainable yield. Grants for millions of dollars have been given for medical bioprospecting of coral reef resources in the Pacific basin, although not yet in the U.S. Pacific Islands. Coral reef resources that have already attracted research interest include bryozoans, sponges, tunicates, coral, and seaweeds.

Bioprospectors are also searching for ingredients that could be used in products advertised as totally organic. Most of this interest is from cosmetic companies, who are seeking a regular supply of raw materials from wild harvest or aquaculture. Far greater quantities of target organisms would be collected in this "harvest model" than in the pharmaceutical-related "synthesis model" of bioprospecting.

The FMP anticipates that coral reef ecosystems in the EEZ around some of the U.S. Pacific Islands will attract bioprospecting activities. Because coral reef ecosystems comprise multi-species resources, which share a long co-evolutionary history, removal of some species can have undesirable secondary effects on others through predator-prey and other interactions.

In summary, the Coral Reef Ecosystems Fishery Management Plan is needed:

- To establish a management regime for the protection and sustainable use of coral reef ecosystems and their associated marine resources.
- To anticipate and avoid potential damage to essential and non-renewable coral reef habitat.
- To address the secondary effects of all reef-related fisheries on non-target coral reef resources, thereby encouraging ecosystem-scale management.
- To ensure that newly emerging coral reef fisheries are managed using precautionary principals and the best available information.
- To manage new underwater harvesting technologies that are extending the depth and time limits at which coral reef resources can be harvested.
- To encourage coherent and coordinated coral reef management, monitoring, and enforcement across jurisdictional boundaries.

- To facilitate consensual management that considers all types of stakeholders, and adaptive management that considers new data and unforeseen impacts.
- To allow sustained use of the coral reef resources, which are important for the continuity of indigenous cultures in the U.S. Pacific Islands.

Four alternatives, including a status quo or No-action alternative (1), were examined to address these issues. Alternative 3, the Preferred Alternative, employs four primary management measures: marine protected areas, permits and reporting requirements, fishing gear and methods, and other ecosystem-based management measures. Each of these measures in turn contain different components and options. The environmental effects of each of the alternatives, management measures, components, and options are analyzed in Chapter 5 of this EIS. In June 2000, the Council adopted a preferred alternative and management options. The alternatives and options considered are listed in Table 2.3.

CHAPTER 2

DESCRIPTION OF THE ALTERNATIVES

2.1 Introduction

Each of the alternatives analyzed in this EIS contains variations on four management (or control) measures. These four measures are: marine protected areas, permit and reporting requirements, allowable gear, and other miscellaneous requirements. Alternative 1 (No-action) would implement no new regulations. Alternative 2 (Minimal Additional Protection) would designate several low-use MPAs, and institute varying permit and gear requirements for the harvest of Coral Reef Ecosystem Management Unit Species (CRE MUS) throughout most of the Region's EEZ. It would also prohibit most live rock or live coral take in low-use MPAs. In addition to the measures contained in Alternative 2, Alternative 3 (Substantial Additional Protection - the Preferred Alternative) would designate several no-take MPAs, require all fishing vessels transiting MPAs to carry wreck cleanup and removal insurance, and prohibit the use of nighttime spearfishing for CRE MUS with scuba and/or hookah gear in the EEZs of the NWHI and the PRIAs. Finally, Alternative 4 (Maximum Additional Protection) would additionally establish no-take MPAs out to 100 fm around all of the region's islands and atolls and extend the Preferred Alternative's prohibition on spearfishing for CRE MUS with scuba and/or hookah gear to apply at all times and throughout most of the Region's EEZ. Brief definitions of important terms and a list of the CRE MUS follow. Then, the remainder of this chapter describes these four alternatives in detail. Several actions, which are not part of the Preferred Alternative, but may be implemented at a later date through a framework process, are also discussed. This chapter concludes by discussing the reasons for selecting Alternative 3 as the Preferred Alternative.

2.2 Definitions and Acronyms Applicable to the Coral Reef Ecosystem FMP

Coral reef ecosystem: those species, interactions, processes, habitats, and resources associated with all substrate from 0-50 fm deep.

Coral Reef Ecosystem Management Area *(CRE management area, or management area)*: all Hawaii, PRIAs, American Samoa, CNMI and Guam EEZ waters (from surface to ocean floor) that are outside of state (see definition of state below) waters and within 200 miles from shore. Because the EEZ of the CNMI currently extends to the shoreline, it is separated into two zones: the inshore zone (0-3 miles from shore) and the offshore zone (3-200 miles from shore), with federal management of the coral reef ecosystem proposed for the offshore zone only. The inshore zone would continue to be managed by local authorities. The CNMI government should manage the inshore zone because: (1) cooperation between the local governments and the

Council relies on recognition of local management authority of nearshore waters; (2) the CNMI-based small vessel fishers are best managed by a local regime with hands-on interaction and knowledge of the issues; and, (3) this regime retains consistency with the other areas under Council jurisdiction.

No-Take MPA: an area in which no fishing or other harvest of marine species is allowed (except for scientific purposes under special permits).

Low-Use MPA: an area in which controlled harvests of coral reef MUS is allowed.

Coral reef ecosystem general permit (CRE general permit, or general permit): a permit that would be required under some alternatives if deemed necessary by the Council to harvest Currently Harvested Coral Reef Taxa from all non-MPA coral reef management areas. This permit would involve simple application procedures and reporting requirements.

Coral reef ecosystem special permit (CRE special permit, or special permit): a permit which would be required under some alternatives to (1) fish for any coral reef MUS (both Currently Harvested and Potentially Harvested Taxa) within low-use MPAs (with some exceptions), and (2) fish for any Potentially Harvested Coral Reef Taxa outside of MPAs. This permit would be approved and issued on a case-by-case basis and would have more complex application procedures and reporting requirements than the general permit.

State: Recognizing that the Council Region comprises several different political entities—a state, a commonwealth, two territories, and unincorporated federal territory—hereafter, as shorthand, these constituent parts (excluding federal territory) will be generically referred to as states.

Small vessel: a vessel less than 50 ft length overall. (These vessels are exempt from alternatives prohibiting anchoring on Guam's southern banks.)

Large vessel: a vessel equal to or greater than 50 ft length overall. (These vessels are prohibited from anchoring on Guam's southern banks.)

2.2.1 List of Acronyms

ARS:	Aquatic Resources Service
CPUE:	Catch per Unit Effort
CNMI:	Commonwealth of the Northern Mariana Islands
CRE:	Coral Reef Ecosystem
CRE-FMP:	Coral Reef Ecosystem Fishery Management Plan
CRE Reserve:	Coral Reef Ecosystem Reserve
CRE-PT:	Coral Reef Plan Team
CRTF:	Coral Reef Task Force
CHCRT:	Currently Harvested Coral Reef Taxa

CITES:	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CDP:	Community Development Plan
DAR:	Division of Aquatic Resources, DLNR, Hawaii
DEIS:	Draft Environmental Impact Statement
DLNR:	Department of Land and Natural Resources, Hawaii
DNA:	Deoxyribonucleic Acid
DOC:	Department of Commerce
DOD:	Department of Defense
DOI:	Department of the Interior
EEZ:	Exclusive Economic Zone
EFH:	Essential Fish Habitat
EIS:	Environmental Impact Statement
ENSO:	El Niño Southern Oscillation
EO:	Executive Order
EPA:	Environmental Protection Agency
EPAP:	Ecosystem Principals Advisory Panel
ESA:	Endangered Species Act
FAD:	Fish Aggregating Device
FDM:	Farallon de Medinilla, CNMI
FEIS:	Final Environmental Impact Statement
FEP:	Fishery Ecosystem Plan
FFS:	French Frigate Shoals, NWHI
FLPMA:	Federal Land Policy Management Act
fm:	fathoms
FMP:	Fisheries Management Plan
ft:	feet
HAPC:	Habitat Areas of Particular Concern
HINWR:	Hawaiian Islands National Wildlife Refuge
HIR:	Hawaiian Islands Reservation
HMSRT	Hawaiian Monk Seal Recovery Team
IRFA:	Initial Regulatory Flexibility Analysis
ITQs:	Individual Transferable Quota
IUCN:	Union for the Conservation of Nature
IWC:	International Whaling Commission
kg:	kilograms
lbs:	pounds
LORAN:	Long Range Navigation
m:	meters
mt:	metric tons
mm:	millimeters
MARPOL:	International Convention for the Prevention of Pollution from Ships
MHI:	Main Hawaiian Islands
MMC	Marine Mammal Commission

MMPA:	Marine Mammal Protection Act
MMRT	Marine Mammal Recovery Team
MPAs:	Marine Protected Areas
MSFCMA:	Magnuson-Stevens Fisheries Conservation and Management Act
MFMT:	Maximum Fishing Mortality Thresholds
MSY:	Maximum Sustainable Yield
MUS:	Management Unit Species
NDSA	Naval Defensive Sea Area
NEPA:	National Environmental Policy Act
NISA:	National Invasive Species Act
nm:	nautical miles
NMFS:	National Marine Fisheries Service
NMFS-HL:	National Marine Fisheries Service - Honolulu Laboratory
NMSA:	National Marine Sanctuaries Act
NPOA-s:	National Plan of Action for Seabirds
NOA:	Notice of Availability
NOAA:	National Oceanic and Atmospheric Administration
NOI:	Notice of Intent
NWHI:	Northwestern Hawaiian Islands
NWR:	National Wildlife Refuge
NWRSAA:	National Wildlife Refuge System Administration Act
OY:	Optimum Yield
PHCRT:	Potentially Harvested Coral Reef Taxa
PIAO:	Pacific Islands Area Office
PRIAs:	Pacific Remote Island Areas
RA:	Regional Administrator, NMFS
RFA:	Regulatory Flexibility Act
RIR:	Regulatory Impact Review
ROD:	Record of Decision
RPAs:	Reserve Preservation Areas
SLA:	Submerged Lands Act
SPR:	Spawning Potential Ratio
SSC:	Scientific and Statistical Committee
TSLA:	Territorial Submerged Lands Act
USFWS:	United States Fish and Wildlife Service
USCG:	United States Coast Guard
VMS:	Vessel Monitoring System
WPacFin:	Western Pacific Fisheries Information Network
WPRFMC:	Western Pacific Regional Fishery Management Council

2.2.2 Management Unit Species

Coral Reef Ecosystem Management Unit Species *(CRE MUS or MUS)*: an extensive list of coral reef organisms, many only identified by membership in higher-level taxa such as family or

sub-family. It includes some management unit species from the Council's implemented Bottomfish and Seamount Groundfish, Crustaceans, and Precious Corals FMPs, but these species would be mainly managed under their respective FMPs. However, ecosystem effects would be addressed via the CRE-FMP. Coral reef MUS are separated into two categories:

Currently Harvested Coral Reef Taxa (CHCRT). Because these organisms are commercially harvested, fishery information for them is available, allowing more effective management. The species in this group have been reported on commercial fishery catch reports but are not MUS under any of the Council's already-implemented FMPs. Membership in this group is based on two criteria: (1) More than 1,000 lbs. annual harvest for all members of a taxon, based on commercial fishery catch reports (these taxa are families or subfamilies); and (2) within these taxa particular genera or species are identified, based on their appearance on catch reports. CHCRT are listed in Table 2.1, grouped by family or subfamily. Table 2.1 also lists aquarium taxa that are known to be harvested in the EEZ (discussed below).

Potentially Harvested Coral Reef Taxa (PHCRT). These are coral reef organisms that are not known to be currently caught, or for which very little fishery information is available. However, emerging coral reef fisheries—such as the rapidly expanding marine ornamental products trade and the emerging industries for pharmaceutical and natural products—may target them at some future date. Several family/subfamily taxa in the CHCRT list are also PHCRT. As noted in Table 2.2, which lists PHCRT, all genera or species in these taxa that are not listed as CHCRT are by default PHCRT.

Because fishing for coral reef resources is light to non-existent in the EEZ, the CHCRT list was developed as a functional means to facilitate data collection and monitoring of coral reef ecosystem species that are currently being harvested, both directly and incidentally in commercial fisheries in state/territorial and federal waters. It will also help fishery managers to develop harvest strategies and proxies so that they can begin managing the coral reef ecosystem as a whole. The CHCRT also includes a subgroup of species that aquarium fish collectors presently harvest. With the exception of the nearshore waters of West Hawaii (Big Island), the commercial collection of Aquarium Taxa is minimal throughout the management area. However, the taxa listed in this category represent individual species that have been harvested in the EEZ and will likely continue to be harvested in the EEZ. For this reason they are listed separately at the end of Table 2.1. Their inclusion in the CHCRT list will allow continuing data collection by existing local management programs. As a result, the impacts on resources and habitats by aquarium fish collectors in the EEZ can be better assessed.

The PHCRT list consists of literally thousands of taxa for which little to no catch or effort data exist. For a great majority of these species scientific knowledge about their life histories, habitat requirements, and other biological information is completely lacking. Therefore, to begin data collection for management purposes, special permits will be required to target the PHCRT listed in Table 2.2, and for any species that are not explicitly listed on the CHCRT list.

In 1999, the bottomfish plan team noted that a large number of species were currently being harvested in Guam, American Samoa and the CNMI using bottomfish gear and techniques. There regularity in catch has been documented since the onset of the WPacFIN creel surveys. They recommended the Council include these species under the bottomfish FMP to allow for future management measures as needed. The Council approved this revision to the BMUS list at the June 2000 Council meeting. The list of species is found in Table 2.2.a and will be part of the Bottomfish MUS upon approval of an amendment to be submitted to the NMFS at the same time as this document.

Table 2.1: Currently Harvested Coral Reef Taxa.

Acanthuridae (Surgeonfishes)	Orange-spot surgeonfish (*Acanthurus olivaceus*) Yellowfin surgeonfish (*Acanthurus xanthopterus*) Convict tang (*Acanthurus triostegus*) Eye-striped surgeonfish (*Acanthurus dussumieri*) Blue-lined surgeon (*Acanthurus nigroris*) Whitebar surgeonfish (*Acanthurus leucopareius*) Blue-banded surgeonfish (*Acanthurus lineatus*) Blackstreak surgeonfish (*Acanthurus nigricauda*) Whitecheek surgeonfish (*Acanthurus nigricans*) White-spotted surgeonfish (*Acanthurus guttatus*) Ringtail surgeonfish (*Acanthurus blochii*) Brown surgeonfish (*Acanthurus nigrofuscus*) Elongate surgeonfish (*Acanthurus mata*) Mimic surgeonfish (*Acanthurus pyroferus*) Yellow-eyed surgeonfish (*Ctenochaetus strigousus*) Striped bristletooth (*Ctenochaetus striatus*) Twospot bristletooth (*Ctenochaetus binotatus*)
	Bluespine unicornfish (*Naso unicornus*) Orangespine unicornfish (*Naso lituratus*) Humpnose unicornfish (*Naso tuberosus*) Blacktounge unicornfish (*Naso hexacanthus*) Bignose unicornfish (*Naso vlamingii*) Whitemargin unicornfish (*Naso annulatus*) Spotted unicornfish (*Naso brevirostris*) Humpback unicornfish (*Naso brachycentron*) Barred unincornfish (*Naso thynnoides*) Gray unicornfish (*Naso caesius*)
Balistidae (Triggerfishes)	Titan triggerfish (*Balistoides viridescens*) Clown triggerfish (*B. conspicillum*) Orangstriped trigger (*Balistapus undulatus*) Pinktail triggerfish (*Melichthys vidua*) Black triggerfish (*M. niger*) Blue triggerfish (*Pseudobalistesfucus*) Picassofish (*Rhinecanthus aculeatus*) Wedged Picassofish (*B. rectangulus*) Bridled triggerfish (*Sufflamen fraenatus*)
Carangidae (Jacks)	Bigeye scad (*Selar crumenophthalmus*) Mackerel scad (*Decapterus macarellus*)

Carcharhinidae (Sharks)	Grey reef shark (*Carcharhinus amblyrhynchos*) Silvertip shark (*Carcharhinus albimarginatus*) Galapagos shark (*Carcharhinus galapagenis*) Blacktip reef shark (*Carcharhinus melanopterus*) Whitetip reef shark (*Triaenodon obesus*)
Holocentridae (Soldierfish/Squirrelfish)	Bigscale soldierfish (*Myripristis berndti*) Bronze soldierfish (*Myripristis adusta*) Blotcheye soldierfish (*Myripristis murdjan*) Bricksoldierfish (*Myripristis amaena*) Scarlet soldierfish (*Myripristis pralinia*) Violet soldierfish (*Myripristis violacea*) Whitetip soldierfish (*Myripristis vittata*) Yellowfin soldierfish (*Myripristis chryseres*) Pearly soldierfish (*Myripristis kuntee*) (*Myripristis hexagona*) Tailspot squirrelfish (*Sargocentron caudimaculatum*) Blackspot squirrelfish (*Sargocentron melanospilos*) File-lined squirrelfish (*Sargocentron microstoma*) Pink squirrelfish (*Sargocentron tieroides*) Crown squirrelfish (*Sargocentron diadema*) Peppered squirrelfish (*Sargocentron punctatissimum*) Blue-lined squirrelfish (*Sargocentron tiere*) Ala'ihi (*Sargocentron xantherythrum*) (*Sargocentron furcatum*) (*Sargocentron spiniferum*) Spotfin squirrelfish(*Neoniphon spp.*)
Kuhliidae (Flag-tails)	Hawaiian flag-tail (*Kuhlia sandvicensis*) Barred flag-tail (*Kuhlia mugil*)
Kyphosidae (Rudderfish)	Rudderfish (*Kyphosus biggibus*) (*Kyphosus cinerascens*) (*Kyphosus vaigienses*)
Labridae (Wrasses)	Saddleback hogfish (*Bodianus bilunulatus*) Napoleon wrasse (*Cheilinus undulatus*) Triple-tail wrasse (*Cheilinus trilobatus*) Floral wrasse (*Cheilinus chlorourus*) Harlequin tuskfish (*Cheilinus fasciatus*) Ring-tailed wrasse (*Oxycheilinus unifasciatus*) Bandcheek wrasse (*Oxycheilinus diagrammus*) Arenatus wrasse (*Oxycheilinus arenatus*) Razor wrasse (*Xyricthys pavo*) Whitepatch wrasse (*Xyrichtes aneitensis*) Cigar wrass (*Cheilio inermis*) Blackeye thicklip (*Hemigymnus melapterus*) Barred thicklip (*Hemigymnus fasciatus*) Threespot wrasse (*Halichoeres trimaculatus*) Checkerboard wrasse (*Halichoeres hortulanus*) Weedy surge wrasse (*Halichoeres margaritacous*) (*Halichoeres zeylonicus*) Surge wrasse (*Thalassoma purpureum*) Redribbon wrasse (*Thalassoma quinquevittatum*) Sunset wrasse (*Thalassoma lutescens*) Longface wrasse (*Hologynmosus doliatus*) Rockmover wrasse (*Novaculichthys taeniourus*)

Mullidae (Goatfishes)	Yellow goatfish (*Mulloidichthys spp.*) (*Mulloidichthys Pfleugeri*) (*Mulloidichthys vanicolensis*) (*Mulloidichthys flaviolineatus*) Banded goatfish (*Parupeneus spp.*) (*Parupeneus barberinus*) (*Parupeneus bifasciatus*) (*Parupeneus heptacanthus*) (*Parupeneus ciliatus*) (*Parupeneus ciliatus*) (*Parupeneus cyclostomas*) (*Parupeneus pleurostigma*) (*Parupeneus indicus*) (*Parupeneus multifaciatus*) Bantail goatfish (*Upeneus arge)*
Mugilidae (Mullets)	Stripped mullet (*Mulgil cephalus)* Engel's mullet (*Moolgarda engeli*) False mullet (*Neomyxus leuciscus*) Fringelip mullet (*Crenimugil crenilabis*)
Muraenidae (Moray eels)	Yellowmargin moray (*Gymnothorax flavimarginatus*) Giant moray (*Gymnothorax javanicus*) Undulated moray (*Gymnothorax undulatus*)
Ocotpodidae	Octopus (*Octupus cyanea; O. ornatus*)
Polynemidae	Threadfin (*Polydactylus sexfilis*) -Moi
Pricanthidae (Bigeye)	Glasseye (*Heteropriacanthus cruentatus*) Bigeye (*Priacanthus hamrur*)
Scaridae (Parrotfishes)	Humphead parrotfish (*Bulbometapon muracatum*) Parrotfishes (*Scarus spp.*) Pacific longnose parrotfish (*Hipposcarus longiceps*) Stareye parrotfish (*Catolomus carolinus*)
Scombridae	Dogtooth tuna (*Gymnosarda unicolor*)*
Siganidae (Rabbitfish)	Forktail rabbitfish (*Siganus aregentus*) Golden rabbitfish (*Siganus guttatus*) Gold-spot rabbitfish (*Siganus punctatissimus*) Randall's rabbitfish (*Siganus randalli*) Scribbled rabbitfish (*Siganus spinus*) Vermiculate rabbitfish (*Signaus vermiculatus*)
Sphyraenidae (Barracuda)	Heller's barracuda (*Sphyraena helleri*) Great Barracuda (*Sphyraena barracuda)*
Turbinidae (Turban shells/green snails)	Green snails (*Turbo spp.*)

*Moved from Pelagic MUS list as part of this FMP.

Aquarium Taxa/Species	**Acanthuridae** Yellow tang (*Zebrasoma flavescens*) Yellow-eyed surgeon fish (*Ctenochaetus strigosus*) Achilles tang (*Acanthurus achilles*) **Muraenidae** Dragon eel (*Enchelycore pardalis*) **Zanclidae** Morrish idol (*Zanclus cornutus*) **Pomacanthidae** Angelfish (*Centropyge shepardi* and *C. flavissimus*) **Cirrhitidae** Flame hawkfish (*Neocirrhitus armatus*) **Chatetodontidae** Butterflyfish (*Chaetodon auriga, C. lunula, C. melannotus* and *C. ephippium*) **Pomacentridae** Damselfish (*Chromis viridis, Dascyllus aruanus* and *D. trimaculatus*) **Sabellidae** Featherduster worm (*Sabellidae*)

Table 2.2: Potentially Harvested Coral Reef Taxa (PHCRT). Several taxa in the CHCRT list appear below. As noted in the table, all species in these taxa that are not listed as CHCRT are by default PHCRT.

Other Labridae spp. (wrasses) *(Those species not listed on CHCRT list)*	Ephippidae (batfish)
Other Carcharhinidae, Sphyrnidae *(Those species not listed on CHCRT list)*	Monodactylidae (mono)
Dasyatididae, Myliobatidae, Mobulidae (rays)	Haemulidae (sweetlips)
Other Serranidae spp. (groupers) *(Those species not managed under the Bottomfish FMP or included in the bottomfish amendment)*	Echineididae (remoras)
Carangidae (jacks/trevallies) *(Those species not listed on CHCRT list or managed under Bottomfish FMP or included in the bottomfish amendment)*	Malacanthidae (tilefish)
	Acanthoclinidae (spiny basslets)
Other Holocentridae spp. (soldierfish/squirrelfish) *(Those species not listed on CHCRT list)*	Pseudochromidae (dottybacks)
Other Mullidae spp. (goatfish) *(Those species not listed on CHCRT list)*	Plesiopidae (prettyfins)
Other Acanthuridae spp. (surgeonfish/unicornfish) *(Those species not listed on CHCRT list)*	Tetrarogidae (waspfish)
Other Lethrinidae spp. (emperors) *(Those species not managed under the Bottomfish FMP or included in the bottomfish amendment)*	Caracanthidae (coral crouchers)

Chlopsidae, Congridae, Moringuidae, Ophichthidae (eels) Other Muraenidae (moray eels) *(Those species not listed on CHCRT list)*	Grammistidae (soapfish)
Apogonidae (cardinalfish)	*Aulostomus chinensis* (trumpetfish)
Other Zanclidae spp. (moorish idols)	*Fistularia commersoni* (coronetfish)
Other Chaetodontidae spp. (butterflyfish)	Anomalopidae (flashlightfish)
Other Pomacanthidae spp. (angelfish)	Clupeidae (herrings)
Other Pomacentridae spp. (damselfish)	Engraulidae (anchovies)
Scorpaenidae (scorpionfish)	Gobiidae (gobies)
Blenniidae (blennies)	Lutjanidae *(Those species not managed under Bottomfish FMP or included in the bottomfish amendment)*
Other Sphyraenidae spp. (barracudas)	Other Ballistidae/Monocanthidae spp. *(Those species not listed on CHCRT list)*
Pinguipedidae (sandperches)	Other Siganidae spp. *(Those species not listed on CHCRT list)*
Gymnosarda unicolor	Other Kyphosidae spp.
Bothidae/Soleidae/Pleurnectidae (flounder/sole)	Caesionidae
Ostraciidae (trunkfish)	Cirrhitidae
Tetradontidae/Diodontidae (puffer/porcupinefish)	Antennariidae (frogfishes)
Stony corals	Syngnathidae (pipefishes/seahorses)
Heliopora (blue)	Echinoderms (e.g., sea cucumbers, sea urchins)
Tubipora (organpipe)	Mollusca
Azooxanthellates (non-reefbuilders)	Sea snails (gastropods)
Fungiidae (mushroom corals)	Trochus spp.
Sm/Lg Polyped Corals (endemic spp.)	Opistobranchs (sea slugs)
Tunicates (solitary/colonial)	*Pinctada margaritifera* (black lipped pearl oyster)
Millepora (firecorals)	Tridacnidae
Soft corals and Gorgonians	Other Bivalves
Anemones (non-epifaunal)	Cephalopods
Zooanthids	Crustaceans (Lobsters, shrimps/mantis, true crabs and hermit crabs) *(Those species not managed under the Crustacean FMP)*
Sponges (non-epifaunal)	Stylasteridae (lace corals)
Hydrozoans	Solanderidae (hydroid fans)

Bryozoans	Annelids
Live rock	Algae
All other coral reef ecosystem marine plants, invertebrates and fishes not listed under existing FMPs	

Table 1.4 Proposed Bottomfish Species for Bottomfish Management Unit Species List

Carangidae	
Carangoides orthogrammus	yellow-spotted trevally
Carangoides caeruleopinnatus	coastal trevally
Caranx melampygus	bluefin trevally
Caranx papuensis	brassy trevally
Caranx sexfasciatus	bigeye trevally
Caranx lugubris	black jack
Seriola rivoliana	almaco jack/amberjack
Lethrinidae	
Gnathodentex aurolineatus	yellowspot emperor, striped large eye bream
Gymnocranius microdon	blue-spotted large-eye bream
Gymnocranius rivulatus	blue-line, large-eye bream
Lethrinus atkinsoni	Pacific yellowtail emperor
Lethrinus erythacanthus	orange-spotted emperor
Lethrinus harak	thumbprint emperor, blackspot emperor
Lethrinus kalliopterus	orange-spotted emperor
Lethrinus obsoletus	orange-striped emperor
Lethrinus olivaceus	longnose emperor
Lethrinus xanthochilus	yellowlip emperor
Monotaxis grandoculus	humphose bigeye bream, bigeye emperor
Lutjanidae	
Aphareus furca	blue smalltooth jobfish
Lutjanus bohar	twinspot snapper, red snapper
Lutjanus fulvus	flametail snapper
Lutjanus gibbus	humpback snapper
Lutjanus monostigmus	onespot snapper
Lutjanus rufolineatus	rufous snapper
Lutjanus sanguineus	blood snapper
Paracaesio kusakarii	kusakar snapper
Paracaesio stonei	stone's snapper
Paracaesio xanthurus	deepwater bream
Pristipomoides argyrogrammicus	blue gindai
Pristipomoides multidens	multidens snapper

Serranidae	
Cephalopholis argus	peacock grouper
Cephalopholis igarashiensis	yellow-banded grouper
Cephalopholis sonnerati	tomato grouper
Cephalopholis urodeta	flagtail grouper
Epinephelus hexagonatus	hexagon grouper
Epinephelus howlandi	blacksaddle grouper
Epinephelus lanceolatus	giant grouper
Epinephelus macrospilos	snubnose grouper
Epinephelus maculatus	highfin grouper
Epinephelus merra	honeycomb grouper
Epinephelus microdon	smalltooth grouper
Epinephelus morrhua	striped grouper
Epinephelus octofasciatus	eightbar grouper
Epinephelus polyphekadion	camouflaged grouper
Epinephelus timorensis	yellowspotted grouper
Plectropomus laevis	giant coral grouper
Saloptia powelli	pink grouper
Variola albimarginata	white-margined lyretail grouper
Scorpaenidae	
Pontinus macrocephala	hogo

2.3 Description of Alternatives by Management Measure

Each of the alternatives analyzed in this EIS would implement four management measures to varying degrees. Tables 2.3a-d summarize how each of the four measures would be implemented in each of the four alternatives. A more in-depth discussion follows, organized by management measure: (1) marine protected areas; (2) permits and reporting requirements; (3) allowable gear; and, (4) other miscellaneous measures. For each measure the way in which they would be implemented under the four alternatives is described.

2.3.1 Management Measure 1: Marine Protected Areas

Marine protected areas (MPAs) are an attractive option for ecosystem-based fisheries management because they do not require detailed knowledge of the management unit species, but nevertheless holistically conserve multi-species resources and the functional attributes of marine ecosystems. They can also provide "insurance" against periods of poor recruitment of individual stocks.

MPAs can vary in scope and extent. They can be areas designated for seasonal or limited use (low-use), or areas that are completely restricted from consumptive use (no-take). Although completely restricted areas are thought to provide the highest degree of protection to marine ecosystems, less restrictive areas can achieve a balance between protection and consequent economic and social impacts.

The optimum size of an MPA depends on many factors, including the resources managed, management goals, enforcement capabilities, and social and economic constraints. However,

researchers do not yet fully understand the relationship between the area covered by an MPA and resulting benefits in the form of ecologically complete coral reef ecosystem protection. To be useful to fisheries and to promote the conservation of coral reef resources on a broader scale, MPAs should serve as sources of reproductive output to replenish larger surrounding or down-current areas. Small and/or isolated MPAs may be inadequate for this purpose.

Few, if any, studies have sought to verify whether MPAs established in the U.S. Pacific Islands do actually benefit nearby fisheries. Clearly, fish populations that build up in small areas temporarily closed to fishing are quickly reduced when fishing is resumed, as evidenced by studies in Hawaii and the Philippines. Existing MPAs in the U.S. Pacific Islands have been criticized for being either too small and fragmented, or for not encompassing sufficient depth range and high quality habitat to provide broad coral reef ecosystem protection or recruitment benefits to fisheries. As a result, it has been suggested that populations in MPAs should be linked over a broad area in order to assure long-term sustainability of coral reef fisheries. Some argue for complete protection from fishing, whereas others believe MPAs are more valuable when they can serve as natural laboratories for fishing experiments and testing of adaptive management strategies.

Table 2.3a: Management measure 1- marine protected areas.

Alternative	No-take MPAs (no harvest of coral reef ecosystem management unit species permitted)	Low-use MPAs (controlled harvest of coral reef ecosystem management unit species permitted)
Alternative 1 No Action	Under existing FMPs there is: no longline fishing within 50 miles of all NWHI; no lobster fishing within 0-10 fathoms around all NWHI and within 20 nm of Laysan Island; and no bottomfishing around Hancock seamount.	None.
Alternative 2 Minimal Additional Protection	No new no-take MPAs.	0-50 fathoms around all NWHI and PRIA.
Preferred Alternative 3 Substantial Additional Protection	0-10 fathoms around all NWHI plus, 0-50 fathoms around FFS, Laysan, northern half of Midway Atoll, Rose Atoll, Jarvis, Howland, and Baker Islands, and Kingman Reef. This will total 12% of the region's EEZ coral reefs.	10-50 fathoms around all other NWHI, 0-50 fathoms around Palmyra, Johnston, and Wake. 0-50 fathoms around the southern half of Midway Atoll.
Alternative 4 Maximum Additional Protection	0-100 fathoms around all islands and atolls throughout the region's EEZs This will total 100% of the region's EEZ coral reefs.	None.

Table 2.3b: Management measure 2- permit requirements.

Alternative	CRE general permit (simple application and reporting requirements)	CRE special permit (more complex application and reporting requirements, approved and issued on a case-by-case basis)
Alternative 1 No Action	None.	None.
Alternative 2 Minimal Additional Protection	None.	Required for all take of any CRE MUS within low-use MPAs, and for all take of PHCRT within the EEZ except by: (1) other FMP permit holders; (2) any take within 3 miles of CNMI.
Preferred Alternative 3 Substantial Additional Protection	None at this time but may be implemented at a later date via a framework process, in which case it would likely be required for all remaining take of CHCRT within the EEZ (outside of the no-take MPAs) except by: (1) other FMP permit holders; (2) any take with 3 miles of CNMI.	Required for all take of any CRE MUS within low-use MPAs, and for all take of PHCRT within the EEZ except by: (1) other FMP permit holders; (2) any take within 3 miles of CNMI.
Alternative 4 Maximum Additional Protection	Required for all remaining take of CHCRT within the EEZ (outside of the no-take MPAs) except by other FMP permit holders.	Required for all EEZ scientific research and management activities which could affect any CRE MUS. Required for all take of any PHCRT within the EEZ except by: (1) other FMP permit holders; (2) any take within 3 miles of CNMI.

Table 2.3c: Management measure 3- allowable gear types and methods.

Alternative	Listing of gears allowed for harvest of coral reef ecosystem management unit species
Alternative 1 No Action	All of the region's FMPs are regulated by a common list of allowable gears, which consist of: allowable chemical gear (e.g., awa/kava root), barrier net, dip net, gillnet, hand harvest, seine, slurp gun, trap, spear, rod and reel, and hook-and-line. Drift gillnets are specifically prohibited for use under the Pelagics FMP, and certain restrictions exist for traps used under the Crustaceans FMP. In addition, the Bottomfish and Seamount Groundfish FMP prohibits the use of bottom trawls, bottom set gillnets, poisons, explosives, and intoxicating substances for the harvest of bottomfish species. This alternative would not impose any new gear restrictions.
Alternative 2 Minimal Additional Protection	Allow the use of only the following gears throughout the regions EEZs for the harvest of any CRE MUS: hand harvest, spear, slurp gun, hand/dip net, hoop net for kona crab, throw net, barrier net for aquarium fish, surround/purse set for targeted schools (e.g. akule, baitfish, weke) with a minimum of bycatch, hook-and-line (powered and unpowered handlines, rod and reel, and trolling), traps (with conditions), and remote operating vehicles/submersibles.
Preferred Alternative 3 Substantial Additional Protection	Allow the use of only the following gears throughout the regions EEZs for the harvest of any CRE MUS: hand harvest, spear, slurp gun, hand/dip net, hoop net for kona crab, throw net, barrier net for aquarium fish, surround/purse set for targeted schools (e.g. akule, baitfish, weke) with a minimum of bycatch, hook-and-line (including powered and unpowered handlines, rod and reel, and trolling), traps (with conditions), and remote operating vehicles/submersibles. **Prohibit nighttime spearfishing for CRE MUS with scuba/hookah in the EEZ of the NWHI and PRIAs.**
Alternative 4 Maximum Additional Protection	Allow the use of only the following gears throughout the regions EEZs for the harvest of any CRE MUS: hand harvest, spear, slurp gun, hand/dip net, hoop net for kona crab, throw net, barrier net for aquarium fish, surround/purse set for targeted schools (e.g., akule, baitfish, weke) with a minimum of bycatch, hook-and-line (powered and unpowered handlines, rod and reel, and trolling), traps (with conditions), and remote operating vehicles/submersibles. Prohibit all spearfishing for CRE MUS with scuba/hookah throughout the region's EEZs.

Table 2.3.d: Management measure 4- miscellaneous measures.

Alternative	Measures affecting the take of live rock and coral, and vessel anchoring and insurance requirements
Alternative 1 No Action	None.
Alternative 2 Minimal Additional Protection	No take of live rock or live coral in low-use MPAs except for: (1) incidental take by other FMP permit holders; (2) take by indigenous people for traditional/ceremonial use; (3) use by aquaculture operations as seed stock; (4) science and management; (5) bioprospecting. All of these (except #1) would require a CRE special permit. No anchoring zone on Guam's offshore southern banks by fishing vessels > 50 feet.
Preferred Alternative 3 Substantial Additional Protection	No take of live rock or live coral throughout the region's EEZs except for: (1) incidental take by other FMP permit holders; (2) take by indigenous people for traditional/ceremonial use; (3) use by aquaculture operations as seed stock; (4) science & management; (5) bioprospecting. All of these (except #1) would require a CRE special permit. Require insurance for all fishing vessels (including existing FMP fisheries) transiting all MPAs. No anchoring zone on Guam's offshore southern banks by fishing vessels > 50 feet.
Alternative 4 Maximum Additional Protection	No take of live rock or live coral throughout the region's EEZs. Require insurance for all fishing vessels transiting all MPAs.

Alternative 1, No Action: No new MPAs of any type would be implemented.

Alternative 2, Minimal Additional Protection to Coral Reef Resources: Low-use MPAs would be established for EEZ waters from 0-50 fm around each of the NWHI and each of the PRIAs. Midway Island, which is located in the NWHI, would be exempted from these MPAs.

Alternative 3, Substantial Additional Protection to Coral Reef Resources (**Preferred Alternative**): No-take MPAs would be established for EEZ waters from 0-10 fm around all NWHI as well as EEZ waters from 0-50 fm around French Frigate Shoals, Laysan Island, and the northern half of Midway Atoll. No-take MPAs would also be established for EEZ waters from 0-50 fm around American Samoa's Rose Atoll, and Jarvis, Howland, Baker and Kingman, in the PRIAs. In addition, low-use MPAs would be established in EEZ waters from 10-50 fm around the remaining NWHI (including 0-50 fm around the southern half of Midway Atoll), as well as EEZ waters from 0-50 fm around Palmyra, Johnston, and Wake Islands. Sustainable use of coral reef resources for customary and traditional purposes would be permitted in the low-use MPAs of the NWHI.

Alternative 4, Maximum Additional Protection to Coral Reef Resources: No-take MPAs would be established for EEZ waters from 0-100 fm around all of the Region's islands and atolls. Due to the broad extent of these areas, there would be no low-use MPAs under this alternative.

Figures 2.1-2.13, found at the end of this chapter, detail the location and extent of these MPAs.

2.3.2 Management Measure 2: Permits and Reporting Requirements

Permits are a fundamental management tool, used as a basis for participation in many U.S. domestic fisheries. Permits establish the legal rights, privileges, and obligations of fishermen. Reporting requirements allow collection of data for fishery monitoring and management. In addition, permit holders' compliance with permit requirements can be evaluated and a register maintained that lists those in good standing. Performance standards can then be established as criteria for renewing permits.

A permit process that allows for monitoring of participation, effort, and catch contributes to seven of the eight FMP objectives outlined in Section 1.4 of the FMP. Permitting, particularly addresses Objective 4, which calls for minimization of adverse human impacts. Permits focus management attention on the specific reef resources and areas to be exploited and the harvest methods to be used. Periodic analysis of catch and effort data collected through mandatory reporting facilitates adaptive management. CRE special permits included in some of the alternatives would be issued on a case-by-case basis. This would encourage applicants to more carefully consider their proposed activities and the potential impacts of those activities. More specifically, special permit conditions allow managers to carefully monitor emerging coral reef fisheries throughout the region's EEZs. The CRE-FMP provides more details of the application and approval process for both the CRE special and general permits.

Alternative 1, No Action: No permit or reporting requirements would be implemented.

Alternative 2, Minimal Additional Protection to Coral Reef Resources: CRE special permits would be required for the harvest of both CHCRT and PHCRT within low-use MPAs, with an exception for vessel operators holding permits and targeting species managed under the Council's already implemented Bottomfish and Seamount Groundfish, Crustaceans, Pelagics, or Precious Corals FMPs.

Alternative 3, Substantial Additional Protection to Coral Reef Resources (**Preferred Alternative**): CRE special permits would be required for the harvest of both CHCRT and PHCRT within low-use MPAs, with an exception for vessel operators holding permits and targeting species managed under the Council's already implemented Bottomfish and Seamount Groundfish, Crustaceans, Pelagics or Precious Corals FMPs. In addition, CRE special permits would be required for all take of PHCRT throughout the Region's EEZ, with an exception for the inshore area of CNMI's EEZ. This alternative would also establish a framework process to allow future implementation of a CRE general permit requirement for the EEZ harvest of both CHCRT and PHCRT outside of low-use MPAs with the same just mentioned exceptions. Permitting and reporting for harvest of CHCRT outside of low-use MPAs will be conducted through existing local permit and reporting systems.

Alternative 4, Maximum Additional Protection to Coral Reef Resources: CRE special permits would be required to harvest PHCRT outside of the no-take MPAs throughout the Region's EEZ. As with the other alternatives, other FMP permit holders and harvests within CNMI's inshore

area would be excepted. This alternative would also implement a CRE general permit requirement for the EEZ harvest of CHCRT outside of the no-take MPAs, with the same exceptions mentioned above. Finally, this alternative would require a CRE special permit for any EEZ research or management activities that could affect any CRE MUS.

2.3.3 Management Measure 3: Allowable Gear Types and Methods

Pacific Islanders have fished on coral reefs for several thousand years. Sustainability resulted in part from the selectivity of the gear that they used and their management practices. Many of these traditional methods are still used in contemporary fisheries, although the introduction of manufactured gear and population growth have increased the impacts. Today's fishers employ a wide variety of gear and methods to harvest extremely diverse resources numbering hundreds of species. Most of these methods are very inefficient when compared to industrial fishing technology, such as bottom trawls, all-terrain trawls, bottom dredges, or industrial netting—used in U.S. continental shelf fisheries but prohibited in many benthic fisheries around the Pacific. However, several potential threats to coral reef resources in the EEZ around U.S. Pacific Islands remain, due to the use of destructive fishing methods.

Controls are needed to prevent the possession or use of destructive gear to harvest coral reef resources. These include poisons, explosives, intoxicating substances, and unattended gillnets that damage coral reef ecosystems. Bioprospecters may also seek to harvest coral reef resources. Despite their potential benefits to society, these harvests must be carried out in a controlled manner. The collection of these organisms, many of which are still unknown, may utilize novel techniques that are difficult to anticipate. Unregulated live reef fish harvesters for food and ornamental markets, already a problem in Southeast Asia, could find their way to U.S. EEZ waters, especially in remote, difficult to monitor areas.

Gear restrictions are also needed in order to address several other issues. Non-selective gears and methods often result in substantial incidental catch (non-targeted catches) or bycatch (discards). In addition, some highly selective methods, such as scuba-assisted spearfishing, prevent fish from seeking refuge.

Placing limits on allowable gear types addresses FMP Objective 1: sustainable use of resources, and Objective 4: minimizing adverse human impacts.

Alternative 1, No Action: No new gear requirements would be implemented.

Alternative 2, Minimal Additional Protection to Coral Reef Resources: Only the following gears would be allowed throughout the region's EEZs for the harvest of any CRE MUS: (1)hand harvest; (2) spear; (3) slurp gun; (4) hand/dip net; (5) hoop net for Kona crab; (6) throw net; (7) barrier net for aquarium fish; (8) surround/purse set for targeted schools (e.g., akule, baitfish, weke) with a minimum of bycatch; (9) hook-and-line (including powered and unpowered handlines, rod and reel, and trolling); (10) traps (with conditions); and, (11) remote operating vehicles/submersibles. Other FMP permit holders would be required to comply with the gear restrictions of that FMP.

Alternative 3, Substantial Additional Protection to Coral Reef Resources (**Preferred Alternative**): This alternative would include the same list of allowable gears as Alternative 2, but would also specifically prohibit nighttime spearfishing for CRE MUS with scuba or hookah gear in all EEZ waters surrounding the NWHI and the PRIAs. Other FMP permit holders would be required to comply with the gear restrictions of that FMP.

Alternative 4, Maximum Additional Protection to Coral Reef Resources: This alternative would include the same list of allowable gears as Alternative 2, but would also specifically prohibit all spearfishing for CRE MUS with scuba or hookah gear in all EEZ waters throughout the region. Other FMP permit holders would be required to comply with the gear restrictions of that FMP.

2.3.4 Management Measure 4: Other (Miscellaneous) Measures

Two issues of concern specifically addressed by this FMP include the take of live rock and live coral, and the impacts of vessel wrecks on coral reef resources. Both have potential to significantly impact essential fish habitat.

Alternative 1, No Action: No new restrictions on the harvest of live rock and live coral, or requirements for vessel insurance would be implemented.

Alternative 2, Minimal Additional Protection to Coral Reef Resources: The take of live rock and live coral in low-use MPAs would be prohibited except for: (1) incidental take by other FMP permit holders; (2) take by indigenous people for traditional/ceremonial use; (3) use by aquaculture operations as seed stock; (4) science and management; and, (5) bioprospecting. Except for the first category, all of these groups would require a CRE special permit. In addition, no anchoring by large vessels would be allowed on Guam's offshore southern banks.

Alternative 3, Substantial Additional Protection to Coral Reef Resources (**Preferred Alternative**): This alternative contains the same management measures as outlined for Alternative 2. In addition, fishing vessels longer than 50 ft would also be prohibited to anchor on Guam's offshore southern banks. This alternative would also require all fishing vessels transiting MPAs to carry wreck and cleanup insurance in case of an accident or fuel spill.

Alternative 4, Maximum Additional Protection to Coral Reef Resources: All take of live rock and live coral would be prohibited throughout the Region's EEZ. In addition, this alternative would require all fishing vessels transiting MPAs to carry wreck and cleanup insurance in case of an accident or fuel spill.

2.4 Future Measures That Could be Implemented through Framework Actions

Because the status of coral resources and their exploitation can change, any management regime must be able to adapt to those changing conditions. This is known as adaptive management and, depending on circumstances, rapid responses to natural or anthropogenic changes may be necessary. In comparison to amending the CRE-FMP, certain management changes can be

implemented in an expedited manner using a framework process. Several measures are identified for possible later implementation using this procedure, including restrictions on anchoring in MPAs, and requiring vessels operating in MPAs to carry a satellite-based vessel monitoring system (VMS). The framework procedure would also simplify reassignment of MUS between the currently harvested taxa and potentially harvested taxa categories. In general, other measures can be implemented through the framework process if their impacts have been previously evaluated, in this FMP or in amendments, for example. Otherwise, an FMP amendment is required. The framework process is discussed in greater detail in Section 5.5 of the FMP. Analyses of framework measures considered in the CRE-FMP are found below. The particular characteristics of the resource, and the desire to take an ecosystem approach to management, make the framework procedure a particularly appropriate component of the CRE-FMP. It should be noted that framework procedures have been included in all of the Council's already-implemented FMPs.

2.4.1 Potential Framework Measures

This section describes changes to the FMP that may be made based on recommendations identified in the annual report, or at Council or other advisory body meetings. Current options being considered for future framework action are: (1) mooring buoy installation and an anchoring prohibition; (2) an electronic vessel monitoring system (VMS) requirement for vessels operating in specific coral reef areas; (3) implementation of the general permit and reporting regime; (4) moving MUS on the PHCRT list to the CHRCT list; and, (5) designating indigenous sub-zones within low-use MPAs. Additional measures could be implemented through the framework process too, if their impacts have been evaluated in this FMP or in amendments; otherwise a full amendment is required.

These five measures are not slated for immediate implementation for several reasons. Details for actions 1, 2 and 5 still need to be worked out. For action 1, mooring buoy locations have not yet been determined, although all parties agree on their importance. For action 2, a closer look at the needs of vessels operating in MPAs and a better understanding of EFH, and habitat areas of particular concern (HAPC) will be required. It has not yet been determined whether the federal government will pay for the installation and operation of a VMS in this fishery. For action 5, the size and location of indigenous sub-zones have not been decided and legal issues were not fully explored.

Framework Action 1: Designate zones in the EEZ where mooring buoys will be installed in order to protect EFH from anchor damage. In areas with approved mooring buoys, prohibit anchoring of fishing vessels within a radius indicated on the buoy.

Rationale: "No anchor zones" in specific habitat areas would protect coral reefs from devastating anchor damage. Mooring buoys have been used successfully in Hawaii and elsewhere in the Pacific as an alternative to anchoring, particularly in high use areas. The use of these buoys by fishers and others would reduce habitat damage caused by anchoring. The buoys would be used on a first-come-first-served basis and allowed time limits would be specified so that no one boat

monopolizes a buoy. This process would ensure that the use of these buoys and the concomitant access to the resources would be fair and equitable to all fishers, consistent with National Standard 4. Only one boat would be allowed to moor at a time at each buoy. The prohibition of anchoring would limit the number of secured boats fishing an area to the number of mooring buoys at the site. While this may concentrate fishing effort around the buoys, it would also limit the number of vessels fishing at one time, increasing vessel safety and minimizing fishing pressure on coral reef resources.

Beneficial Impacts:

- Prevents anchor damage to reef habitats and allows anchoring for safety reasons in EFH and/or HAPC.
- Limits number of vessels fishing on the banks at one time, increasing vessel safety and minimizing fishing pressure on coral reef resources.
- Increases safety of fishers by making anchoring (and its hazards) unnecessary and reducing risk of anchor dragging.
- Is consistent with requirements of the Sustainable Fisheries Act by minimizing degradation of coral reef habitats.

Adverse Impacts:

- Limits number of vessels able to fish in a designated mooring zone at one time.
- Mooring buoy maintenance may be difficult.
- May concentrate fishing effort in areas with buoys.
- Includes a cost for installation and maintenance of buoys.
- May encourage "rafting" of vessels at each mooring buoy (even though it would be prohibited under the measure), which is a safety concern.

Framework Action 2: Require fishing vessels to carry remote VMS as part of an effective monitoring and enforcement system for state and federal agencies. This requirement could be applied to coral reef fisheries in specific geographical areas (e.g., the NWHI). This measure will only be enacted if the cost of such a system is fully subsidized with federal funding.

Rationale: VMS is an effective system for managing vessels operating in areas with different use zones, such as the MPAs, and with different licenses/permits, and for encouraging and documenting compliance with permit conditions. A vessel's precise location would be transmitted via satellite to a Land Earth Station and from there to a computerized monitoring station where the information would be kept in a secure and confidential database. If the vessel enters a designated buffer zone or MPA, an automatic signal is sent to both the ship's captain and the appropriate management agency. Such a system may prove to be a cost-effective compliance tool for realtime and accurate positioning of vessels and instant recognition of a breach of permitted activities, as well as a tool to locate vessels in distress. VMS also has been shown to be an effective tool for monitoring vessels' locations in relation to navigational hazards and, when used in conjunction with automated buffer zones, may serve as an additional warning mechanism to prevent vessel groundings.

Beneficial Impacts:

- Protects coral reef resources by providing early warning of a vessel approaching too close to a reef slope, thereby protecting both the reef and the vessel from grounding damage.
- Protects coral reef resources by providing a tool that can dramatically improve compliance with FMPs.
- Is consistent with the requirements of the Sustainable Fisheries Act.
- Provides precise location information to assist in emergencies and rescues.
- Provides documentation on vessel movements, which can be used to clear up misunderstandings regarding liability or accusations of responsibility for environmental damage.
- Requires no input by captain or crew to run the automatic system.
- Can make enforcement easier and potentially much less costly.

Adverse Impacts:

- Cost of implementation may be burdensome to federal government.
- Implementation will require fiscal and personnel resources.
- Fishermen are concerned over the use of VMS information (security and confidentiality of data).

Framework Action 3: Require general permits to fish for CHCRT MUS outside of MPAs in the EEZ, in the event that regional management is determined inadequate to protect the species and/or ecosystem.

Rationale: This framework measure is described in Section 5.3.1 of the FMP in the subsection outlining the general permit and reporting regime. Initially, general permits will not be required for existing CRE fisheries. This option to implement a general permit requirement would allow fishery managers to assess individual fishing effort and methods for a given target species and associated bycatch before any vessel begins fishing. This more detailed data collection and mandatory reporting would facilitate more effective and adaptive management. This framework measure can be enacted if the Council determines that a locally administered permit and reporting regime does not adequately address CRE-FMP objectives. A general permit, issued by NMFS Pacific Islands Area Office (PIAO), would then be required to harvest CHCRT MUS in the EEZ outside of MPAs.

A number of methods could be used to instigate this framework procedure: (1) as a result of the Council reviewing the Coral Reef Ecosystem Annual Report for adequate data collection, overfishing or potential for overfishing, and other relevant scientific data which reflects the need for additional management measures; (2) the Coral Reef Plan Team issuing a report outlining concerns to the Council to be addressed at the following scheduled Council meeting; or, (3) regional management authorities bringing their concerns to the attention of the Council at any time.

American Samoa can be used as an example of how a general permit and reporting regime could be implemented and applied, using framework procedures. This example is particularly apposite because reef fisheries occur both in territorial and federal waters. The American Samoa Department of Aquatic and Wildlife Resources issues permits to fish for coral reef species and collects data through both creel surveys and commercial purchases reporting. These reef fisheries are small-scale operations, with individuals catching a few to a couple hundred pounds of fish on a given day. If one or more large-scale operations began efficiently targeting these species in the EEZ, increasing the total catch substantially, regional management might not be sufficient to address this development. The Council could then initiate the framework process to require a general permit for reef fisheries in the EEZ of American Samoa.

While details about who would be affected and how the measure would affect fishing are unique and unforeseeable, general procedures can be outlined here. Federal regulation 50 CFR 660.13 details current permitting procedures, which would also apply to this CRE general permit. Permits would be valid only for the fishery management subarea specified on the permit and remain valid for the period specified unless transferred, revoked, suspended, or modified. A permittee first requests an official Southwest Region Federal Fisheries application form. After filling out all required information and attaching necessary documents (see example form in Section 8.2 of the FMP), the permittee returns the application along with any fees, as specified. The PIAO will review and process all completed applications within 15 business days. Permittees will be notified of incomplete or incorrect applications. If deficiencies are not corrected within 30 days following notification, the application will be considered abandoned. Within 15 business days after receiving a completed application, the administrator of the PIAO will issue a permit to the applicant under the CRE-FMP or send a written notification of denial, which will include the reasons for the denied application.

Beneficial Impacts:

- Requires specific data reporting of catch, effort, area, and method of fishing.
- Allows for a thorough understanding of the total fishing effort for given areas and given target species.
- Provides information on bycatch and protected species.
- Allows for standardization of reporting, assisting fishery manager's assessment of impacts.
- Makes fishermen more aware of concerns of impacts from fishing through completing both permit form and logbooks.
- Assists adaptive management with crucial data on fishery.

Adverse Impacts:

- Increases administrative burdens (time and costs) due to the permit process.
- Increases burdens to fishermen not used to completing this type of paperwork.
- Removes management from regional authority which had traditionally managed these fisheries.

Framework Action 4: Allow particular MUS on the PHCRT list to be moved to the CHCRT list when sufficient information has been gathered for less restrictive management.

Rationale: If a market develops for potentially-harvested species, fishers will request to fish those species under the special permit. The special permit embodies the precautionary approach. Permit approval requires a thorough description and evaluation of all aspects of the fishing method for each applicant. Additionally, strict reporting requirements, including bycatch and discards, must be submitted. The data gathered from the vessels will help managers determine MSY, OY, and potential for overfishing. When enough data has been gathered for a given species or species complex and its associated bycatch to understand cumulative impacts on the species and the ecosystem, the Council can determine whether to lessen the stringent requirements by moving such species to the currently harvested list. This reduces administrative and regulatory burdens at the appropriate time without causing risk to the resource.

Beneficial Impacts:

- Relieves unnecessary administrative burdens on species for which management is better understood.
- Reduces burden to the Council and the PIAO Administrator for permit approval.
- Eases burdens on fishermen who have complied with regulations, allowing for given species to be re-listed as CHCRT.
- Procedure to re-list MUS prompts fishery managers to better understand species and the ecosystem to facilitate effective management.

Adverse Impacts:

- Has the potential to put species at risk, which could require more stringent management measures.
- Could facilitate additional fishing pressure for given species due to less stringent permit requirements for allowed harvesting.

Framework Action 5: Designate a set percentage within low-use MPAs for sole use by indigenous people, with the percentage based upon the percentage of indigenous population in the area around the low-use MPA.

Rationale: Discussions during the planning process centered around access for Native Hawaiians to the NWHI for traditional and ceremonial purposes. Later on, other island cultures were included in these discussions, with details to be worked out in the future as new MPAs were designated in their EEZs. Not all of the details, however, were worked out for the NWHI either. Yet to be determined are where these locations would be, the exact percentage of low-use MPA that would be set aside, and also the legal issues surrounding the proposal. Nevertheless, the CRE Plan Team and other groups strongly believe in the premise.

As discussed in Section 1.3.5, the indigenous people of the Samoa, Hawaii and Mariana islands have a close historical and cultural relation with the marine environment and coral reef resources.

Increasing restrictions on customary and traditional uses of marine resources are jeopardizing cultural continuity in many areas of the U.S. Pacific. The designation of no-take zones in the NWHI could result in some negative impact on the Hawaii fishing community by causing a loss of earning potential, investment value, and lifestyle for some bottomfish and lobster fisheries participants.

A 1993 survey of participants in the NWHI bottomfish fishery found that half of the respondents who fish in the Ho`omalu Zone were motivated to fish by a long-term family tradition (Hamilton 1994). This sense of continuity is also reflected in the importance placed on the process of learning about fishing from "old timers" and transmitting that knowledge to the next generation. Hawaii's commercial fishing industry dates back nearly 200 years and closure of some fishing grounds in the NWHI would also likely have a negative impact on those who value the continued existence of Hawaii's maritime tradition and culture. In view of the historic and cultural importance of fishing over the last 2,000 years for Native Hawaiians, this deprivation of the right to make a living at *koa* (see Kahaulelio 1902, pp. 22, 24), which they have been accustomed to frequent in the NWHI, is an especially onerous penalty. The two events have exacerbated this situation. First, annexation of Hawaii by the U.S. opened access to fishery resources to any U.S. citizen (Kosaki 1954). Second, this action increased fishing pressure on resources customarily used by Native Hawaiians and weakened cultural norms that controlled the proper conduct of fishing.

Beneficial Impacts:

- Helps preserve and reestablish island cultures and families whose history of traditional and ceremonial use of coral reef resources dates back thousands of years.
- Adds additional protection within low-use MPAs, by effectively limiting the amount of users in the area.
- Will make the permitting process for certain activities simpler because usage in these areas can be expected to be uniform across these select user groups.
- Potentially supports subsistence fishing.

Adverse Impacts:

- Could be challenged legally on grounds of discrimination.
- Locations and size of the sub-zones could cause contention between user groups.

Concerns have been expressed regarding what constitutes cultural take. For example, modern gear and techniques could alter the purpose of the sub-zone.

2.4.2 Procedure for New Measures (Amendments)

These procedures apply to regulatory measures that have not been included in previous regulations and/or whose impacts have not been analyzed previously in the FMP. These new measures include, but are not limited to, catch limits, resource size limits, closures, and effort limitations. New regulatory measures will follow the procedure outlined for amendments in

NMFS' *Operational Guidelines, Fishery Management Plans* (May 1, 1997 revision). A *Federal Register* notice will be published describing any proposed new management measure. The notice will solicit public comment. At the subsequent Council meeting, the Council will formally address the specific measure for which they will consider recommendations. A *Federal Register* notice will be prepared summarizing the Council's deliberations, rationale, and analysis of the preferred action, and include the time and place for any other Council meetings to consider the measure. At subsequent meetings, the Council will consider public comments and other information received and will draft a document with a recommendation to the NMFS Regional Administrator (RA).

The RA will propose regulations to carry out the action or offer a written explanation supporting the denial of the recommendation within two weeks of the decision. The Council may appeal a denial by writing to the Assistant Administrator. The Assistant Administrator must respond to the Council within 30 days. If the RA agrees with the recommendation, the RA and the Assistant Administrator will make their decision in accordance with the MSFCMA and other applicable laws. Finally, NMFS may implement any recommendation made by the Council by rule-making, if approved by the Regional Administrator.

2.5 Measures to Address Ecosystem Impacts of Existing FMP Fisheries

A formal process will be established (under the Council's Standard Operating Procedures and Practices) to coordinate the CRE-FMP with the Council's already-implemented Pelagics, Bottomfish, Crustaceans, and Precious Corals FMPs. Under this process, the Coral Reef Ecosystem Plan Team (CRE-PT) would coordinate with the existing FMP Plan Teams to recommend methods for minimizing identified impacts to the coral reef ecosystem (e.g., lobster trap impacts to reef habitat). The process is detailed in Section 5.5.3 of the CRE-FMP.

2.6 Management Measures Considered But Not Analyzed Further

Catch Restrictions Including Harvest Quotas: A harvest quota, which limits the amount of fish that may be landed within some time period (typically, a year) is the most common type of quantity control. Quotas can be set for all participants in a fishery or individual quotas can be assigned to fishermen or fishing groups. Bag or per-trip limits are a third type of catch restriction that limit individual catches during a narrowly defined time period, such as a fishing trip. These controls can be applied to species groups or to individual species. The underlying concept of allowable catches has been applied widely; as a result managers have conducted a lot of research on its effects. However, this approach is most widely implemented in temperate zone single-species fisheries.

Some managers favor catch quotas based on the premise that other ecological factors and interdependent stocks can be controlled through careful application of catch restrictions, but this type of quota requires a lot of information about the status of stocks. They are also complicated and expensive to enforce. These problems seriously limit their application to complexes, such as coral reef ecosystems, where fish assemblages are diverse and management agency budgets are often tight (Roberts and Polunin 1991). The high diversity of coral reef species and the variable

selectivity of fishing methods would require that catch quotas either be applied to the total catch from a given area or to selected species. Unless expensive biological surveys are conducted to set quotas, the average catch limit for a particular season or year is either reached within an unduly short time (after good recruitment) or it is never attained (after poor recruitment). Leaving aside limits on agency resources, the cost entailed in measuring all the relevant variables needed to calculate quotas for multi-resource, multi-gear, and data-poor coral reef fisheries would exceed any realistic capabilities or budget. Furthermore, quotas based on equilibrium yield models of particular resources would not necessarily prevent ecosystem overfishing.

Seasonal/Time Closures: A "rest period," when fishing for particular species is temporarily suspended, is a traditional resource management practice in Pacific Island fishing communities. This period can range from hours (prohibiting night fishing when fish are particularly vulnerable to capture, for example) to several months (coinciding with peak spawning periods, for example). Seasonal closures are most effective for species that fishermen can avoid capturing out of season or for species that can survive capture and release. Rather than directly monitoring fishing, seasonal closures for particular species can be enforced at fish landing sites and markets. Despite these advantages, more information is needed on the biology of many coral reef species in order to determine both rest period duration and locality, and the resulting benefits. Furthermore, complementary nearshore regulations, which would have to be implemented by states, would be necessary for effective enforcement.

Harvest Size Restrictions: Setting minimum or maximum sizes for landed organisms is another popular management tool. This approach is only enforceable when regulations apply to possession or sale, rather than harvesting itself. Minimum size restrictions discourage harvesting fish before they reach reproductive size. Maximum size restrictions, on the other hand, discourage taking the most fecund sizes, which contribute disproportionately to reproduction. Size limits may also postpone harvesting resident species that have a limited range. If a fish stock is depleted, increasing the spawning population has a clear benefit. If a stock is not depleted, the benefit of a minimum size limit is less predictable because the connection between spawning population size and future recruitment success is very tenuous. Size limits are enforced by monitoring landing sites. More information on life histories and other biological parameters (e.g., size at maturity) is needed before the proper size limits can be established for most reef species. Setting minimum/maximum sizes is difficult due to the multi-species nature of most coral reef fisheries. This management tool is most appropriate for monospecific stocks and less applicable to the ecosystem management approach.

Harvest Moratorium in all EEZ waters: Because the FMP review, approval, and implementation process is lengthy, there is some concern that in the interim there will be little control over harvesting of coral reef resources in the EEZ. A moratorium on harvesting would protect reef ecosystems until the FMP is implemented. The Secretary of Commerce has the authority to impose a moratorium, but such an action would require as much (and possibly more) justification as an FMP. Even if eventually approved, a moratorium would be controversial and approval could take as long or longer than the FMP approval and implementation.

2.7 Discussion of the Preferred Alternative

There is poor understanding of the basics, much less the intricacies, of coral reef ecosystems. Ecosystem-based management, therefore, can only be achieved over time as new information allows management to improve. It should be recognized that the technical data available for management decisions are almost always uncertain and incomplete. Hence, the group of control measures in Alternative 3, Substantial Additional Protection (the Preferred Alternative) was arrived at using the precautionary approach. The Council chose this combination of options by comparing different possible management measures. At each decision step, options bracketing different solutions and potential environmental, social and economic impacts were considered and preferred options were selected. If approved by the Secretary of Commerce, implementation of Alternative 3 would result in the four major regulatory actions just described: (1) designating "no-take" and "low-use" MPAs in parts of the EEZ; (2) permit and reporting requirements for harvesting EEZ coral reef resources (3) defining allowable gear and methods of fishing for coral reef resources in the EEZ; and, (4) applying other miscellaneous measures. These measures, taken together, reflect the ecosystem approach that has guided plan development. Recommendations made by the Ecosystem Principles Advisory Panel (EPAP 1999), in turn, guided this approach. For a full discussion of the FMP's management approach, see Section 1.5 in that document.

In selecting the management measures contained in this Preferred Alternative, the Council considered trade-offs of costs and benefits to various resources. These trade-offs can be summarized as: (1) between utilization of coral reef resources by controlled fishing versus preservation of coral reef ecosystems by minimal consumptive use; (2) between sustainable use of multi-resource coral reef ecosystems versus sustainable use of particular target resources; (3) between prevention of adverse fisheries impacts versus mitigation of damage; (4) between management actions now versus later; and, (5) between regulatory burdens on potential new coral reef fisheries versus burdens on existing fisheries. In general, the Council selected management measures that provide a balance between these often-conflicting concepts in a manner that meets the objectives of the CRE-FMP as outlined below.

Objective 1: To foster sustainable use of multi-species resources in an ecologically and culturally sensitive manner, through the use of the precautionary approach and ecosystem-based resource management.

Objective 2: To provide a flexible and responsive management system for coral reef resources that can rapidly adapt to changes in resource abundance, new scientific information, and changes in fishing patterns among user groups or by area.

Objective 3: To establish integrated resource data collection and permitting systems, establish a research and monitoring program to collect fishery and other ecological information, and to collect scientific data necessary to make informed management decisions about coral reef ecosystems in the EEZ.

Objective 4: To minimize adverse human impacts on coral reef resources by establishing new—and improving existing—marine protected areas, managing fishing pressure, controlling wasteful harvest practices, reducing other anthropogenic stressors directly affecting coral reef resources, and allowing the recovery of naturally-balanced reef systems. This objective includes the conservation and protection of essential fish habitats.

Objective 5: To improve public and government awareness and understanding of coral reef ecosystems and their vulnerability and resource potential in order to reduce adverse human impacts and foster support for management.

Objective 6: To collaborate with other agencies and organizations concerned with the conservation of coral reefs, in order to share in decision-making and to obtain and share data and resources needed to effectively monitor this vast and complex ecosystem.

Objective 7: To encourage and promote improved surveillance and enforcement to support the plan's management measures.

Objective 8: To provide for sustainable participation by fishing communities in coral reef fisheries and, to the extent practicable, minimize the adverse economic impacts on such communities.

2.7.1 Marine Protected Areas

No-take Marine Protected Areas

No-take marine protected areas are a powerful tool for ecosystem management because detailed knowledge of the management unit species is unnecessary in order to achieve conservation of multi-species resources, diverse habitats, and the functional attributes of marine ecosystems. The designation of no-take MPAs proposed by the FMP combines preferences for: (1) their location, (2) their extent, and (3) how seaward boundaries for no-take areas are best defined. As shown in Table 2.4, the CRE-FMP would designate a significant proportion of the Region's EEZ as no-take MPAs. If the State of Hawaii takes parallel action, so designating adjacent nearshore reefs around the NWHI, MPA coverage would almost double in that sub-region. (As federal jurisdiction extends to the shoreline in the PRIAs, the values in both columns of Table 2.4 remain the same for that sub-region.) Taken together, these designations represent an important step towards meeting the U.S. Coral Reef Task Force's goal of restricting access to 20% of the region's coral reefs over the next 10 years.

Table 2.4: Preliminary estimates of no-take MPAs as a percent of total reef area.

Area	Percent in Federal Waters	Percent in all waters (State and Federal)
NWHI	14%	24%
PRIAs	10%	10%
All WP Region	12%	15%

The Preferred Alternative's no-take areas were chosen to protect ecologically sensitive areas while allowing continued carefully controlled commercial bottomfish and lobster fisheries in the NWHI, as well as recreational fishing by visitors to Midway Atoll. The desire for continued recreational fishing by residents of Johnston Atoll and Wake Island, and establishing a recreational fishing program at Palmyra, were also taken into account in locating no-take MPAs.

Under the Preferred Alternative (3), the relevant isobath, or depth contour, would be used to delineate the seaward boundaries for no-take MPAs. Basing these seaward boundaries on either the closest State of Hawaii commercial catch reporting grid square inclusive of the relevant contours (for the NWHI) or on circles drawn around islands or banks that are inclusive of these areas was considered but was rejected due to the significantly larger closed area that would result. These approaches to boundary delineation would have a major impact on fisheries, and most of this additional closed area would be beyond the depth of coral reefs.

Amendments to Already-Implemented FMPs

The CRE-FMP designates no-take MPAs within the management area. Commercial, recreational, subsistence, or cultural take of any marine species within these areas is prohibited. No described or undescribed gear is exempt from this designation. Fisheries managed under the Council's four already-implemented FMPs [1] are mostly exempt from the regulations outlined in this CRE-FMP and will observe the management regime of their respective FMPs. No-take marine protected areas are the main exception; they will apply to all Council-managed fisheries. To ensure designated no-take MPAs effectively apply to all of the fisheries managed under Council FMPs, each of the four already-implemented FMPs must be amended to ensure the no-take status of these areas. The following four subsections describe these amendments.

[1] The Bottomfish and Seamount Groundfish, Crustaceans, Pelagics, and Precious Corals FMPs. Additionally, the Council is currently developing an amendment to the to include the CNMI and the PRIA under Council-developed FMPs and designating 26 additional bottomfish MUS. These FMPs and their fisheries are summarized in Chapter 3 of the EIS.

Amendment 7 to the Bottomfish and Seamount Groundfish FMP

It is prohibited to harvest the bottomfish management unit species listed in Table 2.5, and all future additions to the bottomfish MUS list, in no-take marine protected areas designated in the Coral Reef Ecosystem FMP, and in any marine protected areas that may be designated by amendment to the Coral Reef Ecosystem FMP. The locations of the no-take MPAs are:

(1) federal waters shallower than 10 fm in the Northwestern Hawaiian Islands;

(2) federal waters shallower than 50 fm around Jarvis Island (0°23' S, 160°01' W), Howland Island (0°48' N, 176° 38' W), Baker Island (0° 13' N, 176°38' W), Kingman Reef (6°23' N, 162°24' W), Laysan Island (25° 45' N, 171°45' W), French Frigate Shoals (23° 45' N, 166°15' W), the Northern half of Midway Atoll (28° 14' N, 177° 22' W), and Rose Atoll (14° 33' S, 168°09' W).

Table 2.5: Bottomfish management unit species list.

Scientific Name	English Common Name	Scientific Name	English Common Name
Aphareus rutilans	red snapper/silvermouth	*Pristipomoides auricilla*	yellowtail snapper
Aprion virescens	gray snapper/jobfish	*P. filamentosus*	pink snapper
Caranx ignobilis	giant trevally/jack	*P. flavipinnis*	yelloweye snapper
C. lugubris	black trevally/jack	*P. seiboldi*	pink snapper
Epinephelus fasciatus	blacktip grouper	*P. zonatus*	snapper
E. quernus	sea bass	*Pseudocaranx dentex*	thicklip trevally
Etelis carbunculus	red snapper	*Seriola dumerili*	amberjack
E. coruscans	red snapper	*Variola louti*	lunartail grouper
Lethrinus amboinensis	ambon emperor	*Beryx splendens*	alfonsin
L. rubrioperculatus	redgill emperor	*Hyperoglyphe japonica*	ratfish/butterfish
Lutjanus kasmira	blueline snapper	*Pseudopentaceros richardsoni*	armorhead

Amendment 11 to the Crustaceans FMP

It is prohibited to harvest the crustacean management unit species listed in Table 2.6, and all future additions to the crustacean MUS list, in no-take marine protected areas designated in the Coral Reef Ecosystem FMP, and in any marine protected areas that may be designated by amendment to the Coral Reef Ecosystem FMP. The locations of the no-take MPAs are:

(1) federal waters shallower than 10 fm in the Northwestern Hawaiian Islands;

(2) federal waters shallower than 50 fm around Jarvis Island (0°23' S, 160°01' W), Howland Island (0°48' N, 176° 38' W), Baker Island (0° 13' N, 176°38' W), Kingman Reef (6°23' N,

162°24' W), Laysan Island (25° 45' N, 171°45' W), French Frigate Shoals (23° 45' N, 166°15' W), the Northern half of Midway Atoll (28° 14' N, 177° 22' W), and Rose Atoll (14° 33' S, 168°09' W).

Table 2.6: Crustacean management unit species list.

Scientific Name	English Common Name
Panulirus marginatus	Spiny lobster
Panulirus penicillatus	Spiny lobster
Family Scyllaridae	Slipper lobster
Ranina ranina	Kona crab

Amendment 10 to the Pelagics FMP

It is prohibited to harvest the pelagic management unit species listed in Table 2.7, and all future additions to the pelagic MUS list, in no-take marine protected areas designated in the Coral Reef Ecosystem FMP, and in any marine protected areas that may be designated by amendment to the Coral Reef Ecosystem FMP. The locations of the no-take MPAs are:

(1) federal waters shallower than 10 fm in the Northwestern Hawaiian Islands;

(2) federal waters shallower than 50 fm around Jarvis Island (0°23' S, 160°01' W), Howland Island (0°48' N, 176° 38' W), Baker Island (0° 13' N, 176°38' W), Kingman Reef (6°23' N, 162°24' W), Laysan Island (25° 45' N, 171°45' W), French Frigate Shoals (23° 45' N, 166°15' W), the Northern half of Midway Atoll (28° 14' N, 177° 22' W), and Rose Atoll (14° 33' S, 168°09' W).

The Council also recommends that the Pelagic FMP be amended to specifically identify only the nine pelagic shark species that are to remain as Pelagic MUS. In doing so, all other oceanic sharks belonging to the families Alopiidae, Carcharhinidae, Sphyrnidae, and Lamnidae will be removed from the Pelagic MUS list at this time. The Council further recommended that all coastal shark species belonging to these families are to be managed under the CRE-FMP. Therefore, the Pelagic FMP is amended to:

(1) Remove all species of shark belonging to the families Alopiidae, Carcharhinidae, Sphyrnidae, and Lamnidae from the Pelagic MUS list except for the nine shark species listed in Table 2.7;

(2) Remove dogtooth tuna (*Gymnosarda unicolor*) from the Pelagic MUS list. (*Gymnosarda unicolor* is to be managed under the CRE-FMP.)

Table 2.7: Pacific Pelagic management unit species list, as amended.

Scientific Name	English Common Name	Scientific Name	English Common Name
Coryphaena spp.	Mahimahi (dolphinfishes)	*Isurus oxyrinchus*	Shortfin mako shark
Acanthocybium solandri	Wahoo	*Isurus paucus*	Longfin mako shark
Makaira mazara: *M. indica*	Indo-Pacific blue marlin Black marlin	*Lamna ditropis*	salmon shark
Tetrapturus audax	Striped marlin	*Thunnus alalunga*	Albacore
T. angustirostris	Shortbill spearfish	*T. obesus*	Bigeye tuna
Xiphias gladius	Swordfish	*T. albacares*	Yellowfin tuna
Istiophorus platypterus	Sailfish	*T. thynnus*	Northern bluefin tuna
Alapias pelagicus	Pelagic thresher shark	*Katsuwonus pelamis*	Skipjack tuna
Alopias superciliousus	Bigeye thresher shark	*Euthynnus affinis*	Kawakawa
Alopias vulpinus	Common thresher shark	*Lampris* spp.	Moonfish
Carcharhinus falciformis	Silky shark	Gempylidae	Oilfish family
Carcharhinus longimanus	Oceanic whitetip shark	family Bramidae	Pomfret
Prionace glauca	Blue shark	*Auxis* spp., *Scomber* spp.; *Allothunus* spp.	Other tuna relatives

Amendment 5 to the Precious Corals FMP

It is prohibited to harvest the precious corals management unit species listed in Table 2.8, and all future additions to the precious corals MUS list, in no-take marine protected areas designated in the Coral Reef Ecosystem FMP, and in any marine protected areas that may be designated by amendment to the Coral Reef Ecosystem FMP. The locations of the no-take MPAs are:

(1) federal waters shallower than 10 fm in the Northwestern Hawaiian Islands;

(2) federal waters shallower than 50 fm around Jarvis Island (0°23' S, 160°01' W), Howland Island (0°48' N, 176° 38' W), Baker Island (0° 13' N, 176°38' W), Kingman Reef (6°23' N, 162°24' W), Laysan Island (25° 45' N, 171°45' W), French Frigate Shoals (23° 45' N, 166°15' W), the Northern half of Midway Atoll (28° 14' N, 177° 22' W), and Rose Atoll (14° 33' S, 168°09' W).

Table 2.8: Precious corals management unit species list.

Scientific Name	English Common Name	Scientific Name	English Common Name
Corallium secundum	Pink coral (also known as red coral)	*Lepidisis olapa*	Bamboo coral
Corallium regale	Pink coral (also known as red coral)	*Acanella* spp.	Bamboo coral
Corallium laauense	Pink coral (also known as red coral)	*Antipathes dichotoma*	Black coral
Gerardia spp.	Gold coral	*Antipathes grandis*	Black coral
Narella spp.	Gold coral	*Antipathes ulex*	Black coral
Calyptrophora spp.	Gold coral		

Low-use Marine Protected Areas

Zone-based management, where particular areas are designated for prescribed uses, is an important principal in ecosystem-based fishery management (EPAP 1999). The Preferred Alternative designates all the coral reefs in the EEZ around the NWHI (to a depth of 50 fm), which are not already designated no-take MPAs, as low-use MPAs. Low-use MPAs are also designated for coral reefs in the EEZ around Palmyra, Johnston and Wake atolls.

The seaward boundaries for all low-use MPAs would extend to a uniform depth of 50 fm. Generally, the inner boundary of low-use MPAs coincides with the outer boundary of no-take MPAs, or at 10 fm, and to a depth of 50 fm. (In those areas where no-take MPAs extend to 50 fm, no-take MPAs are not designated.) Low-use MPAs would begin at the shoreline at the southern half of Midway Atoll, and Palmyra, Johnston and Wake.

Summary: Marine Protected Areas

A zone-based management approach is applied to MPA design and designation. Under the Preferred Alternative, all EEZ coral reefs in unpopulated areas—that is, in the NWHI, PRIAs, and Rose Atoll in American Samoa—would be designated MPAs. The outer boundary for these MPAs is the 50 fm isobath. Two types of MPAs are proposed: no-take and low-use. This recommendation is incorporated in the CRE-FMP through low-use marine protected areas. The designation of marine protected areas combines preferences for: (1) their location; (2) their extent; and, (3) how seaward boundaries for low-use MPAs are best defined. No fishing is allowed in no-take MPAs, including that by existing FMP fisheries. No-take MPAs are delineated by the 10 fm isobath except for certain ecologically sensitive areas where the boundary is extended to the 50 fm isobath. These areas are French Frigate Shoals, Laysan Island, the northern half of Midway Atoll and Jarvis, Howland and Baker Islands, Kingman Reef, and Rose Atoll. The remaining EEZ waters around the NWHI and PRIAs (within the 50 fm isobath) would become low-use MPAs, where fishing is tightly controlled by special permits and conditions.

All extractive activities would be prohibited in no-take MPAs, except for small harvests related to scientific research and resource management. In low-use MPAs existing fishing activities, including other FMP fisheries and recreational fisheries by residents on certain remote islands, would be allowed. The permit regime and its specific exemptions, outlined below, would regulate these activities but allow certain indigenous or cultural uses.

Using the framework process, vessel anchoring areas may be designated in MPAs at a future date. The only immediate restriction proposed in the CRE-FMP would be an anchoring ban for large fishing vessels at Guam's southern banks. (This area is not designated an MPA, however.) Fishing vessels transiting MPAs would be required to carry insurance in order to pay for the costs of vessel removal and habitat damage mitigation in the event of a grounding. The Council felt that prohibiting large non-fishing vessels, and in particular cruise ships, from entering MPAs would be beneficial. However, the Council does not have the authority to regulate these vessels. Several longer term, cooperative efforts are proposed to manage the potential impacts of these vessels.

2.7 Permits and Reporting

The Preferred Alternative (3) would implement permit requirements for the harvest of coral reef resources in the low-use MPAs that would be designated in the EEZ around the NWHI, Palmyra Atoll, Johnston Atoll, and Wake Island. Vessels regulated and targeting species managed by other FMPs would be exempt from this requirement. However, they would continue to report any incidental harvest of coral reef ecosystem MUS. Permit and reporting requirements for the region's remaining EEZ waters would be administered by local jurisdictions. They would also continue permitting and monitoring the harvest of CHCRT in areas adjacent to inhabited islands since these areas are managed under local laws and regulations.

However, the Preferred Alternative (3) would also require detailed permit and reporting for PHCRT throughout the Region's EEZ. In this manner, the expanding marine ornamentals fishery and emerging bioprospecting industries, which target a broader spectrum of coral reef resources including species about which little is known, can be controlled and managed appropriately.

Due to their ecological vulnerability, the Preferred Alternative (3) would prohibit the of collection live stony coral or live rock for commercial purposes, except small amounts to be collected under a special permit for use as seed stock for aquaculture and for traditional and ceremonial purposes by indigenous peoples.

Summary: Permits and Reporting

In populated areas, permitting and reporting of CHCRT would be conducted through existing local monitoring programs, although under the Preferred Alternative's framework provisions, a general permit could be developed and implemented for all EEZ coral reef resources at a later date, if needed. In unpopulated areas where MPAs, would be designated, special permits would regulate the harvest of these resources. Additionally, special permits would also be required to

harvest any PHCRT. However, permit holders in other FMP-managed fisheries would not have to obtain an additional permit for the incidental catch of coral reef taxa. Scientific collection of coral reef resources in both no-take and low-use MPAs could occur, if approved by the NMFS RA. These scientific permits are separate from the special permit regime that would be implemented by the CRE-FMP.

In addition, the harvest of live rock and coral would also be specifically prohibited. However, limited harvest of live rock and coral could be allowed via the special permit for traditional and ceremonial indigenous purposes and seed stock for aquaculture operations. They could also be collected under the aforementioned scientific permit.

2.7.3 Allowable Gears and Methods

Adverse impacts from fishing gear may include physical, chemical or biological alterations of the substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other components of the ecosystem. Controls on fishing gear and methods are an effective tool for mitigating such impacts.

The Preferred Alternative's list of allowable gears is based first on a consideration of the potential of the gear to minimize damage to EFH. Use of poisons, explosives and intoxicating substances, methods of choice for harvesting live reef fish in Southeast Asia, would not be allowed. Nets would be allowed only if they are tended and if their retrieval does not break coral and damage bottom habitat (e.g., purse nets/surround nets for baitfish, akule, weke). Traps would be allowed in areas and under conditions where there is low potential for damage to EFH and gear loss. (Traps must also be permanently marked to identify their owners.) Manned and remotely-operated submersibles have minimal adverse effects on EFH and they too are allowed.

A second criterion for allowable gear is its catch selectivity. Hand harvest, spear, slurp gun, hand net, dip net, hoop net (for Kona crab), throw net, barrier net (for aquarium fish) are selective types of gear that would be allowed. Manned and remotely-operated submersibles are also highly selective, producing negligible bycatch. Surround nets and seines can be used to target schooling fish species (e.g., akule, weke, taape, baitfish) with a minimum of non-target catch and would be allowed for this purpose. The selectivity of traps varies with fishing techniques and species preferences by seafood consumers in the different island groups of the U.S. Pacific. Non-targeted species of fish can be released alive if carefully handled. The selectivity of hook-and-line gear (including handlines, electrically and hydraulically retrieved lines, rod-and-reel and trolling) varies enormously, depending on the skill and knowledge of the individual fisherman. Amateur fishermen casting from shore will catch a variety of wanted and unwanted fish species. Bottomfishing vessels are often equipped with electronic navigational devices to relocate fishing areas, and sonar devices to target productive habitat and fish aggregations. This gear is relatively selective, with the ability to successfully target particular species groups depending on the skill of the vessel captain. Experienced vessel crew have the ability to catch the desired species with little non-target catch. It is, however, impossible to completely avoid non-target species with most hook-and-line fishing methods. Despite variations in selectivity, all types of hook-and-line methods are allowed because of their low impact.

Although spearfishing is a highly selective method of fishing that has little adverse impact on EFH, the Preferred Alternative (3) would allow scuba-assisted fishing in the EEZ around the NWHI and PRIAs only during daylight hours. This is because, when used at night, this method allows no refuge for target species, which are captured while sleeping.

Summary: Allowable Gears and Methods

In order to minimize resource and habitat impacts, three conditions on gear use are incorporated into the Preferred Alternative (3). There is a list of allowable gear types, which includes the following:

1. hand harvest;
2. spear;
3. slurp gun;
4. hand/dip net;
5. hoop net (for Kona crab);
6. throw net;
7. barrier net for aquarium fish;
8. surround/purse set net for targeted schooling fish (e.g., akule, baitfish, weke) with a minimum of bycatch and must be attended by swimmers or divers at all times;
9. hook-and-line (powered and unpowered handlines, rod and reel, and trolling);
10. traps (with conditions); and,
11. remote operating vehicles/submersibles.

There are several gears specifically prohibited for the harvest of coral reef ecosystem management unit species: gillnets, trawls, dredges, tanglenets, longlines, explosives, and poisons. Scuba-assisted spear fishing is prohibited at night in EEZs of the PRIAs and the NWHI.

Submersible supported studies conducted in 2001 at precious coral beds in the MHI and bottomfishing banks in the NWHI have reported minimal evidence of fishing impacts to habitat (R. Grigg pers comm. 2001 and C. Kelley pers comm. 2001). However, the Council remains concerned with issues regarding gear impacts on habitat. Therefore, the Council has proposed habitat and stock assessment projects to obtain information regarding coral reef habitats, including impacts of benthic fisheries on coral reef ecosystems (see section 7 of the FMP). Additionally, a Council appointed Coral Reef Ecosystem Plan Team will prepare annual reports to assess coral reef ecosystem-level impacts associated with fishing activities regulated under this and other plans.

2.7.4 Other (Miscellaneous) Management Measures

As discussed above, the Preferred Alternative would allow only small collections of coral reef organisms for aquaculture seed stock, scientific research, bioprospecting, and cultural or indigenous uses. A special permit would be required for these activities. In addition, fishing vessels transiting through MPAs would be required to carry insurance to cover the cost of wreck removal and pollution liability in the event of grounding. Finally, it would create a no-anchoring zone on offshore banks south of the island of Guam for fishing vessels longer than 50 ft.

2.7.5 Summary of the Preferred Alternative

The Preferred Alternative's combination of management measures should provide more protection and enable better management of the region's coral reef ecosystem resources. The Coral Reef Ecosystem FMP would use harvest controls and careful monitoring in use of these vital resources.

Figure 2.1: NWHI Marine Protected Area (MPA) Map legend.

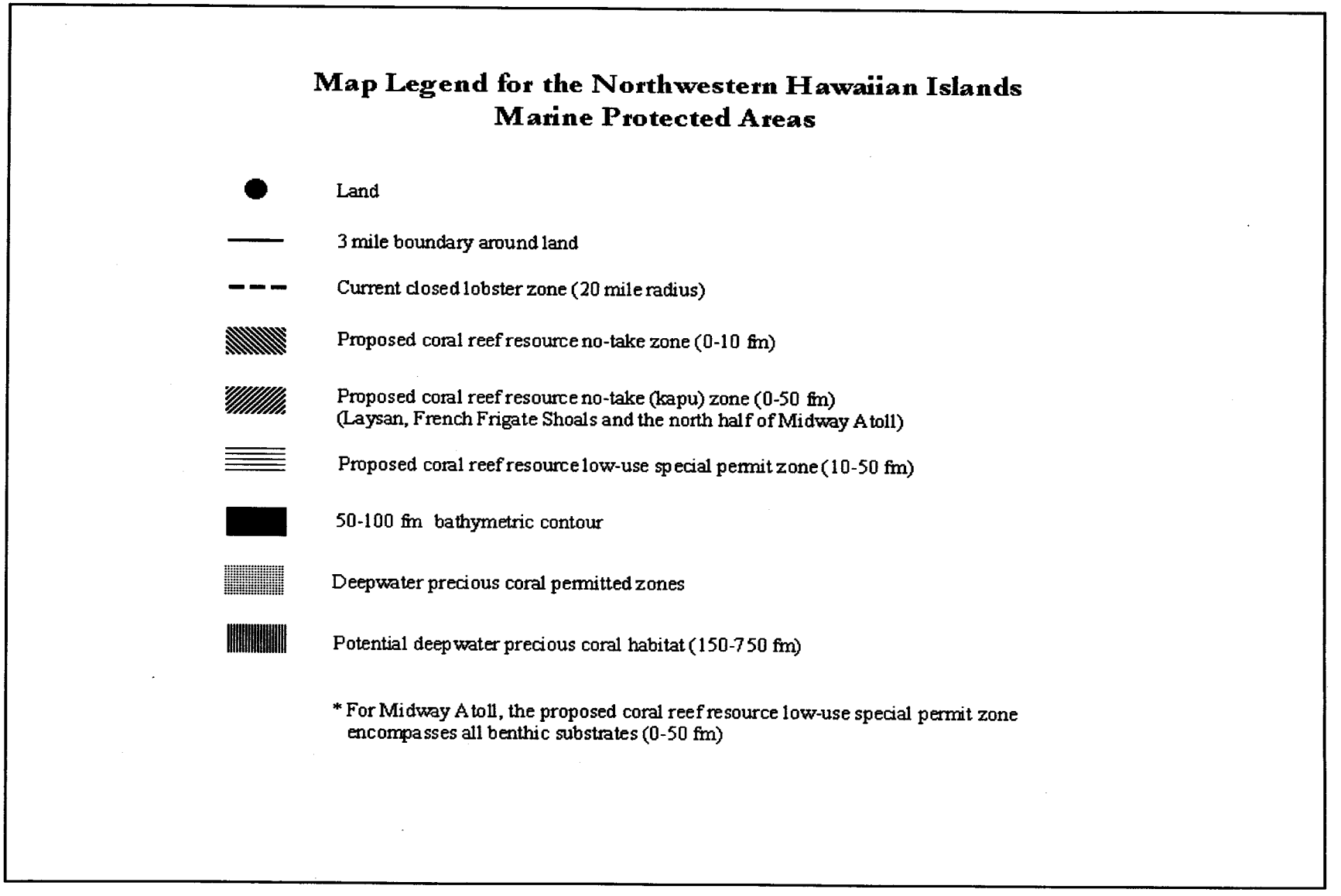


Figure 2.2 : Nihoa to Necker Island Marine Protected Area.

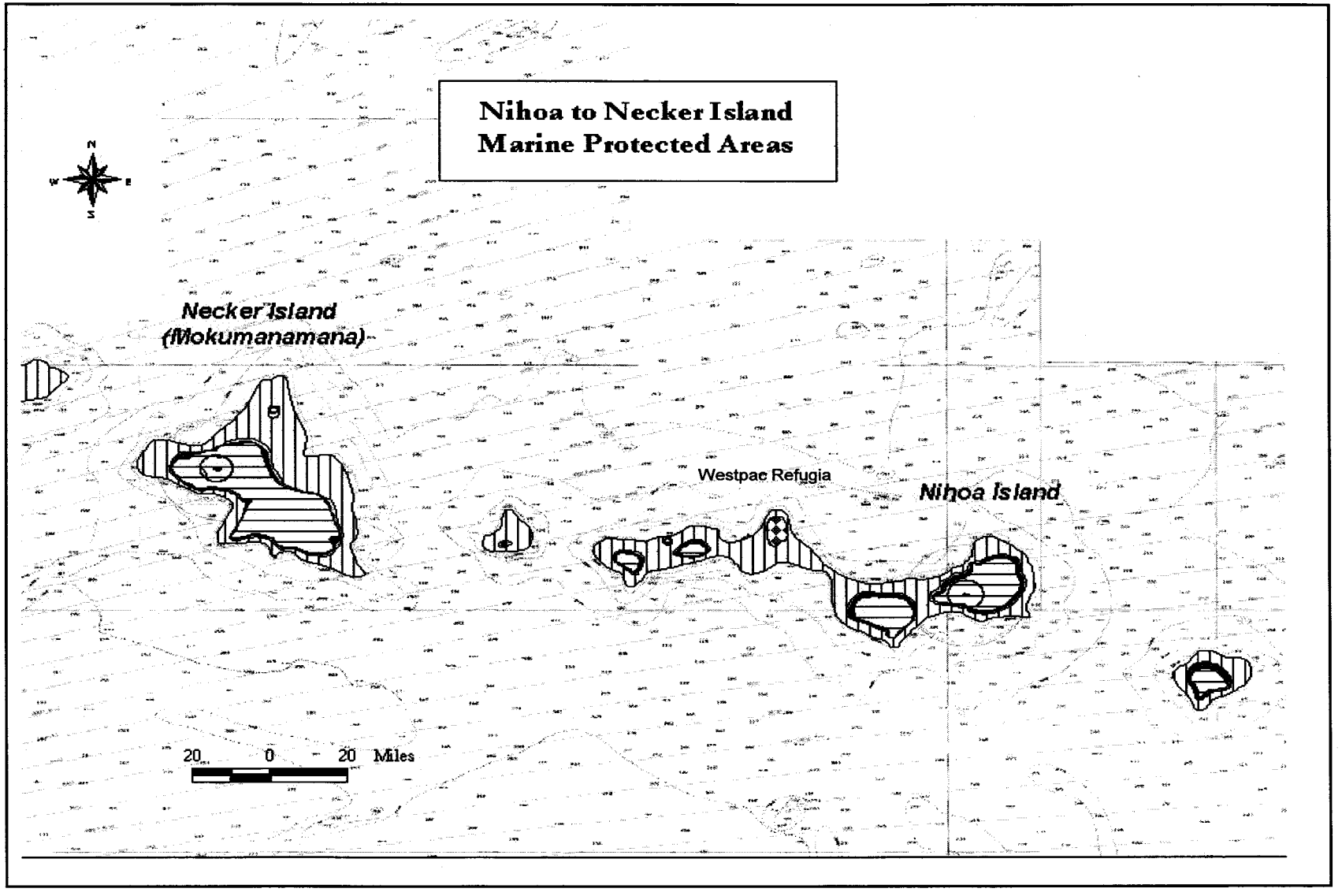


Figure 2.3: French Frigate Shoals to Raita Bank Marine Protected Area.

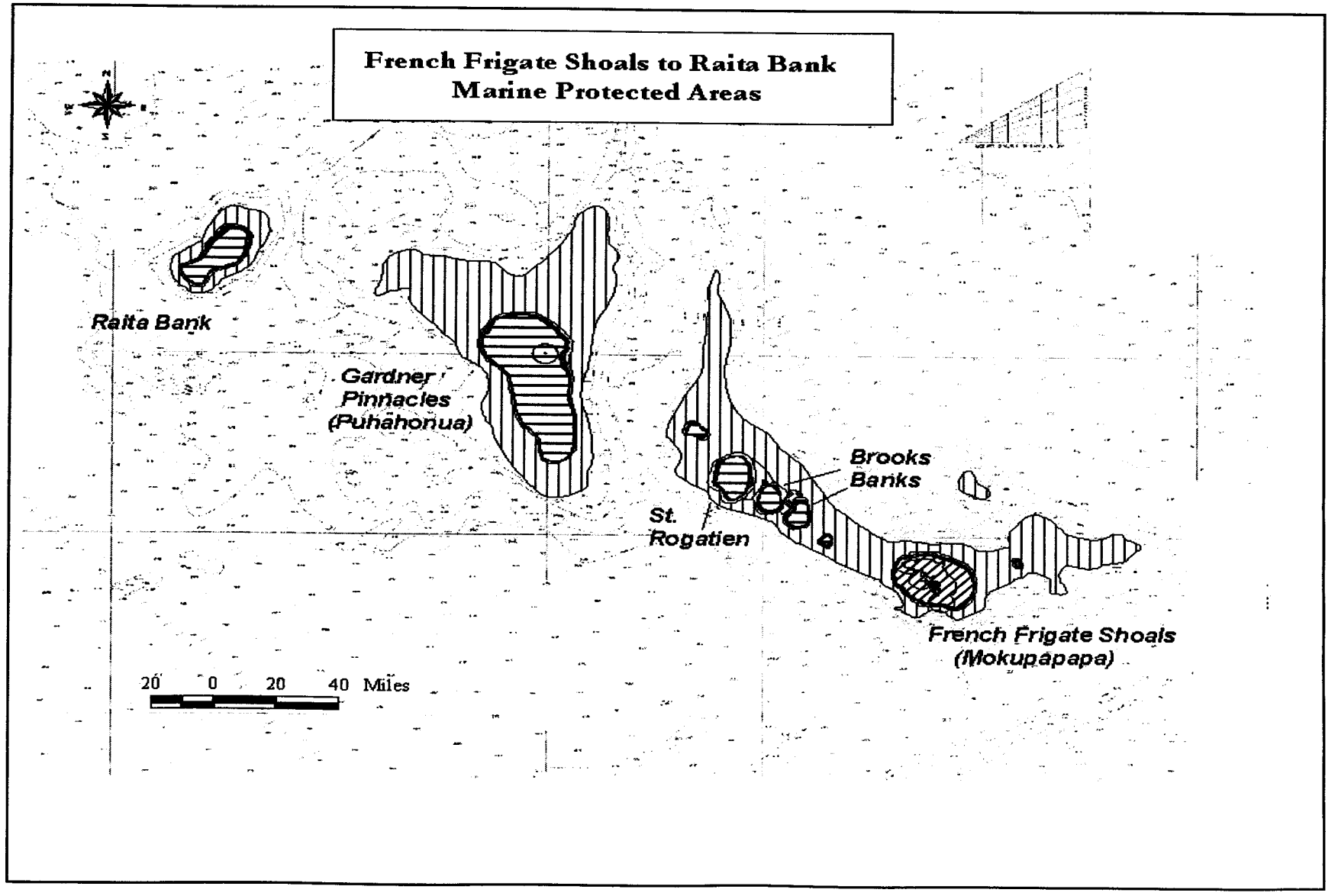


Figure 2.4: Maro Reef to Lisianski Island Marine Protected Area.

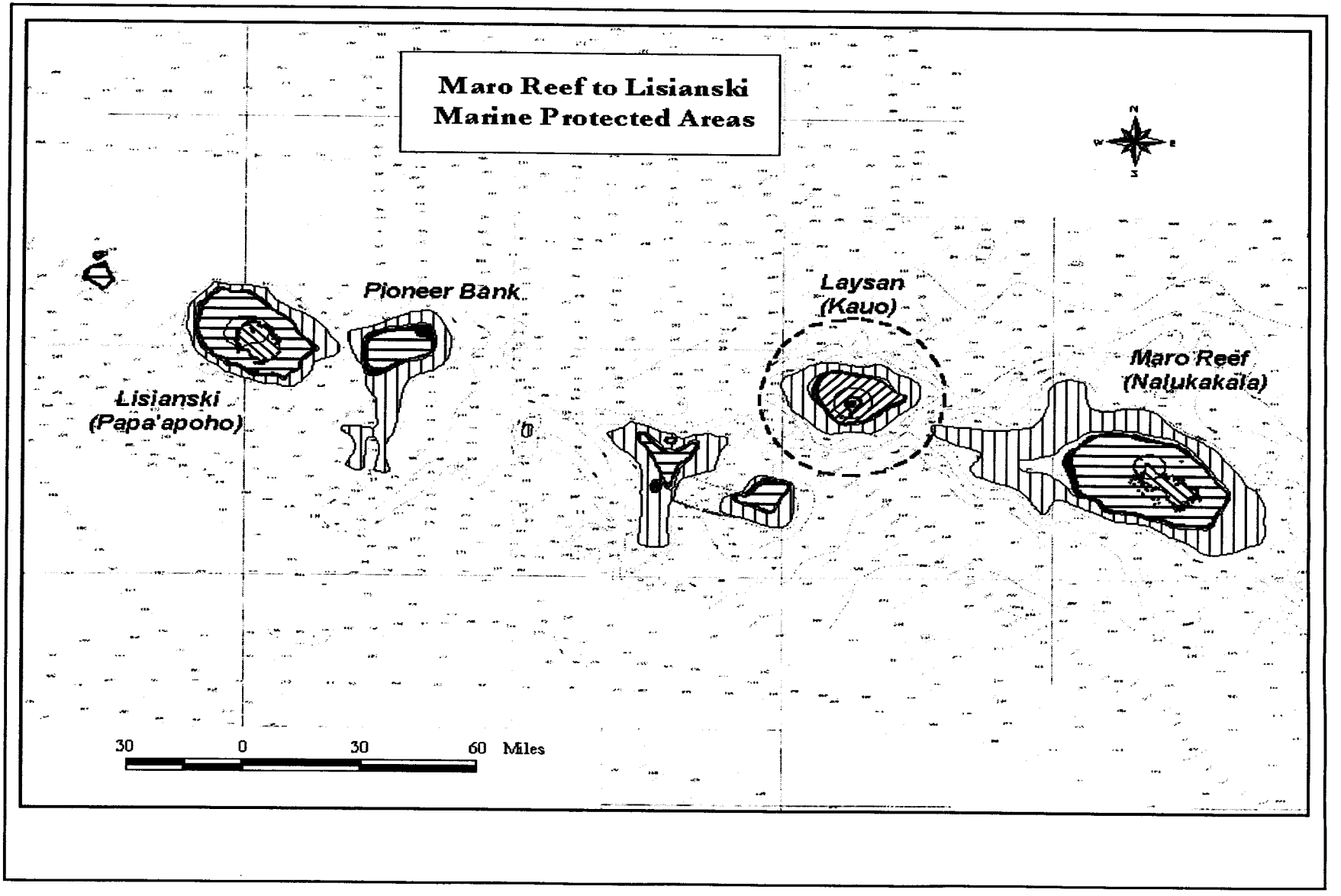


Figure 2.5: Pearl and Hermes Reef to Midway Atoll Marine Protected Area.

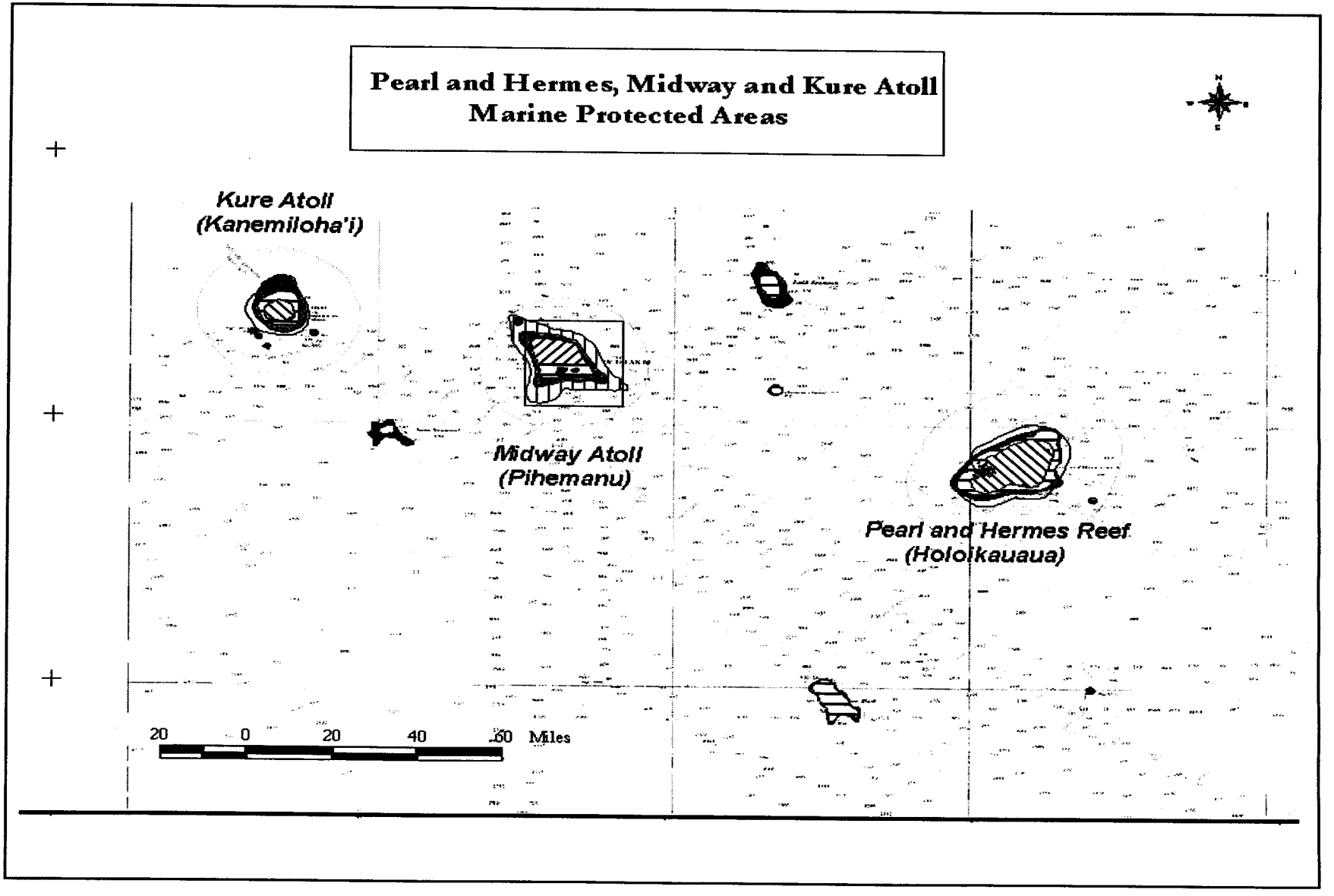


Figure 2.6: Rose Atoll Marine Protected Area.

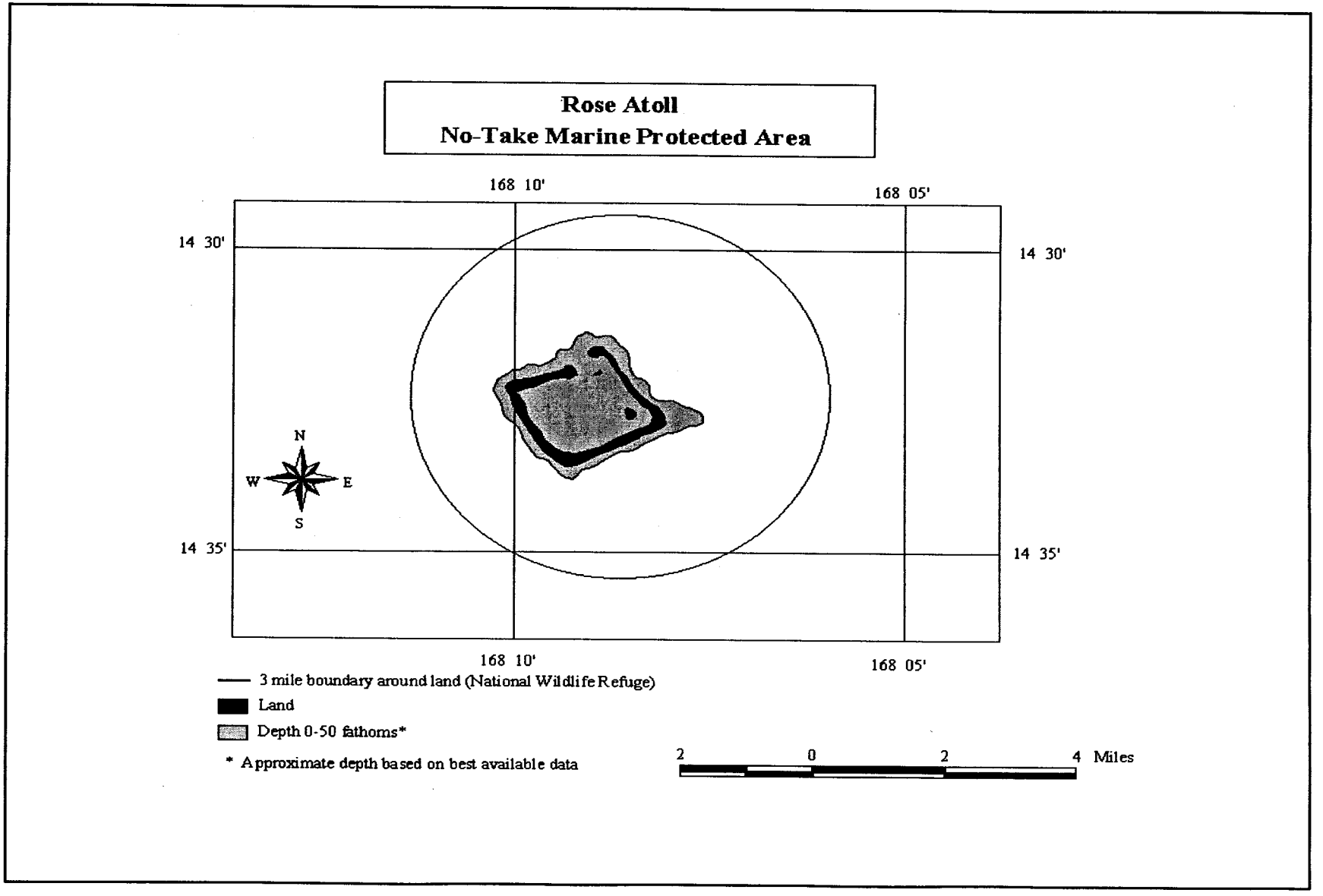


Figure 2.7: Howland Island Marine Protected Area.

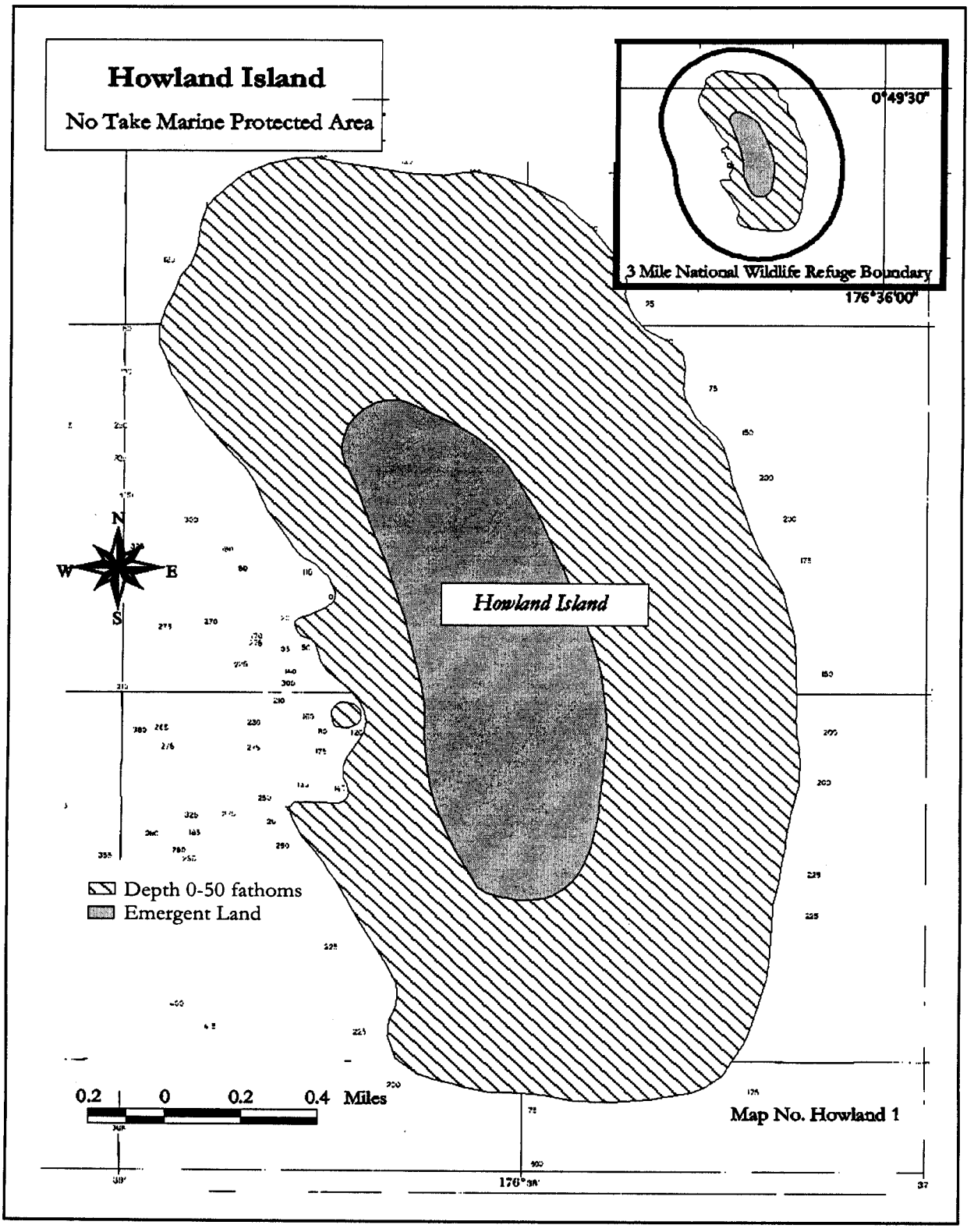


Figure 2.8: Baker Island Marine Protected Area.

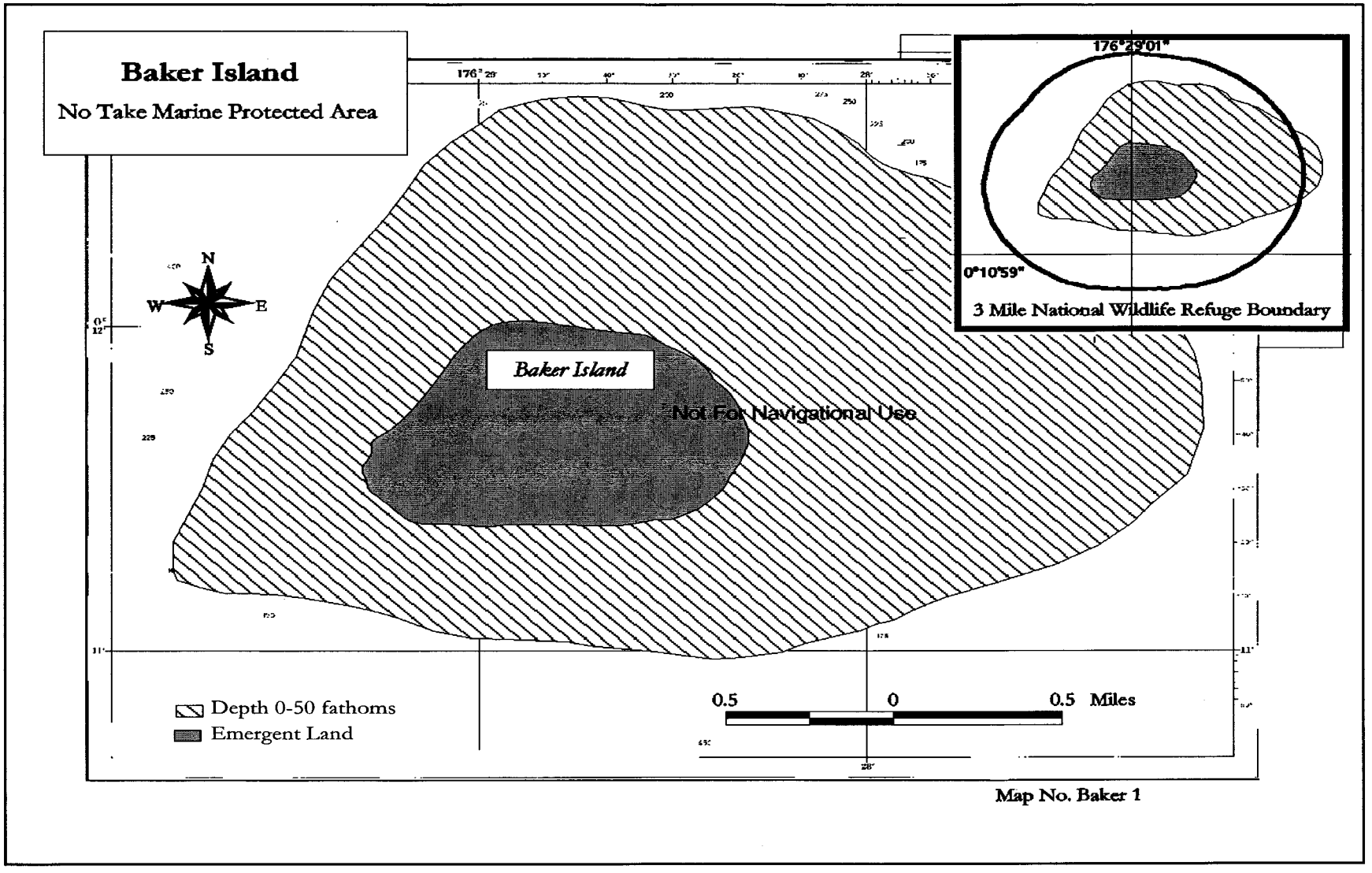


Figure 2.9: Jarvis Island Marine Protected Area.

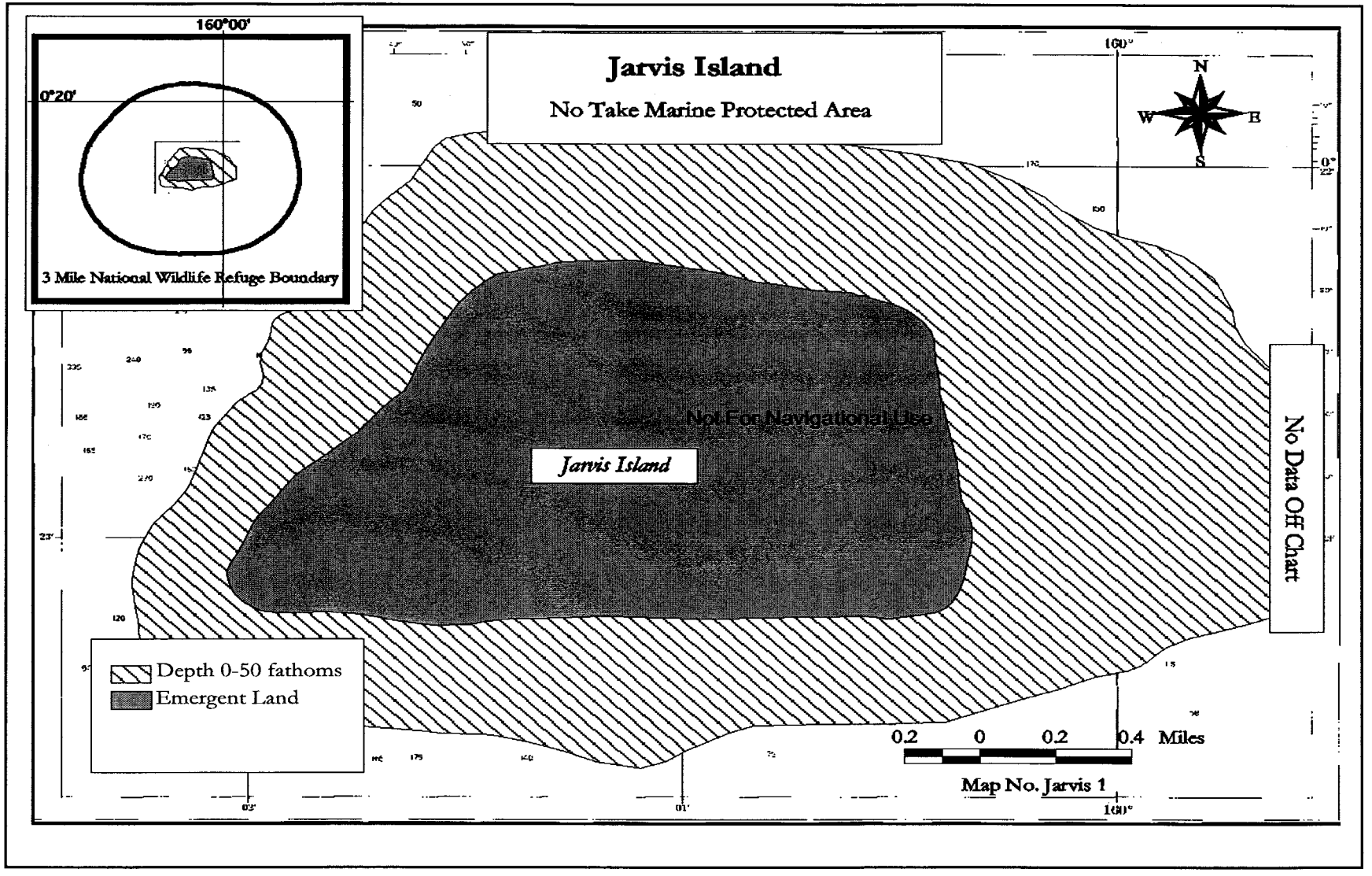


Figure 2.10: Kingman Reef Marine Protected Area.

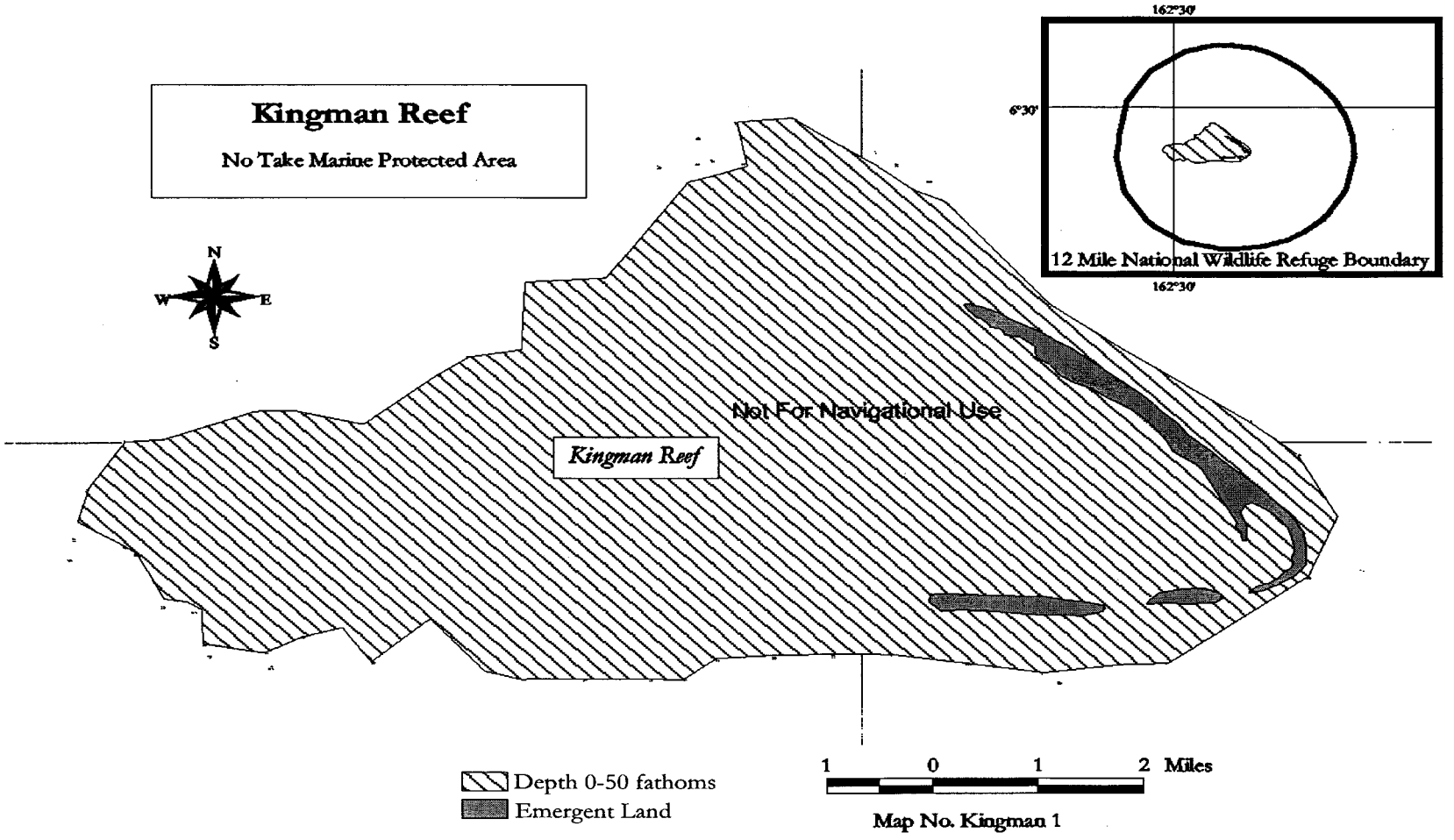


Figure 2.11: Palmyra Atoll Marine Protected Area.

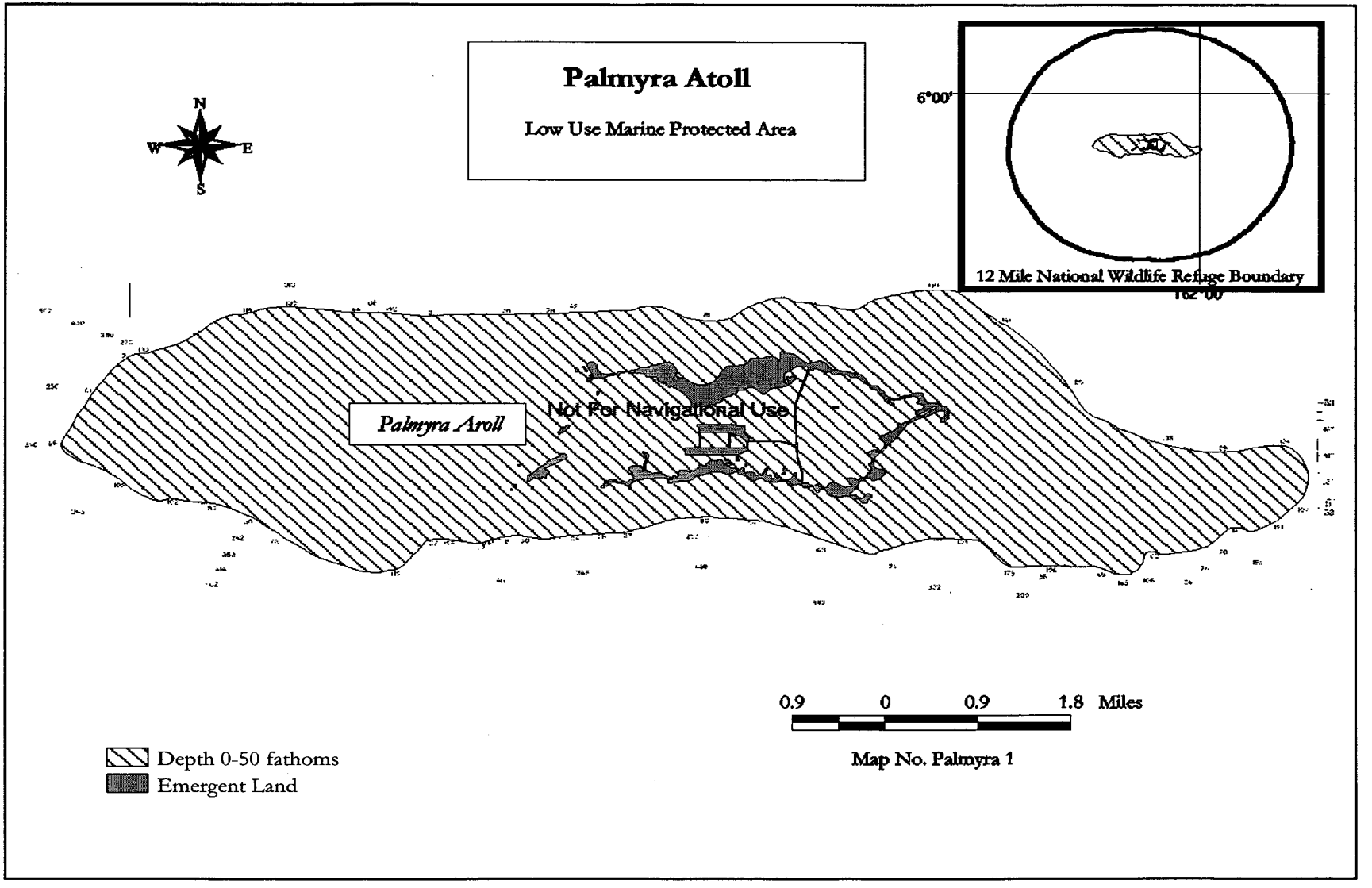


Figure 2.12: Wake Island Marine Protected Area.

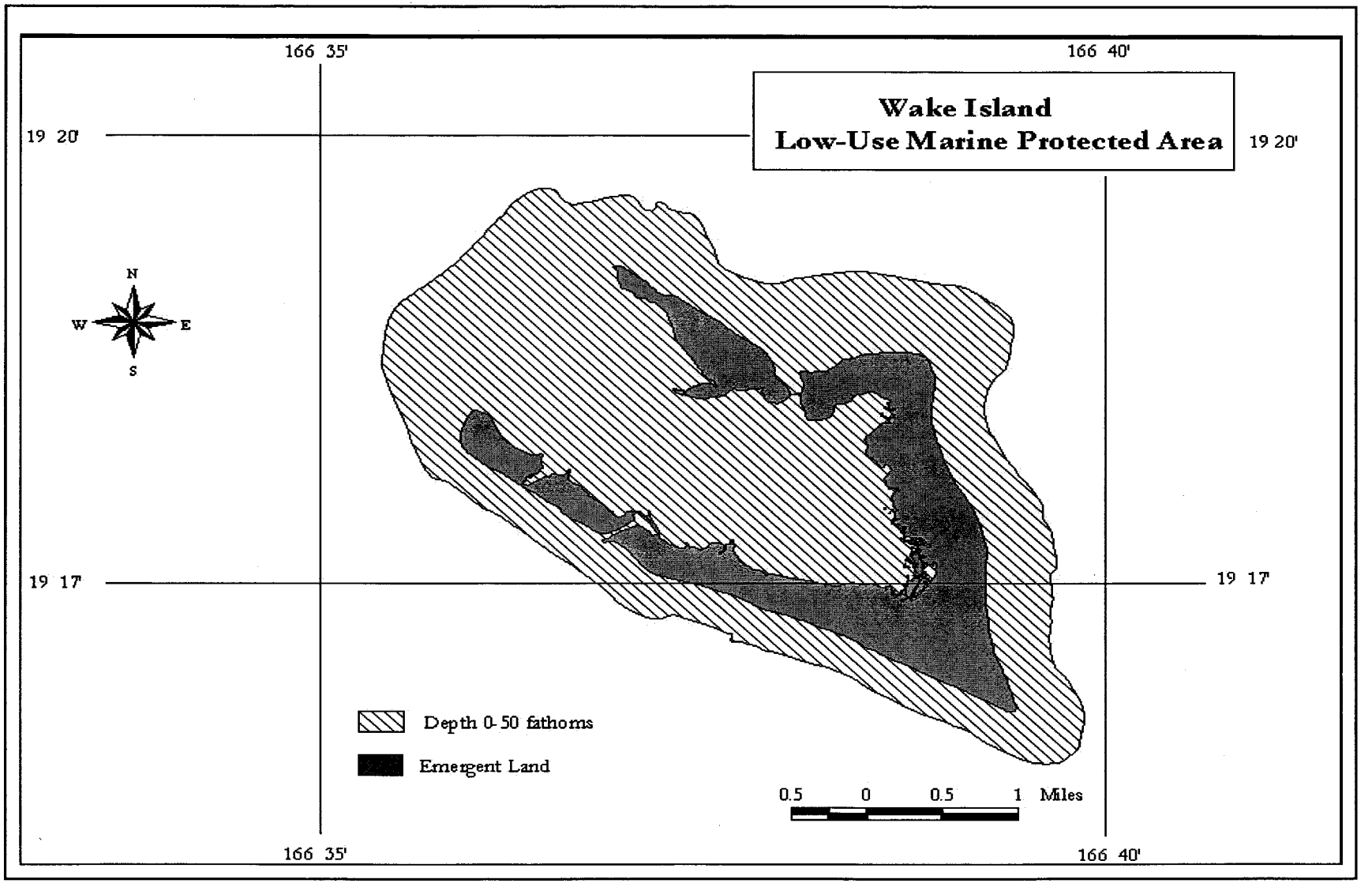
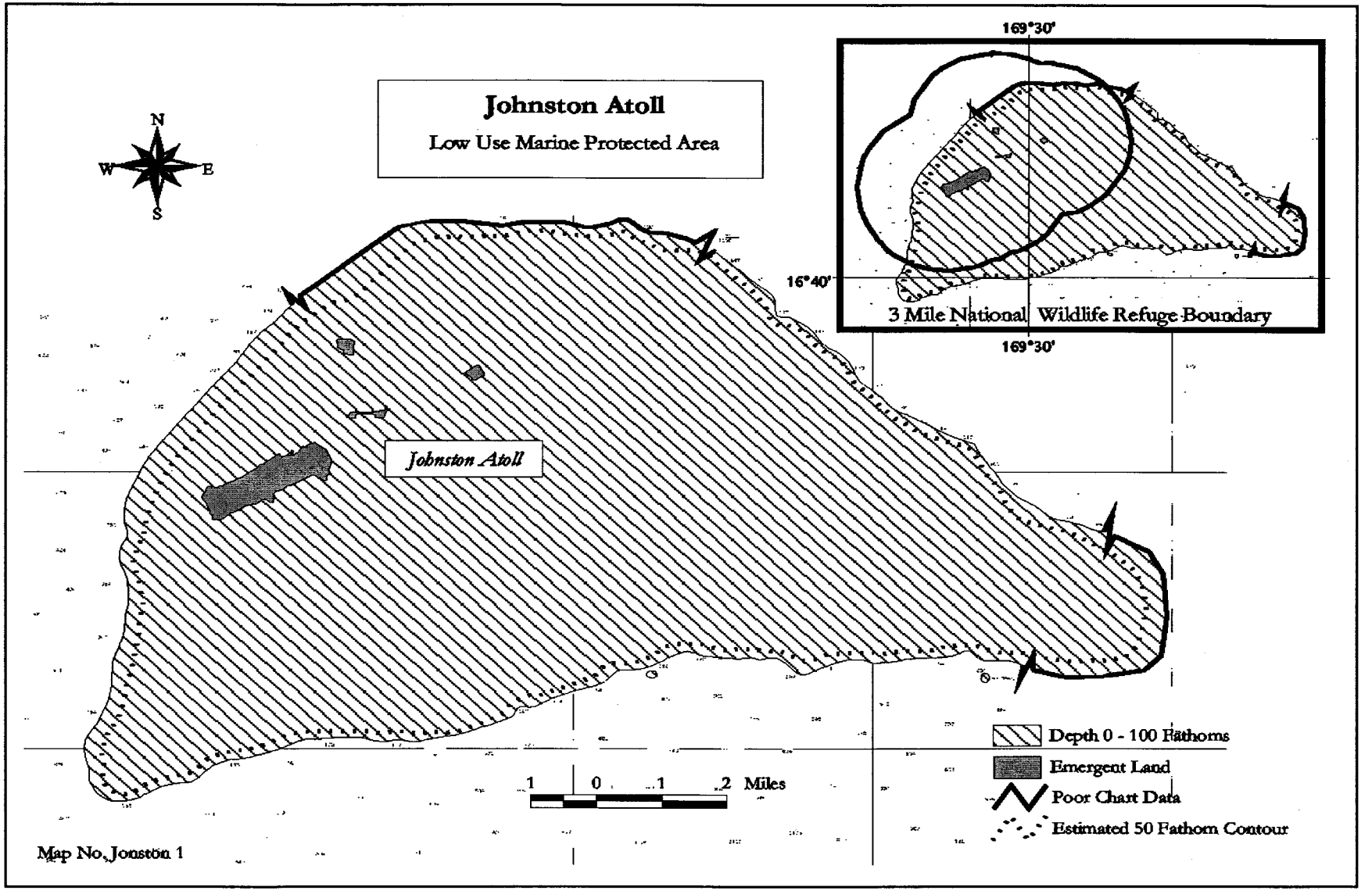


Figure 2.13 : Johnston Atoll Marine Protected Area.



CHAPTER 3

CORAL REEFS: THE ECOLOGICAL, FISHERIES AND SOCIAL CONTEXT

3.1 Introduction

This chapter describes the setting for management or, in the language of NEPA, the affected human environment. It forms the basis for the analysis of environmental consequences described and discussed in Chapters 4 and 5. This chapter is divided into three sections, which cover different aspects of the human environment. The first section details the biology and ecology of coral reefs in the Western Pacific Region, including the natural perturbations that can affect coral reef condition. The second section looks at the nature and value of fisheries currently managed by the Council. It also describes the other Council-managed fisheries. The third section details economic conditions and reef resource uses in each of the jurisdictions under the Council. It ends with a brief discussion of jurisdictional issues.

3.2 The Ecological Context

3.2.1 The Coral Reef Ecosystem

Coral reefs are carbonate rock structures at or near sea level that support viable populations of scleractinian or reef-building corals. Apart from a few exceptions, coral reefs are confined to the warm tropical and sub-tropical waters lying between 30° N and 30° S. Coral reef ecosystems are arguably the oldest and certainly the most diverse and complex ecosystems on earth. Their complexity is manifest on all conceptual dimensions, including geological history, growth and structure, biological adaptation, evolution and biogeography, community structure, organism and ecosystem metabolism, physical regimes, and anthropogenic interactions (see sources cited by Hatcher *et al.* 1989). There is a voluminous and *expanding* literature on coral reefs and coral reef ecosystems (Birkeland 1997b), beginning with Charles Darwin's 1842 volume, *The Structure and Distribution of Coral Reefs*, which remains the seminal volume on reef formation and structure, including reefs in the Western Pacific Region. The symbiotic relationship between the animal coral polyps and algal cells known as zooxanthellae is a key feature of reef building corals. Incorporated into the coral tissue, these photosynthesizing zooxanthellae provide much of the polyp's nutritional needs, primarily in the form of carbohydrates. Most corals supplement this food source by actively feeding on zooplankton or dissolved organic nitrogen, due to the low nitrogen content of the carbohydrates derived from photosynthesis.

The corals and coral reefs of the Pacific are described in Wells and Jenkins (1988) and Veron (1995). The number of coral species declines in an easterly direction across the western and central Pacific in common with the distribution of fish and invertebrate species. Over 330 species are contained in 70 genera on the Australian Barrier Reef, compared with only 30 coral genera present in the Society Islands of French Polynesia, and 10 genera in the Marquesas and Pitcairn Islands. Hawaii, by virtue of its isolated position in the Pacific, also has relatively few species of coral (about 50 species in 17 genera) and, more importantly, lacks most of the branching or "tabletop" *Acropora* species that form the majority of reefs elsewhere in the Pacific. The *Acropora* species provide a large amount of complex three-dimensional structure and protected habitat for a wide variety of fishes and invertebrates. As a consequence, Hawaiian coral reefs provide limited 'protecting' three-dimensional space. This is thought to account for the exceptionally high rate of endemism among Hawaiian marine species. Further, many believe that this is the reason certain fish and invertebrate species look and act very differently from similar members of the same species found in other parts of the South Pacific (Gulko 1998).

Most forms of coral reef development can be found in the Western Pacific Region, including barrier reefs in Guam and Saipan, fringing reefs in the Samoas and Hawaii, and patch and submerged reefs, banks and shoals throughout the region, but particularly abundant in the NWHI and within the EEZ of the Northern Mariana Islands. Other habitats commonly associated with coral reefs include mangrove forests, particularly in estuarine areas. The natural eastern limit of mangroves in the Pacific is American Samoa, although the red mangrove *Rhizophora mangle*, was introduced into Hawaii in 1902, and has become the dominant plant within a number of large protected bays and coastlines on both Oahu and Molokai (Gulko 1998). Apart from the usefulness of the wood for building, charcoal, and tannin, mangrove forests stabilize areas where sedimentation is occurring and, from a fisheries perspective, are important as nursery grounds for peneaeid shrimps and some inshore fish species, and form the habitat for some commercially valuable crustaceans.

Sea grasses are common in all marine ecosystems and are a regular feature of most of the inshore areas adjacent to coral reefs in the Pacific Islands. According to Hatcher *et al.* (1989), sea grasses stabilize sediments because leaves slow current flow, thus increasing sedimentation of particles. The roots and rhizomes form a complex matrix that binds sediments and stops erosion. Sea grass beds are the habitat of certain commercially valuable shrimps, and provide food for reef-associated species such as surgeonfishes (Acanthuridae) and rabbitfishes (Siganidae). Sea grasses are also important sources of nutrition for higher vertebrates such as dugongs and green turtles. A concise summary of the seagrass species found in the western tropical South Pacific is given by Coles and Kuo (1995). From the fisheries perspective, the fishes and other organisms harvested from the reef coral and associated habitats such as mangroves, seagrass beds, shallow lagoons, bays, inlets and harbors, and the reef slope beyond the limit of coral reef growth, contribute to the total yield from coral reef-associated fisheries. Unlike other Council FMPs, which are broadly species-based, this FMP is ecosystem-based. It is concerned not only with the health of target stocks, but also with the preservation of the coral reef ecosystems within the Western Pacific Region. To do this requires an understanding of the ecosystem components and how these various components interact.

Reef Productivity

Coral reefs are among the most biologically productive ecosystems in the world. The global potential for coral reef fisheries has been estimated at nine million metric tons per year, which is impressive given the small area of reefs compared to the extent of other marine ecosystems, which collectively produce between 70 - 100 million metric tons per year (Munro 1984; Smith 1978). An apparent paradox of coral reefs, however, are their location in the nutrient deserts of the tropical oceans. In these areas the water is very clear because gross primary productivity is low, generally ranging between 20 to 50 $gCm^{-2}yr^{-1}$. Coral reefs themselves are characterized by the highest gross primary production in the sea, with reef flats and margins sustaining primary production rates of between 1,800-3,700 $gCm^{-2}yr^{-1}$, and sand and rubble zones about 370 $gCm^{-2}yr^{-1}$. The main primary producers on reefs are the benthic microalgae, macroalgae, symbiotic microalgae of corals, and other symbiont-bearing invertebrates. Zooxanthellae living in the tissues of hard corals make a substantial contribution to primary productivity in zones rich in corals due to their density—greater than 10^6 cells cm^{-2} of live coral surface—and the high rugosity of the surfaces on which they live, as well as their own photosynthetic potential. However, zones of high coral cover make up only a small part of entire coral reef ecosystems, and so their contribution to total reef gross primary productivity is small.

Although the ocean's surface waters in the tropics generally have low productivity, these unproductive waters, which bathe coral reefs, are continually moving. Reefs therefore have access to substantial open-water productivity. Thus, particularly in inshore continental waters, shallow benthic habitats such as reefs must not always be considered the dominant sources of carbon for fisheries. Outside sources may be important for reefs, and while this significance is rarely estimated, its input may be in living (plankton) or dead (detrital) forms. In coastal waters detrital matter from land, plankton, and fringing marine plant communities are particularly abundant. There may be passive advection of particulate and dissolved detrital carbon onto reefs, and active transport onto reefs via fishes that shelter on reefs but feed in adjacent habitats. There is, therefore, greater potential for nourishment of inshore reefs than offshore reefs by external carbon sources, and this inshore nourishment will be enhanced by large land masses.

For most of the Pacific Islands, rainfall typically ranges from 2,000 to 3,500 mm per year. Low islands, such as atolls, tend to have less rainfall and may suffer prolonged droughts. Further, when rain does fall on coral islands that have no major catchment area, there is little allochthonous nutrient input into surrounding coastal waters and lagoons. Lagoons and embayments around high islands in the South Pacific are therefore likely to be more productive than atoll lagoons. There are however, some exceptions. Both Palmyra Atoll and Rose Atoll are unique in that they may receive up to 4,300 mm of rain per year. These atolls are among the few wet atolls in the world. The productivity of high island coastal waters, particularly where there are lagoons and sheltered waters, is possibly reflected in the greater abundance of small pelagic fishes such as anchovies, sprats, sardines, scads, mackerels, and fusiliers. Furthermore, the range of different environments that can be found in the immediate vicinity of the coasts of high islands also contributes to the greater range of bio-diversity found in such locations.

Studies on coral reef fisheries are relatively recent, commencing with the major study by Munro and his co-workers during the late 1960s in the Caribbean (Munro 1983). Even today, only a relatively few examples are available of in-depth studies on reef fisheries. It was initially thought that the maximum sustainable yields for coral reef fisheries were in the range of 0.5-5 $t/km^{-2}yr^{-1}$, based on limited data (Marten and Polovina 1982; Stevenson and Marshall 1974). Much higher yields of around 20 $t/km^{-2}yr^{-1}$, for reefs in the Philippines (Alcala 1981; Alcala and Luchavez 1981) and American Samoa (Wass 1982), were thought to be unrepresentative (Marshall 1980), but high yields of this order have now been independently estimated for a number of sites in the South Pacific and Southeast Asia (Dalzell and Adams 1997; Dalzell *et al.* 1996). These higher estimates are closer to the maximum levels of fish production predicted by trophic and other models of ecosystems (Polunin and Roberts 1996). Dalzell and Adams (1997) suggest that the average MSY for Pacific reefs is in the region of 16 $t/km^{-2}yr^{-1}$ based on 43 yield estimates where the proxy for fishing effort was population density.

However, Birkeland (1997b) has expressed some scepticism about the sustainability of the high yields reported for Pacific and south east Asian reefs. Among other examples, he notes that the high values for American Samoa reported by Wass (1982) during the early 1970's were followed by a 70% drop in coral reef fishery catch rates between 1979 and 1994. Saucerman (1995) ascribed much of this decline to a series of catastrophic events over the same period. This began with a crown of thorns infestation in 1978, followed by hurricanes in 1990 and 1991, which reduced the reefs to rubble, and a coral bleaching event in 1994, probably associated with the El Niño phenomenon. These various factors reduced live coral cover in American Samoa from a mean of 60% in 1979, to between 3-13% in 1993.

Further, problems still remain in rigorously quantifying the effects of factors on yield estimates, such as primary productivity, depth, sampling area, or coral cover. Polunin *et al.* (1996) noted that there was an inverse correlation between estimated reef fishery yield and the size of the reef area surveyed, based on a number of studies reported by Dalzell (1996). Arias-Gonzales *et al.* (1994) have also examined this feature of reef fisheries yield estimates and noted that this was a problem when comparing reef fishery yields. The study noted that estimated yields are based on the investigator's perception of the maximum depth at which true reef fishes occur. Small pelagic fishes, such as scads and fusiliers, may make up large fractions of the inshore catch from a particular reef and lagoon system, and if included in the total catch can greatly inflate the yield estimate. The great variation in reef yield summarized by authors such as Arias-Gonzales *et al.* (1994), Dalzell (1996) and Dalzell and Adams (1997) may also be due in part to the different size and trophic levels included in catches.

Another important aspect of the yield question is the resilience of reefs to fishing and recovery potential when overfishing or high levels of fishing effort have been conducted on coral reefs. Evidence from a Pacific atoll where reefs are regularly fished by community fishing methods, such as leaf sweeps and spearfishing, indicated that depleted biomass levels may recover to pre-exploitation levels within one to two years. In the Philippines, abundances of several reef fishes have increased in small reserves within a few years of their establishment (Russ and Alcala 1994; White 1988), although recovery in numbers of fish is much faster than recovery of biomass,

especially in larger species such as groupers. Other studies in the Caribbean and South East Asia (Polunin *et al.* 1996) indicate that reef fish populations in relatively small areas have the potential to recover rapidly from depletion in the absence of further fishing. Conversely, Birkeland (1997b) cites the example of a pinnacle reef off Guam fished down over a period of six months in 1967, that has still not recovered thirty years later.

Estimating the recovery from, and reversibility of, fishing effects over large reef areas appears more difficult to determine. Where growth overfishing predominates, recovery following effort reduction may be rapid if the fish in question are fast growing, as in the case of goatfish (Garcia and Demetropolous 1986). However, recovery may be slower if biomass reduction was due to recruitment overfishing because it takes time to rebuild adult spawning biomasses and high fecundities (Polunin and Morton 1992). Further, many coral reef species have limited distributions; they may be confined to a single island or a cluster of proximate islands. Widespread heavy fishing could cause global extinctions of some such species, particularly if there is also associated habitat damage. Unfortunately, the majority of species with a limited range are also valuable to the aquarium trade, and in the future restrictions on capture, possibly through the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) listing, may be appropriate to prevent overfishing.

Extent and Distribution of Coral Reefs

Roughly 70% of the world's coral reefs, or 420,000 km^2 are located in the Pacific Ocean (Bryant *et al.* 1998). Of all reefs under U.S. jurisdiction, 94%, or an estimated 15,852 km^2 of reef area, are associated with U.S. Pacific Islands (Clark and Gulko 1999; Hunter 1995). Table 3.1 shows their geographical distribution. Note that many of these coral reefs are located in areas where there is no human population, like the NWHI and the PRIAs, or in island archipelagos, like American Samoa and the CNMI, where population is concentrated on one or two islands.

Table 3.1: Coral reef area (in km^2 <100m deep) in nearshore waters (0-3 nm from shore) and offshore waters (3-200 nm from shore) in each location in the Western Pacific Region (Hunter 1995).

Location	0-3 nm	3-200 nm	Total Coral Reef Area
American Samoa	271	25	296
Guam	69	110	179
Hawaii			
MHI	1,655	880	2,535
NWHI	2,227	9,104	11,331
CNMI	45	534	579
PRIAs	620	89	709
Midway*	203	20	223
Total	5,090	10,762	15,852

*Midway is a PRIA located in the Hawaiian Archipelago.

Coral Reef Ecological Characteristics and Resource Dynamics

Coral reefs and reef-building organisms are confined to the shallow upper photic zone and area normally restricted to depths less than 50-100 m (25-50 fm) (Holthus and Maragos 1995). Maximum reef growth and productivity occurs between 5-15 m (Hopley and Kinsey 1988) and maximum diversity of reef species occurs at 10-30 m (Huston 1985).

Available biological and fishery data are poor for all species and areas covered by the CRE-FMP; therefore, it is not possible to implement the Fishery Ecosystem Plan action item 4, elaborated by EPAP.[1] Furthermore, high biological and environmental variability is a natural characteristic of coral reef ecosystems around the U.S. Pacific Islands, with or without fishing. Irregular pulses of new recruits (Walsh 1987) cause cycles in the abundance and harvest potential of individual reef species. Environmental variability is both spatial, related to differences in the quality of habitat (Friedlander and Parrish 1998a), and temporal, related to monthly moon phase, seasonal and longer-term environmental changes (Friedlander and Parrish 1998b).

Polovina *et al.* (1994) examined a large-scale climatic shift that affected coral reef resources in the NWHI from the mid-1970s to the late 1980s. During this period, the central North Pacific experienced increased vertical mixing, with a deepening of the wind-stirred surface layer into nutrient-rich lower waters and probable increased injection of nutrients into the upper ocean. Resulting increased primary productivity likely provided a larger food base for fish and animals at higher tropic levels. In the NWHI, changes of 60-100% over baseline levels in productivity for lobsters, seabirds, reef fish, and Hawaiian monk seals were observed and attributed to deeper mixing during 1977-1988.

The highest quality habitat on a coral reef is often where abundant living coral has created high bottom relief. Natural disturbance cycles in areas exposed to large storm waves can dramatically alter habitat quality. For example, periodic storms in the NWHI reduce live coral cover to 10% in some areas. Coral cover eventually returns to 50% or more, depending on how protected the area is (R. Grigg, 104th Council meeting, June 2000).

Unlike pelagic ecosystems, which are driven primarily by oceanographic forces operating on a large scale, coral reef ecosystems are strongly influenced by biological processes, habitat utilization, and environmental conditions at a relatively small scale. Innumerable animals and plants shelter, attach, or burrow into the reef structure, creating some of the most biologically diverse and complex ecosystems on earth.

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[1]As discussed on page 14 in the FMP, FEP action item four states "Calculate total removals—including incidental mortality—and show how they relate to standing biomass, production, optimum yields, natural mortality, and trophic structure."

Ecological Relationships

Coral reef ecosystems have existed in geological terms for nearly twice as long as flowering plants, and some of the coral genera are more ancient than any grasslands. Therefore, the ecological relationships have had more time to develop complexity in coral reefs. A major portion of the primary production of the coral reef ecosystem comes from complex inter-kingdom relationships of animal/plant photo-symbioses hosted by animals of many taxa, most notably stony corals. Most of the geological structure of reefs and habitat is produced by these complex symbiotic relationships.

Complex symbiotic relationships for defense from predation, removal of parasites, building of domiciles, and other functions are also prevalent. About 32 of the 33 animal phyla are represented on coral reefs (only 17 are represented in terrestrial environments) and this diversity produces complex patterns of competition. The diversity also produces a disproportionate representation of predators, which have strong influences on lower levels of the food web in the coral reef ecosystem (Birkeland 1997a).

In areas with high gross primary production but low net primary production or yield—such as rain forests and coral reefs—animals and plants tend to have a higher variety and concentration of natural chemicals as defenses against herbivores, carnivores, competitors, and microbes. Because of this tendency, and the greater number of phyla in the system, coral reefs are now a major focus for bioprospecting, especially in the southwest tropical Pacific (Birkeland 1997a).

Coral Reef Habitat

Even within a thriving coral reef habitat, not all space is occupied by corals or coralline algae. Reefs are typically patchworks of hard and sediment bottoms. A reef provides a variety of environmental niches, or combination of resources. The wide variety of survival strategies employed by coral reef organisms allows different species to exploit some combination of resources better than their competitors. The ecosystem is dynamic, however. If conditions change, a very specialized species may not be able to survive the rigors of the new environment or may be forced out by another species more adept at using the available resources, including space, food, light, water motion, and temperature.

Long-term Ecosystem Variability

Climate and ecosystem shifts may occur over decadal scale cycles or longer, meaning that resources management decisions need to consider changes in target level productivity over the long-term as well as short-term inter-annual variation. For example, the climatic shift that occurred in the central North Pacific in the late 1980s produced an ecosystem shift in the NWHI to a lower carrying capacity, with a 30-50% decline in productivity (Polovina *et al.* 1994). This in turn reduced recruitment and survival of monk seals, reef fish, albatross, and lobsters. Under the lower carrying capacity regime, fishing alters the age-structure of the population and may also lead to stock depletion.

At Laysan Island, where lobster fishing is prohibited, spawning biomass of lobsters was also depleted by natural mortality. This suggests that marine reserves may not guarantee the protection that is typically assumed (Polovina and Haight 1999). In response to this natural variability, the Council adjusted its management measures (e.g., limited entry, annual quota) to reduce catch and effort to about 25% of its 1980s level.

The destruction of coral reefs around the principal island in American Samoa, Tutuila, forced fishermen to move into predominantly pelagic fishing, initially trolling, and later, small-scale longline fishing. As a result, much of reef fish consumed in American Samoa now come from Western Samoa. The reduction of fishing on coral reefs may also aid in the recovery of live coral cover, but the long-term recovery of the reefs around Tutuila will principally depend on a benign climate and marine environment over the next decade. Furthermore, these destructive events occurred during a long-term shift in the physical environment of the equatorial Pacific Ocean, which began in 1977 (Miller *et al.* 1994). Conditions included more clouds, more rainfall, warmer sea surface temperatures, and weaker trade winds, similar to a weak decadal El-Niño state. They were most pronounced in the central equatorial Pacific, so American Samoa was close to the center of this shift, which persisted until 1999, when conditions began to change. Whether 1999 marks another regime shift will not be known until research is completed (J. Polovina, pers. comm.).

The destruction of American Samoan coral reefs included, in 1994, a coral bleaching episode. This phenomenon also affected reefs in the Cook Islands and French Polynesia, and was due to unseasonably high seawater temperatures. Coral bleaching occurs when corals lose or expel their zooxanthellae in large numbers, usually due to some trauma such as high or low temperatures or lower than usual salinities (Brown 1997). The corals that lose zooxanthellae also lose their color, becoming white and hence the term 'bleaching.' Although first described in the 1900s, interest in this phenomenon was heightened in the 1980s and 1990s after a series of major bleaching events in the Atlantic and Pacific Oceans. Some of these episodes were linked to the El-Niño Southern Oscillation or ENSO events (Gulko 1998).

When bleaching occurs, some corals are able to regain zooxanthellae by slowly re-infecting themselves with the algae, or through the reproduction of remaining zooxanthellae within the colony. Frequently, the loss of large amounts of symbiotic algae results in the colony becoming energy deficient; it expends more energy than it is consuming. If this occurs over the long term the colony dies (Brown 1997; Gulko 1999). Coral bleaching events require only a 1-2° C increase in water temperature. Thus, due to global warming, bleaching may become more common. According to Goreau *et al.* (1997), similar events in the Atlantic and the Indian Oceans suggest that worldwide corals are acclimated close to their upper temperature limits. As a result, they are unable to adapt rapidly to an anomalous warming (Goreau *et al.* 1997). Consequently, global warming represents a very serious threat to the survival of coral reefs.

Other physical phenomena that may bring long-term change to coral reef systems include the impact of hurricanes and tectonic uplift. Bayliss-Smith (1988) describes the changes in reef islands at Ontong-Java Atoll over a 20-year period following a severe hurricane. Most atoll

islands are on reef flats in what are frequently high wave-energy locations near to seaward reef margins. Unless composed of coarse shingle and rubble, these islands are unstable. Hurricanes will destroy such small cays and scour *motu* beaches, and strip small or narrow islands of fine sediment during over-wash periods. Bayliss Smith (1988) notes that while hurricanes tend to erode islands, they also produce the material for their reconstruction. More frequent, lower magnitude storms contribute to the process by transporting the rubble ramparts thrown up by hurricanes. This reconstructs scoured beaches and eroded shorelines. Clearly, such destruction and reconstruction activity on reef flats will have an effect on reef organisms, including fish and invertebrates, particularly where large areas of reef are smothered by sand and silt following a hurricane.

The process of tectonic uplift can profoundly influence coral reef systems. It is a much slower process, however, taking several centuries or even millennia to significantly change coral reefs. Tectonic uplift can push a productive reef flat above the water's surface, producing an exposed limestone terrace. This reduces the amount of reef area available for fishing, as occurred at Niuatoputapu and in the Tonga archipelago (Kirch and Dye 1979). Tectonic uplift was also partially responsible for changing Tongatapu Island's central lagoon from a marine to a brackish water environment. This resulted in the loss of an important reef mollusc resource, *Anadara antiquata,* which could not survive the reduced salinity. A similar event occurred at Tikopia in the Solomon Islands. There, a circular bay with a narrow entrance became a brackish coastal lake as the bay entrance was sealed through a combination of tectonic uplift and increased sedimentation caused by agricultural runoff from neighboring slopes. Again, this major habitat change wiped out reef- and lagoon-associated molluscs, a major food source for the indigenous people (see sources cited in Dalzell 1998).

Coral Reef Communities

Coral reef communities are among the most diverse and ecologically complex systems known. The structure of reef communities is usually defined in terms of the diversity and relative abundances of species characteristic of a habitat type. Commonly, only a few species compose over half the abundance, while hundreds of others are present in low numbers.

Life History

The literature on coral reef fish life histories is voluminous, but convenient entries into the literature are provided by Sale (1991), Polunin and Roberts (1996), and Birkeland (1997b). The life of a coral reef fish includes several stages. Typically, spawning occurs in the vicinity of the reef and is characterized by frequent repetition throughout a protracted time of the year, a diverse array of behavioral patterns, and extremely high fecundity. The eggs of many species are fertilized externally and dispersed directly into the pelagic environment as plankton. Other species have demersal eggs, which upon hatching disperse larvae into the pelagic realm. Planktonic mortality is very high and unpredictable. Recruitment is the transition stage from the planktonic larval life to demersal existence on a coral reef. Recruitment is both spatially and temporally highly variable. This is when post-larval juveniles begin their residence on reefs

where many remain for life. Highest predation mortality occurs in the first few days or weeks, thus rapid growth out of the juvenile stage is a common strategy.

Terrestrial animal populations are usually dispersed by adults, who deposit eggs or build nests in selected locations. In contrast, the most frequent pattern for coral reef organisms is dispersion of eggs and larvae in water currents, which determine the final location of adults. The adults are often sedentary or territorial. The differences in factors that bring about success in these two life history phases complicate fisheries management (Birkeland 1997a).

Species Distribution and Abundance

Species diversity declines eastwards across the Pacific from the locus of maximum species richness in Southeast Asia (especially in the Philippines and Indonesia), and is related in part to the position of land masses in relation to the Pacific Plate, the earth's largest lithospheric plate (Springer 1982). In general, species richness is greatest along the plate margin and declines markedly on the plate itself. As a result, islands in the Central Pacific generally have a lower reef organism diversity, but also a high degree of endemism. For example, Guam has about 269 species of zooxanthellate Scleractinian corals, about 40 Alcyonacea and just under a thousand species of fishes; Hawaii has far fewer in comparison. The proportion of endemic species increases in the opposite direction. For example, the Hawaiian Islands have about 18% endemic zooxanthellate corals, 60% endemic Alcyonacea and 25% endemic reef fishes, compared to the islands in the southwest part of the Western Pacific Region. The proportion of alien species in Hawaiian waters is also greater, and it is increasing (Birkeland 1997a).

As noted above, among the diverse array of species in each taxa on coral reefs, there are usually only a few that are consistently abundant, with the relative abundance of species within a taxa possibly approximating a log-normal distribution. The majority of species are relatively uncommon or only episodically abundant, following unusually successful recruitment (Birkeland 1997a).

Individual sub-populations of larger stocks of reef species may increase, decrease, or cease to exist locally without adversely affecting the overall population. The condition of the overall populations of particular species is linked to the variability among sub-populations: the ratio of sources and sinks; their degrees of recruitment connection; and, the proportion of the sub-populations with high variability in reproductive capacity. Recruitment to populations of coral reef organisms depends largely on the pathways of larval dispersal and "downstream" links. In considering recruitment mechanisms one must ask: Are the connections sufficient to actually restock distant sub-populations or only enough to maintain a homogenous genetic stock?

Reproduction and Recruitment

The majority of coral reef animals are very fecund, but temporal variations in recruitment success have been recorded for some species and locations. Many of the large, commercially-targeted coral reef animals are long-lived and reproduce for a number of years. This is in contrast to the majority of commercially-targeted species in the tropical pelagic ecosystem. Long-lived species

adapted to coral reef systems are often characterized by complex reproductive patterns like sequential hermaphroditism, sexual maturity delayed by social hierarchy, multi-species mass spawnings, and spawning aggregations in predictable locations (Birkeland 1997a).

Growth and Mortality Rates

Recruitment of coral reef species is limited by high mortality of eggs and larvae, and also by competition for space to settle out on coral reefs. Predation intensity is due to a disproportionate number of predators, which limits juvenile survival (Birkeland 1997a). In response some fishes—such as scarids (parrotfish) and labrids (wrasses)—grow rapidly compared with most coral reef fishes. But they still grow relatively slowly compared to pelagic species. In addition, scarids and labrids may have complex haremic territorial social structures that contribute to the overall effect of harvesting these resources. It appears that many tropical reef fishes grow rapidly to near-adult size, and then often grow relatively little over a protracted adult life span; they are thus relatively long-lived. In some groups of fishes, such as damselfish, individuals of the species are capable of rapid growth to adult size, but sexual maturity is still delayed by social pressure. This complex relationship between size and maturity makes resource management more difficult (Birkeland 1997a).

Community Variability

High temporal and spatial variability is characteristic of reef communities. At large spatial scales, variation in species assemblages may be due to major differences in habitat types or biotopes. Seagrass beds, reef flats, lagoonal patch reefs, reef crests, and seaward reef slopes may occur in relatively close proximity, for example, but represent notably different habitats.

As suggested in Section 2.2.3, reef fish communities from the geographically isolated Hawaiian Islands are characterized by low species richness, high endemism, and exposure to large semiannual current gyres, which may help retain planktonic larvae. The NWHI is further characterized by: (1) high latitude coral atolls; (2) a mild temperate to subtropical climate, where inshore water temperatures can reach below 18° C in late winter; (3) species that are common on shallow reefs and attain large sizes, which to the southeast occur only rarely or in deep water; and, (4) inshore shallow reefs that are largely free of fishing pressure.

3.2.2 Ecosystem Models

Several approaches to model multi-species fisheries have been used by coral reef fishery scientists with varying levels of success. The simplest approach has been to treat a community as the sum of its species. These general multi-species models have been applied by several researchers to estimate yields in coral reef fisheries. They are based on simultaneous Lotka-Voltera equations, which incorporate the impact of each species' population size on every other species through use of shared resources. Researchers have also incorporated predation and harvesting effects into these models. Unfortunately, with highly diverse systems such as coral reefs, this leads to an extremely complex model with potentially hundreds of parameters. Nonetheless, these approaches are mentioned as possible avenues for future assessment methodologies, although at present the lack of data precludes their usage.

An alternative is to divide the assemblage into separate trophic levels and model the energy flow through the system to estimate potential yields. The two linked models described in more detail below take this approach.

ECOPATH

ECOPATH is a simple mathematical model that estimates mean annual biomass, production, and food consumption for major components—defined in terms of species groups—of a coral reef ecosystem (Polovina 1984). Polovina used the following species groups to model the ecosystem at French Frigate Shoals in the NWHI: tiger sharks, monk seals, seabirds, reef sharks, sea turtles, small pelagics, jacks, reef fish (and octopus), lobsters and crabs, deepwater bottomfish, nearshore scombrids, zooplankton, phytoplankton, herterotrophic benthos, and benthic algae. A box model illustrates a biomass budget schematic for major predator-prey pathways and lists annual production and annual biomass for each group. The model shows a high percentage of internal predation, which partially explains why fishery yields from coral reefs are generally low despite high primary productivity. The allocation of species to trophic compartments constrains the ECOPATH approach because it imposes an artificial structure that may not coincide with actual community structure. This approach is also data intensive and requires information on each species' diet, mortality, and growth rates.

Extensive field work from French Frigate Shoals provided estimates of parameters used to validate the model. Application of ECOPATH to French Frigate Shoals found that the coral reef ecosystem is controlled mainly by predation from the top down and primary production is controlled mainly by nutrients, photosynthetic rate limits, and habitat space (Grigg *et al.* 1984). Fishery yields can be maximized by targeting lower trophic levels and cropping top predators to release pressure on prey. Thus, a fishery targeting tiger sharks at French Frigate Shoals should help ease predation pressure on endangered Hawaiian monk seals and threatened green turtles. Coral reef ecosystems are susceptible to overfishing due to high levels of natural mortality and low net annual production. A study of coral reef fish communities on patch reefs at Midway Atoll found that they were relatively resilient to several years of fishing pressure on top predators, while some control by predation was detected (Schroeder 1989).

ECOSIM

ECOSIM is a computer model that uses the output of the ECOPATH model. Input parameters by species (or species group) include natural and fishing mortality, diet composition, and production to biomass ratio. The vulnerability level of prey to predators can be adjusted and gear selectivity levels can also be set. Predation levels are then determined. In order to determine qualitative changes in the structure of the resource community, the model can be run to stimulate several decades. Applying various levels of fishing pressure can reveal which target and non-target species increase and which decrease in abundance, considering predator-prey interactions (Kitchell *et al.* 1999).

3.2.3 Ecosystem Overfishing

The special vulnerability of targeted coral-reef resources comes from life-history traits of these economically valuable species, which live in diverse communities with strong predatory and competitive forces. Coral reef species are adapted to reproduce often because so few of their progeny are likely to survive. Therefore, they grow slowly, delay first reproduction, and are more territorial than pelagic species. These life history traits make recovery from overfishing very uncertain. Some coral reef ecosystems, driven by biological interactions, have not recovered for decades following intensive harvest, and there are no indications that they will recover. In contrast, pelagic fisheries, driven by oceanographic processes, usually do recover. For example, black-lipped pearl oysters at Pearl and Hermes Atoll in the NWHI were over-harvested to commercial extinction in the late 1920s; according to recent surveys, stocks have still not recovered after 70 years. Holothuroids (sea cucumbers) were over-harvested in the late 1930s in Chuuk, Eastern Caroline Islands, and recent surveys there also show no recovery after 60 years. Dalzell *et al.* (1996) cite several other examples from the Pacific Islands where pearl oyster and sea cucumber populations have failed to recover from over-harvesting, even after several decades of no fishing.

Overfishing may degrade coral reef ecosystems and ultimately affect ecosystem processes. For example, the removal of herbivorous fishes can lead to the overgrowth of coral by algae, eventually destroying some coral reef resources. Munro (1983) has suggested that overfishing of predatory reef species may lead to a decline in the natural mortality of herbivores; in response, their biomass increases. When the herbivores are in turn overfished, algal production is uncontrolled. Most of the resulting increase in algae and sea-grass biomass then turns to detritus. However, there are few well documented examples of such effects cascading through ecosystems.

Munro (1983) cites the north coast of Jamaica as an example of reefs almost entirely overgrown by macro-algae and where the cover of live coral is extremely low. Although scientists do not fully agree, it appears that this can be attributed to the long-term effects of overfishing. The very narrow island shelf (less than one kilometer wide) was covered by flourishing coral reefs until 1984. Then several events combined to change the situation. First, the herbivorous long-spined sea urchin, *Diadema antillarum,* spread rapidly throughout the Caribbean. Then the north coast of Jamaica took a direct hit from a major hurricane. The reefs were pulverized by heavy seas and large corals were stripped of tissue. Macro-algae colonized all these newly exposed surfaces. In the absence of sea urchins and herbivorous fish, the macro-algae have remained dominant (Hughes 1994). Other parts of the Caribbean with less heavily exploited fish stocks also lost their urchin populations and suffered hurricanes, but these reefs were not massively overgrown with algae. While it cannot be proven that overfishing was the cause of this catastrophe, the evidence points in that direction.

The MSFCMA requires managers to identify the individual species composing a fishery management unit and calculate Maximum Sustainable Yield (MSY) for each. But on coral reefs, although there are thought to be thousands of economically valuable species, many of them have

not been named or described by scientists. However, bio-prospectors—the major near-term users of reef resources—will try to find as many pharmaceutically useful species as possible, whether or not they have been officially described by scientists. If managers have to name each species, and estimate their MSY, it will be many decades before an FMP can be completed and these kinds of economic uses can begin. Thus, the sort of ecosystem-level approach espoused by EPAP is well suited to the complex multi-species coral reef ecosystem.

In concert with the ecosystem approach, an alternative overfishing definition seems most appropriate for the CRE-FMP. In contrast to the single-species approach, the ecosystem overfishing concept considers how fishing pressure can cause changes to species composition in a multi-species setting, often resulting in changes in ecosystem function (DeMartini *et al.* 1999). This can be detected by shifts in species composition or trophic web dynamics. Using this concept can also guard against single-stock recruitment overfishing, where applicable. There are other reasons for adopting this approach. First, the loss of some species in the multi-species coral reef ecosystem—due to overfishing or other human impacts—could allow often less valuable generalist species to predominate. As in the example cited above, these types of changes to heavily fished reefs have been reported for a number of tropical stocks from various areas around the world. Second, multi-species systems become more vulnerable to environmental fluctuations as exploitation increases.

3.2.4 Status of Protected Species Listed Under the ESA

Several species listed as endangered or threatened under the Endangered Species Act (ESA) occur in and around the coral reef ecosystem, and in the region where Council-managed fisheries operate. These include marine mammals, sea turtles and seabirds. Other species of concern are terrestrial-based birds and terrestrial plants because of the possibility of ship wreck and the threat of invasive species introductions. The species of concern are:

Marine Mammals	**Status**
Hawaiian monk seal (*Monachus schauinslandi*)	Endangered
Humpback whale (*Megaptera novaeangliae*)	Endangered
Sperm whale (*Physeter macrocephalus*)	Endangered
Blue whale (*Balaenoptera musculus*)	Endangered
Fin whale (*Balaenoptera physalus*)	Endangered
Sei whale (*Balaenoptera borealis*)	Endangered
North Pacific right whale (*Eubalaena glacialis*)	Endangered
Sea Turtles	
Green turtle (*Chelonia mydas*)	Threatened/Endangered
Hawksbill turtle (*Eretmochelys imbricata*)	Endangered
Leatherback turtle (*Dermochelys coriacea*)	Endangered
Loggerhead turtle (*Caretta caretta*)	Threatened
Olive Ridley turtle (*Lepidochelys olivacea*)	Threatened/Endangered

Seabirds	
Short-tailed albatross (*Phoebastria albatrus*)	Endangered
Newell's shearwater (*Puffinus auricularis newelli*)	Endangered
Terrestrial-based birds	
Laysan duck (*Anas platyrhynchos laysanensis*)	Endangered
Laysan finch (*Telespyza cantans*)	Endangered
Nihoa millerbird (*Acrocephalus familiaris kingi*)	Endangered
Nihoa finch (*Telespyza ultima*)	Endangered
Micronesian megapode (*Megapodius laperouse laperouse*)	Endangered
Terrestrial Plants (in NWHI)	
Sesbania tomentosa (legume)	Endangered
Schiedea verticillata (fleshy root herb)	Endangered
Pritchardia remota (palm)	Endangered
Amaranthus brownii (weedy herb)	Endangered
Mariscus pennatiformes (sedge)	Endangered
Cenchrus agriminioides (kamanomano)	Endangered

Endangered Marine Mammals

Marine mammals that occur in and around the coral reef ecosystem, and that are listed as endangered under the ESA, include the Hawaiian monk seal (*Monachus schauinslandi*), humpback whale (*Megaptera novaeangliae*), sperm whale (*Physeter macrocephalus*), blue whale (*Balaenoptera musculus*), fin whale (*B. physalus*), the sei whale (*B. borealis*) and the North Pacific right whale (*Eubalaena glacialis*). With the exception of the Hawaiian monk seal, there have been no reported interactions between endangered marine mammals and Council-managed fisheries or by other fishing vessels operating in the proposed coral reef management areas of the region.

Hawaiian Monk Seal

The Hawaiian monk seal is the most endangered pinniped in U.S. waters and is second only to the northern right whale as the nation's most endangered marine mammal (MMC 1999). It was designated depleted in 1976 under the Marine Mammal Protection Act (MMPA), and was listed as endangered under the ESA following a 50% decline in beach counts from the late 1950s to the mid-1970s.

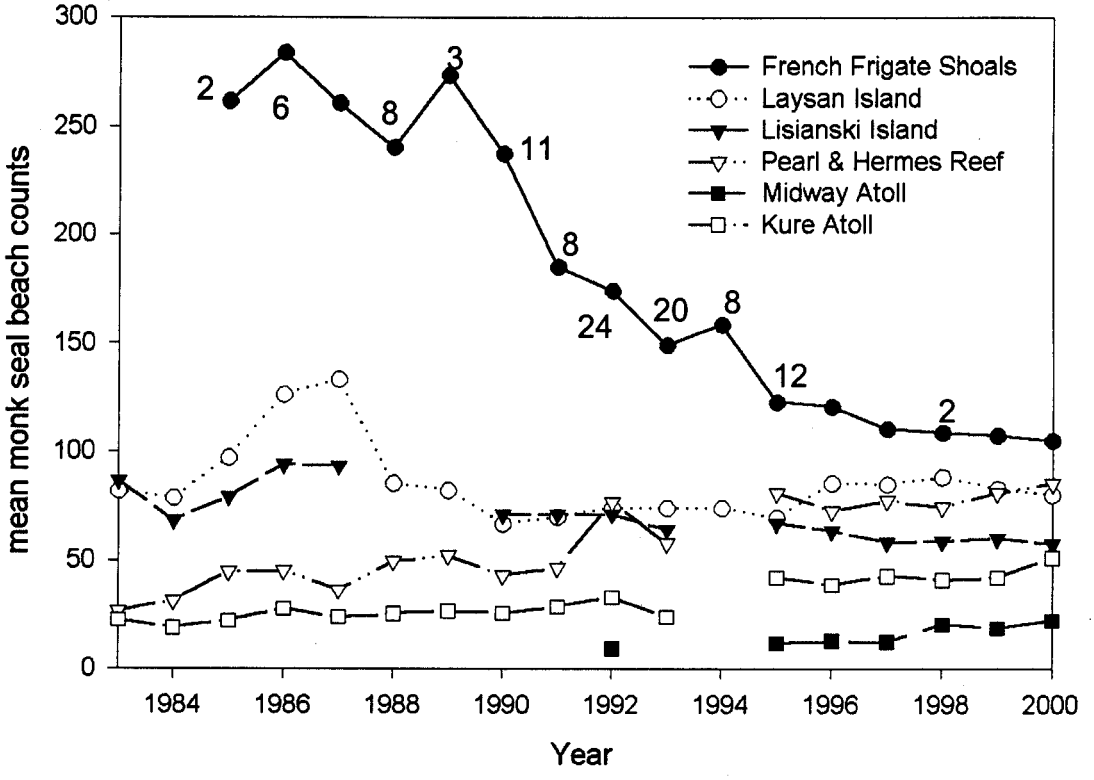
The historical abundance of the Hawaiian monk seal is unknown, The first estimate of monk seal numbers was made in 1958, when a total of 1,206 seals were counted. However, the beach counts conducted were of aerial surveys of the leeward islands only, and during these beach counts researchers estimated that approximately one third of the population remained at sea (Kenyon and Rice 1959; Rice 1960a).

The Hawaiian monk seal breeds only in the Hawaiian Archipelago, with most monk seals inhabiting the remote, largely uninhabited atolls and surrounding waters of the NWHI. More than 90% of all pups are born at six major breeding colonies located at French Frigate Shoals, Laysan Island, Pearl and Hermes Reef, Lisianski Island, Kure Atoll and Midway Atoll. A few births also occur annually at Necker, Nihoa, and Niihau Islands and in the main Hawaiian Islands. Although monk seals occasionally move between islands, females generally return to their natal colony to pup. Since 1990, there has been an increase in the number of monk seal sightings and births in the main Hawaiian Islands (MMC 2000; Johanos and Baker 2000).

Little is known about Hawaiian monk seals or their population status before the 1950s. As a result of natural constraints, the species was probably never very abundant, presumably numbering, at most, in the thousands (as opposed to hundreds of thousands) (Ragen and Lavigne 1999). The arrival of humans in the Hawaiian Islands may have reduced the range of the Hawaiian monk seal largely to the NWHI and contributed to its current endangered status. In historic times, human-related mortality appears to have caused two major declines of the Hawaiian monk seal (MMC 2000). It generally is acknowledged that the species was heavily exploited in the 1800s during a short-lived sealing venture. Several island populations may have been completely eliminated during that period. The second major decline occurred after the late 1950s and appears to have been determined by the pattern of human disturbance from military activities at Kure Atoll, Midway Atoll, and French Frigate Shoals. Such disturbance caused pregnant females to abandon prime pupping habitat, and nursing females to abandon their pups. The result was a decrease in pup survival, which led to poor reproductive recruitment, low productivity, and population decline (MMC 2000).

The decline in monk seal numbers seemed to have slowed by the early 1980s, due primarily to a sevenfold increase in monk seal counts at French Frigate Shoals between the 1960s and mid-1980s. By 1985, the French Frigate Shoals colony had grown to a point where it included nearly half of the entire population (MMC 2000). However, the overall population again began to decline in the late 1980s and early 1990s (see Figure 3.1). The downward trend was driven primarily by a high mortality of juveniles at French Frigate Shoals, where the species' largest breeding colony resides (MMC 2000). Since the mid-1990s total monk seal numbers appear to have stabilized at about 1,300 to 1,400 individuals. The first-year survival of pups at French Frigate Shoals increased significantly in 1998 (MMC 2000).

Figure 3.1: Mean beach counts of Hawaiian monk seals (no pups) at six major breeding colonies from 1983 - 2000. Note that there are missing data points for some years at some locations. Beach counts are not necessarily a good indicator of population abundance as monk seals migrate between islands. In addition, monk seals have been captured and translocated between colonies. For instance, the numbers above the mean beach counts for French Frigate Shoals represent monk seals removed and/or moved to other areas for recovery purposes. (Source: NMFS, SWFSC Honolulu Laboratory unpubl. data).



Contributing to the species' decline over the past four decades have been (1) human disturbance, (2) reduced prey availability, shark predation, (3) attacks by aggressive adult male monk seals on females and immature seals of both sexes (called "mobbing"), (4) entanglement in derelict fishing gear, and (5) recovery efforts (MMC 1999). At each colony, differing combinations of these factors likely have contributed to local trends in abundance, with relative importance of individual factors changing over time (MMC 2000). Factors contributing to the changes in monk seal abundance are described in greater detail in the following sections.

Human Disturbance

As noted above, human disturbance was probably the principal cause of monk seal population declines before the 1980s. Between 1958 and the mid-1970s, monk seal colonies at the western end of the archipelago between Kure Atoll and Laysan Island declined by at least 60%, and the colony at Midway Atoll all but disappeared (MMC 1999). Most human activity was concentrated at the westernmost atolls of the chain during this period, suggesting that human disturbance contributed to the decline. The Navy undertook a major expansion of its air facility on Midway Atoll during the 1950s. The U.S. Coast Guard established LORAN stations at Tern Island, French Frigate Shoals, in 1952, and Kure Atoll in 1960, which were was occupied year-round. Ownership of Midway Atoll was transferred from the Navy to the U.S. Fish and Wildlife Service (USFWS) in 1996, and the atoll is now managed as the Midway Atoll National Wildlife Refuge. The U.S. Coast Guard (USCG) closed the LORAN station at Kure Atoll in 1992, and removed most of the manmade structures by 1993. The Tern Island LORAN station was decommissioned in 1979, and returned to the U.S. Fish and Wildlife Service.

The human population of approximately 160 people at Midway Atoll has decreased substantially in the last two decades, but year-round human habitation of the atoll has continued. Since 1996, there has been limited ecotourism and public use within the Midway Atoll National Wildlife Refuge in the form of charter boat and shore fishing, diving and wildlife observation. A privately owned corporation was awarded a concession to develop and manage the tourist facilities in the refuge. The number of visitors allowed on the atoll at any one time is limited to 100 to reduce impacts to wildlife. The Hawaiian Monk Seal Recovery Team indicated that it supports the efforts of the USFWS to provide compatible visitor opportunities and educational programs at the refuge. It is also important to note that the Midway Atoll monk seal population has increased since the atoll was transferred to the USFWS. However, some monk seal researchers have expressed concern about the possible long-term impacts of developing Midway Atoll as a tourist destination:

> Such developments will of course yield benefits to the management bureaucracy, providing continued support for the Fish and Wildlife Service station on the island. It will also ease the logistical problems for scientists who wish to study the animals on the islands, and it will provide an opportunity for public education. But the conservation benefits of tourism for monk seals at Midway will not be measured by the numbers of visitors or their vacation experience, only its effects on the seals. Although these remain to be determined, one can only wonder what would happen if humans simply vacated Midway entirely (Lavigne 1999, page 260).

Similarly, NMFS (1997) noted that as the tourism venture develops, so does a potential conflict of interest. The economic success of the venture may depend on the nature and variety of human activities permitted on the island. Importantly, those activities that are intended to enhance the Midway experience may be disruptive or detrimental to the refuge and its wildlife. It is clear from several documented cases in the MHI that the sportfish fishery occurring on Midway Atoll has the potential to interact with the monk seals. For instance, in 1994 a monk seal was found dead with a recreational hook lodged in its esophagus (Henderson 1998). In addition, at least seven other monk seals have been hooked by recreational fishermen in the main Hawaiian Islands (MHI), with at least three of these fishermen targeting *ulua* (Henderson 1998). As the monk seal population increases in the Hawaiian Archipelago, it is likely that this may also increase the potential for interactions between the species and sportfisheries, including the recreational fishery operating on Midway.

During World War II, the Navy enlarged Tern Island, one of several small islets at French Frigate Shoals, from its original 4.5 hectares (11 acres) to about 16.2 hectares (40 acres) to accommodate a landing strip (MMC 1999). To do so, the Navy constructed a sheet metal bulkhead around most of the island and backfilled behind the structure with dredged spoil and coral rubble from the surrounding lagoon. The island was artificially enhanced by 23 acres and the surrounding coral reefs destroyed and used as fill material. The Coast Guard took over the island from 1952 to 1979 to operate a LORAN station. Since then, it has been used by the USFWS as a field station for the Hawaiian Islands National Wildlife Refuge.

The continued existence of the runway and field station at Tern Island—in fact, the integrity of the entire island—is in doubt because the sheet metal bulkhead, now more than 50 years old, is badly deteriorated (MMC 1999). If the bulkhead fails, the airstrip would be lost, the field station would have to be abandoned, most of the island would erode away, buried debris would be exposed and create entanglement hazards to wildlife, and erosion pockets behind the rusted-out seawall would become serious entrapment hazards for monk seals and other wildlife. In 1991, a monk seal died after becoming trapped behind the eroding sea wall (USFWS 2000a). In 1999, the USFWS began NEPA assessment for sea wall construction at Tern Island. The total cost of the project is estimated to be about $15 million (MMC 1999).

Another legacy of past human use of the NWHI is environmental pollution from abandoned landfill areas and debris sites that could work its way into atoll food chains (MMC 2000). Most notably, the presence of a point source of contaminants at Tern Island has been identified as a threat to monk seals and other components of the ecosystem at French Frigate Shoals. A recent analysis of risks to Hawaiian monk seals, based on dietary exposure and contaminant concentrations in blubber and blood, shows that no contaminants are present at concentrations believed to present a risk to the seals (CH2M Hill 2000). However, due to the dynamic nature of the environment at the site, an episodic storm event could pose a risk if part or all of the contaminants in the landfill were redistributed into the lagoon.

Reduced Prey Availability

In the early 1980s, steps were taken to prevent human disturbance of monk seals, and the western colonies began to increase slowly (MMC 2000). As noted earlier, however, the breeding colony of monk seals at French Frigate Shoals experienced a high juvenile mortality from 1989 to the mid-1990s. Whereas first-year survival rates for pups at the atoll in the early 1980s were between 80% and 90%, they dropped significantly between 1989 and the mid-1990s (MMC 2000). It was also during this period when the Marine Mammal Research Program translocated seals from French Frigate Shoals to Midway Islands and Kure Atoll (see section on recovery efforts).

One of the potential explanations of the poor juvenile survival at this site during this time period is limited prey availability and subsequent effects on both adults and juveniles. There are two factors related to food that influence weaned pup survival: (1) the amount of food (milk) pups acquire from their mothers prior to weaning; and, (2) the amount of food available to pups immediately after weaning (G. Antonelis, pers. comm.). The first factor is related to the mother's condition and ability to forage successfully prior to parturition and may be viewed as an indicator of prey availability during gestation. The second factor is related to the pup's ability to forage successfully after weaning. Evidence of limited prey availability at French Frigate Shoals included small and, in some cases, emaciated pups, juveniles that were smaller and thinner than those at other colonies and delayed sexual maturity of adult females (Craig and Ragen 1999; MMC 2000).

Further evidence of limited prey availability at French Frigate Shoals has been provided by satellite-linked, time-depth recorders that have been used to track movements and record diving patterns of Hawaiian monk seals at various locations. All but one of the animals tracked at Pearl and Hermes Reef foraged either within the fringing reef or just outside the reef (Stewart 1998). Most dives were to depths of 8-40 m, though there was a secondary mode at 100 to 120 m, and the seals appeared to segregate diving behavior by age and sex. Seals at Lisianski also segregate diving behavior by age and sex, where females and juveniles tend to dive shallow during the day while reproductive males make deeper dives at night (DeLong *et al.* 1984). Monk seals studied at French Frigate Shoals, where the population of seals is considerably larger, exhibited more variation in their habitat use (Abernathy and Siniff 1998). The most prevalent pattern, particularly among males, was use of the banks to the northwest (some of which are more than 200 km from haul-out sites), with daytime diving in the 50-80 m range and a nocturnal or crepuscular shift to the 110-190 m range. The next most common group included seals that did not leave the vicinity of French Frigate Shoals and rarely dived deeper that 80 m. Finally, a small number of seals made many dives greater than 300 m. Abernathy and Siniff (1998) suggested that reduced prey availability could account for the greater variety of foraging patterns at French Frigate Shoals as some individuals are forced to venture to new areas and alter their prey base.

The two leading hypotheses to explain the lack of prey at French Frigate Shoals are: (1) the local population reached its carrying capacity during the mid-1980s, and essentially diminished its own food supply; and, (2) carrying capacity was simultaneously reduced by large-scale natural

perturbations in ecosystem productivity (NMFS 1997; MMC 2000). Declines in Hawaiian monk seal, seabird and lobster reproductive success in the late 1980s appear to have been linked to a large-scale climatic event (Polovina *et al.* 1994). From the mid-1970s to late 1980s, the central North Pacific experienced increased vertical mixing, with a deepening of the wind-stirred surface layer into nutrient-rich lower waters and probable increased injection of nutrients into the upper ocean. Resulting increased primary productivity likely provided a larger food base for fish and animals at higher trophic levels. In the NWHI changes of 60% to 100% over baseline levels in productivity for lobsters, seabirds, reef fish and monk seals were observed and attributed to deeper mixing during 1977-1988 (Polovina *et al.* 1994). The variation in the geographical position of this vertical mixing is in turn related to the position of the Aleutian low-pressure system.[2] As this system deviates from its long-term average position, productivity may be more or less affected in the waters around the NWHI.

Polovina *et al.* (1994) suggested that the average position of the Aleutian low-pressure system moved northward in the mid- to late-1980s. The "declines" in productivity observed at Midway Atoll and French Frigate Shoals after 1988 actually represented returns to more "normal," lower levels of productivity. Productivity may have been most affected at French Frigate Shoals, the southernmost reproductive colony of Hawaiian monk seals (Craig and Ragan 1999). Furthermore, the adverse impact of a return to less productive oceanographic conditions on monk seal reproduction and survival could presumably have been greater at French Frigate Shoals because that island's monk seal population was closer to carrying capacity (Ragen and Lavigne 1999).

The general decreases in reef fish abundance observed at Midway Atoll and French Frigate Shoals in 1992-1993 may also have been influenced by interdecadal changes in ecosystem productivity in the central Pacific, at and above the latitudes of the NWHI (DeMartini *et al.* 1996a). In 1995, a dramatic increase in recruitment and availability of reef fish was detected at both French Frigate Shoals and Midway Atoll (DeMartini *et al.* 1996a,b). No further increase in apparent abundance of reef fish since that time has been found (DeMartini and Parrish 1998), but from the mid- to late-1990s there was an improvement in the condition of monk seal pups at weaning and in local pup births at French Frigate Shoals and other major island populations (NMFS 1997; MMC 2000). Trends in pup girth measurements indicate that prey resources may have started to increase during the 1990s, most notably at Laysan Island, Lisianski Island, and French Frigate Shoals (NMFS 1997; MMC 2000).

Fisheries also have the potential of reducing the prey available to Hawaiian monk seals. Hawaiian monk seals have the capability to dive to depths at which many species targeted by the bottomfish fishery occur. It is suspected that monk seals may strip bottomfish from handlines and consume them (Nitta 1999). Observers reported that seals appeared to prefer *opakapaka*, but

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[2]There are also considerable biological data showing higher fish and zooplankton densities in the Gulf of Alaska during the 1970s and 1980s compared to earlier decades, as well as correlations between biological indices and an index of the strength of the Aleutian low-pressure system (Polovina *et al.* 1995).

would also eat *onaga*, *butaguchi*, and *kahala*. However, the results of dietary studies suggest that these species do not constitute a significant component of the natural diet of monk seals (Goodman-Lowe 1998).

An analysis of fecal and regurgitate samples from Hawaiian monk seals at five islands in the NWHI demonstrated that monk seals are opportunistic predators that feed on a wide variety of available prey in comparison to the case of other seals, whose diet is mainly made up of only a few species (Goodman-Lowe 1998). The analysis revealed that teleosts (bony fish) were the most represented prey (78.6%), followed by cephalopods (15.7%) and crustaceans (5.7%). The most common teleost families found were marine eels (22.0%), Labridae (20.6%), Holocentridae (14.4%), Balistidae (13.1%), and Scaridae (10.5%). All teleosts found were common, shallow-water reef fishes, except for the beardfish family, Polymixiidae (1.0%), which is recognized to consist of deep-water benthic fish. The deep-water Polymixiidae are not caught in the bottomfish fishery, either as target or non-target species. Evidence of target species, such as snapper and grouper, appeared infrequently in fecal and regurgitate samples.

A recent study contracted by NMFS used quantitative fatty acid signature analysis to identify which prey items are most important to the various age and sex components of the several island populations of monk seals. Initial estimates of diet suggest an array of prey species that are in some cases comparable to that found in the analysis of fecal and regurgitate samples. To date, the study has focused on the identification of fatty acids of lobster species and not on identification of the fatty acids of the fish species most commonly targeted by the NWHI bottomfish fishery.

Shark Predation and Mobbing

Evidence suggests that during the mid- to late-1990s, shark predation and male monk seal aggression contributed significantly to the mortality of weaned and pre-weaned pups at French Frigate Shoals (MMC 2000). Predation by Galapagos sharks (*Carcharhinus galapagensis*) and perhaps tiger sharks (*Galeocerdo cuvieri*) of monk seal pups seems to be increasing in occurrence, as 17 (18%), 16 (15%) and 25 (27%) pup mortalities or disappearances were believed to be associated with shark attacks at French Frigate Shoals in 1997, 1998, and 1999, respectively (Laurs *et al.* 2000). In 1999, shark predation may have accounted for the deaths of 51% (23 of 45) of the pups born at Trig Island in French Frigate Shoals (G. Antonelis, pers. comm.). A preliminary analysis of the impacts of shark predation on the recovery of the French Frigate Shoals population of monk seals indicates that the mitigation of this interaction is essential to the recovery of this population. The Hawaiian Monk Seal Recovery Team (HMSRT) has recommended that NMFS undertake a program to remove Galapagos and/or tiger sharks observed patrolling beaches where monk seal pups are present within French Frigate Shoals.

Aggressive behavior or mobbing of females and immature seals by adult males is a source of mortality at French Frigate Shoals, Laysan Island, and Lisianski Island. The deaths can be a direct result of injuries inflicted by the aggressive males or as a result of later shark attacks on

wounded seals or pups chased into the water by aggressive males. The primary cause of mobbing is thought to be an imbalance in the adult sex ratio, with males outnumbering females (Ragen and Lavigne 1999). Such imbalances are more likely to occur when populations are reduced. In 1997, 14 incidents of individual adult male aggression toward pups were documented at French Frigate Shoals, and eight pups subsequently died (MMC1999). In 1998, there were 13 documented cases of male aggression toward females, juveniles or pups that resulted in injury or death. Of these, three were at French Frigate Shoals, one of which resulted in a death; two were at Laysan Island, one of which resulted in a death; and eight were at Lisianski Island, one of which resulted in a known mortality. The subsequent removal and relocation of aggressive male monk seals has reduced or eliminated deaths caused by males at French Frigate Shoals and Laysan Island (MMC 2000).

While aggressive male monk seal mobbers can be removed to reduce attacks, shark predation on the population is more difficult to control and monitor. For instance, great white shark (*Carcharodon carcharias*) sightings have been recorded and photographed near Kauai, Nihoa, and Necker Islands since 1995, and ecotourist charter operators note that the behavior of the seals in the area changes when a great white shark is present (L. Bail, pers. comm.). The distribution and migratory patterns of the great white shark in the NWHI, or if the shark has preyed upon monk seals, are unknown. Great white sharks are known to prey upon pinniped species in other regions, and a loss of even one adult Hawaiian monk seal per month to this single shark might represent a significant impact on the population. Although, monk seals can survive shark attacks, as evidenced by seals with healed bite marks, the presence of the shark could modify monk seal foraging behavior. As shown by satellite tracking of seals, adult females with nursing pups, weaned pups and immature seals may prefer shallow water protected by reefs because it excludes larger sharks (DeLong *et al.* 1984). Adult monk seals at French Frigate Shoals may have learned to avoid sharks by retreating to underwater caves at La Pérouse Pinnacles, where scuba divers see seals breathing from bubbles of air trapped at the ceiling of the cave (Rauzon 2001). In addition to physically harming seals, sharks have been seen to steal food away from foraging monk seals (F. Parrish, pers. comm.). To control future shark attacks on weaned pups and juveniles, the NMFS Marine Mammal Research Program, Honolulu Laboratory, has applied for permits to cull aggressive sharks known to prey on monk seals. However, to date, there are no studies investigating the impact of changes in shark abundance with monk seal survival.

Entanglement in Marine Debris

Marine debris, particularly derelict fishing nets, poses a serious risk of injury and death to Hawaiian monk seals. The inquisitive nature of seals, particularly pups and juveniles, tends to make them attracted to debris. Subsequent interactions can lead to entanglement and, unless they are able to free themselves quickly, entangled seals risk drowning or death through injuries caused by the entangling gear. In 1998, 18 seals were found entangled in debris (MMC 1999). Of these, five were able to disentangle themselves, 12 were disentangled by field crews and one was found dead in a fishing net caught on the reef at Laysan Island. In 1999, a record 25 monk seals were reported to have been found entangled in marine debris (Laurs *et al.* 2000). Most of

the net debris in the NWHI appears to be trawl webbing. Although its origin is unclear, no trawl or gillnet fishing occurs in the NWHI, and it is assumed that virtually all of the debris has been transported by ocean currents from distant fisheries around the rim of the North Pacific Ocean (MMC 2000).

In 1998, NMFS organized a multi-agency cleanup effort to remove derelict fishing nets and other debris from the reefs surrounding French Frigate Shoals and Pearl and Hermes Reef. NMFS was able to remove only a small proportion of this debris, and the agency estimates that 38,000 pieces of netting remain in the waters surrounding each of these locations (MMC 2000). NMFS continued the task of cleaning up this marine debris in 1999 and 2000.

Recovery Efforts

The Hawaiian monk seal was listed as an endangered species on November 23, 1976, and the first recovery plan was issued in 1983. Critical habitat for the monk seal was designated in 1988, and included all beach areas, including beach crest vegetation, lagoon waters, and ocean waters out to a depth of 20 fm around Kure Atoll, Midway Islands (except Sand Island and its harbor), Pearl and Hermes Reef, Maro Reef, Lisianski Island, Laysan Island, Gardner Pinnacles, French Frigate Shoals, Necker Island, and Nihoa Island.

Hawaiian monk seal recovery efforts include monitoring the seals and assessing their abundance, distribution and health status. Other recovery efforts have focused on reducing the high ratio of males to females at Laysan Island, a condition thought to elicit mobbing of females and pups by aggressive males. For instance, in 1994, 21 adult male monk seals, identified as participating in mobbing attacks on females seals, were collected and translocated from Laysan Island to selected locations throughout the MHI. Since the male seals were removed from Laysan Island, the remaining seals showed an improvement in reproductive success.

Monk seal research activities can also inadvertently have a negative impact on monk seals. Since 1982, for instance, three seals have died from research efforts, and an additional 22 seals have died during translocation and rehabilitation efforts (G. Antonelis, pers. comm. 2000). However, many of the seals chosen for rehabilitation were in poor health before inclusion in the program, and therefore it is assumed their risk of mortality from natural causes was already high (G. Antonelis, pers. comm.). According to a recent study by the NMFS Honolulu Laboratory, with current handling procedures, research handling of monk seals will not result in mortality if the seals are released in a healthy condition (Baker and Johanos 2000). Still, between 1982 and 1998, a total of 157 seals have been handled and/or translocated from one island area to another by researchers during recovery efforts, and these recovery efforts need to be taken into consideration when assessing changes in population trends (Figure 3.1). According to some researchers, it is also possible that continuous human habitation of research field camps in the NWHI could have an adverse effect on monk seals if not carefully monitored and controlled.

In 1996, NMFS completed a Section 7 consultation Biological Opinion in association with Amendment 9 to the Fishery Management Plan for Crustaceans. This consultation considered impacts to protected species from the crustacean fishery. Species considered that may occur in the management area included the Hawaiian monk seal, green sea turtle, leatherback turtle, and humpback whale. It concluded that Amendment 9 was not likely to jeopardize the continued existence of the listed species within the management areas or adversely affect any designated critical habitats. In addition, conservation recommendations were developed identifying those activities that NMFS and the Council could pursue to further reduce the adverse effects of fishing activities to listed species and their critical habitats.

In 1999, NMFS conducted an informal Section 7 Consultation regarding the establishment of permanent lobster fishing areas and allocation of the 1999 harvest guideline for the commercial lobster fishery in the NWHI. This also concluded there was no evidence to suggest that the proposed 1999 harvest guideline for lobster, or establishment of permanent lobster fishing areas in the NWHI, would likely adversely affect Hawaiian monk seals, and that the 1996 Biological Opinion remains valid.

In June 2001, the Council endorsed voluntary measures to reduce potential interactions between the Hawaiian monk seal and the bottomfish fishery. These monk seal measures were proposed by the bottomfish fishermen, and require fishermen to immediately stop fishing and retain all gear on deck whenever a monk seal is sighted within a ten yard radius of fishing operations. If the monk seal remains in the designated area for more than two hours, the captain of the vessel will relocate to other fishing grounds where there are no monk seals. Bottomfish fishermen also proposed to voluntarily retain all injured and/or dead catch and discard offal only after fishing operations have ceased and only if there are no monk seals in the area.

Other Endangered Marine Mammals

Other marine mammals listed as endangered under the Endangered Species Act that have been recorded in waters in which Council managed fisheries operate are the humpback whale (*Megaptera novaeangliae*), sperm whale (*Physeter macrocephalus*), blue whale (*Balaenoptera musculus*), fin whale (*B. physalus*), sei whale (*B. borealis*) and the North Pacific right whale (*Eubalaena glacialis*). With the exception of the Hawaiian monk seal, there have been no reported interactions with other endangered marine mammals in the bottomfish or crustacean fisheries of the region. There was one reported interaction of a sperm whale with the Hawaii longline fishery in 1999. The whale was released alive.

Humpback Whale

Humpback whales (*Megaptera novaeangliae*) can attain lengths of 16 m. These whales are black or gray, and have very long flippers, with white on the underside. The fins of the humpback have knobs on the edges. Four stocks of humpback whales inhabit the north Pacific basin, based on genetic and photo identification studies. Two stocks are recognized as eastern north Pacific stocks. One stock is recognized as a central north Pacific stock. Another stock is recognized as a

western Pacific stock. The central north Pacific stock of humpback whales winters in the waters of the MHI and feeds on the summer grounds of Southeast Alaska and Prince William Sound (Hill *et al.* 1997). Humpback whales feed on krill and small schooling fish. The two known feeding areas for the central north Pacific stock are Prince William Sound and southeastern Alaska. In Hawaiian waters, their distribution is almost exclusively within the 1,000 fm isobath and usually within 100 fm (Nitta and Naughton 1989). It is not unusual to observe humpback whales during the months of October to May in the nearshore waters off of the island of Oahu.

A population estimate of 1,407 whales for the north Pacific stock was derived using capture-recapture methodology (95% C.I. 1,113-1,701) for data collected in 1980-83 (Baker and Herman 1987). The current humpback whale population is estimated at between 3,500 and 5,000 individuals for the north Pacific (Calambokidis *et al.* 1997).

In 1995, a humpback whale in Maui waters was found trailing and entangled in numerous mooring lines (not fishery-related). The whale was successfully released, but subsequently stranded and was attacked and killed by tiger sharks in the surf zone. In 1996, one humpback whale calf was found stranded on Oahu with evidence of vessel collision (propeller cuts) (NMFS unpubl. data). In 1991, a humpback whale was observed entangled in longline gear and released alive (Hill *et al.* 1997). In 1998, a humpback whale was fouled in longline fishing gear. It was released alive. Very few observations of interactions with longline and other Hawaii fisheries have been documented (Dollar 1991; Nitta and Henderson 1993).

Sperm Whale

The sperm whale (*Physeter macrocephalus*) is the most easily recognizable whale with a darkish gray brown body and a wrinkled appearance. The head of the sperm whale is very large, comprising up to 40% of its total body length. These whales have a single blowhole on the left side of their head. The current average size for male sperm whales is about 15 m, with females reaching up to 12 m. Sperm whales primarily eat squid, but also some fish including salmon (*Oncorhynchus* spp.), rockfish (*Sebastes* spp.), and lingcod (*Ophiodon elongatus*).

Sperm whales are found in tropical to polar waters throughout the world (Rice 1989). The Hawaiian Islands marked the center of a major nineteenth century whaling ground for sperm whales (Gilmore 1959; Townsend 1935). Since 1936, at least five strandings have been reported from Oahu, Kauai (Nitta 1991), and Kure Atoll (Woodward 1972). Sperm whales have also been sighted around several of the NWHI (Rice 1960b), off the main islands of Hawaii (Lee 1993), in the Kauai channel and in the Alenuihaha Channel between Maui and the island of Hawaii (Shallenberger 1981). In addition, the sounds of sperm whales have been recorded throughout the year off Oahu (Thompson and Freidl 1982).

The stock identity of sperm whales in the north Pacific has been inferred from historical catch records (Bannister and Mitchell 1980) and from trends in CPUE and tag-recapture data (Ohsumi

and Masaki 1977), but much uncertainty remains. The status of sperm whales within Hawaiian waters in unknown.

There was one reported interaction of a sperm whale with the Hawaii longline fishery in 1999. A NMFS observer aboard a Hawaii longline vessel reported a whale hooked and entangled in a longline, and then released alive (NMFS Observer Program unpubl. data).

Blue Whale

The blue whale (*Balanoptera musculus*) is the largest living animal. Blue whales can reach lengths of 30 m and weights of 160 mt with females usually larger than males of the same age. Blue whales migrate long distances to forage for food. Their migration routes are well known and well studied by researchers. They are shallow feeders, primarily eating krill found within the top 100 m. They occur in all oceans, usually along continental shelves, but can also be found in the shallow inshore waters, and the high seas. There are three major populations of blue whales: the north Pacific, north Atlantic, and southern hemisphere populations. The north Pacific population tends to summer from central California to the Gulf of Alaska, and winter in the open waters of the mid-temperate Pacific at about 20° N latitude.

No sightings or strandings of blue whales have been reported in Hawaii. Acoustic recordings made off Oahu and Midway (Northrop *et al.* 1971; Thompson and Freidl 1982) islands have reported blue whales somewhere within the U.S. EEZ off of Hawaii. The recordings made on Oahu showed bimodal peaks throughout the year, suggesting the animals were migrating to the area in summer and winter. There have been no reported incidences of blue whales interacting with the Hawaii-based longline or other western Pacific regional fisheries.

Fin Whale

Fin whales (*Balanoptera physalus*) are found throughout all oceans and seas of the world from tropical to polar latitudes. They are rare in Hawaiian waters. There have been only two confirmed sightings off Oahu and a single stranding on Maui (Shallenberger 1981). Balcomb (1987) observed 8-12 fin whales in a multi species assemblage in May 1966 about 250 miles south of Honolulu. Thompson and Freidl (1982; and see Northrop *et al.* 1971) suggested that fin whales migrate into Hawaiian waters mainly in fall and winter, based on acoustic recordings off Oahu and Midway Islands. Although the exact positions of the whales producing the sounds could not be determined, at least some of them were almost certainly within the U.S. EEZ.

The status of fin whales in Hawaiian waters is unknown. Some of the whales taken by the commercial whalers in the north Pacific may have been from populations that migrate seasonally into the Hawaiian EEZ. There have been no reported interactions between fin whales and the Hawaii-based longline fishery or other Western Pacific Regional fisheries.

Sei whale

Sei whales (*Balanoptera borealis*) are rare in Hawaiian waters. They are distributed far out to sea in temperate regions and do not appear to be associated with coastal features. The harvest of sei whales has been distributed continuously across the north Pacific between 45° N and 55° N latitudes (Masaki 1977). Sei whales are now rare in California waters (Barlow 1995; Dohl *et al.* 1983; Forney *et al.* 1995; Mangels and Gerrodette 1994), but were the fourth most common whale taken by California coastal whalers in the 1950s-1960s (Rice 1974). They are extremely rare south of California (Lee 1993; Wade and Gerrodette 1993). There are no data on the abundance of sei whales in the eastern North Pacific. There have been no reported interactions between sei whales and the Hawaii-based longline fishery or with any other western Pacific regional fisheries.

North Pacific right whale

The North Pacific right whale (*Eubalaena japonica*) is a large baleen whale which is often found near coastal waters in the Gulf of Alaska and the Aleutian Islands. The whales are known to leave these feeding grounds during the winter months and migrate south, but the extent of their southern range is unknown. To date, no sightings of the North Pacific right whale exist in the region where the Hawaii longline fishery operates.

The adults are generally between 45 and 55 feet in length and can weigh up to 70 tons. The animal's girth is often close to its length, giving the whale a stout appearance with the head making up almost a fourth of the body's length. Females are larger than males. Overall, very little is known about the north Pacific right whale, except that it was hunted to near extinction by the whaling industry over the last eight centuries. Currently, the population is estimated to have fewer than 100 animals and the whale is considered one of the whale species most in danger of becoming extinct in the near future.

Right whales were first protected by the League of Nations in 1935, and later by the International Whaling Commission (IWC) in 1946. The whale was first listed under the Endangered Species Conservation Act in June 1970, and later listed as endangered under ESA in 1973. Collisions with ships, entanglements in fishing gear, degradation of habitat, and disturbances with natural behavior are threats that impede the recovery of the North Pacific right whale.

Non-Endangered Marine Mammals

Species of marine mammals that are protected under the Marine Mammal Protection Act (MMPA), but are not listed as threatened or endangered, and could occur in the areas where coral reef ecosystem fisheries operate are as follows:

- Pacific white-sided dolphin (*Lagenorhynchus obliquidens*)
- Rough-toothed dolphin (*Steno bredanensis*)
- Risso's dolphin (*Grampus griseus*)

- Spotted dolphin (*Stenella attenuata*)
- Spinner dolphin (*Stenella longirostris*)
- Striped dolphin (*Stenella coeruleoalba*)
- Bottlenose dolphin (*Tursiops truncatus*)
- Melon-headed whale (*Peponocephala electra*)
- Pygmy killer whale (*Feresa attenuata*)
- False killer whale (*Pseudorca crassidens*)
- Killer whale (*Orcinus orca*)
- Blainsville's beaked whale (*Mesoplodon densirostris*)
- Cuvier's beaked whale (*Ziphius cavirostris*)
- Pygmy sperm whale (*Kogia breviceps*)
- Dwarf sperm whale (*Kogia simus*)
- Bryde's whale (*Balaenoptera edeni*)

Only the Pacific bottlenose dolphin (*Tursiops truncatus*) was observed to interact with vessels targeting bottomfish management unit species in the NWHI (Nitta 1999). Fish theft by bottlenose dolphins occurred at about 5-10 fm from the surface during the handline retrieval, and the dolphins would often play with the fish for a few minutes before consuming them. Observers only sighted about 40 Spinner dolphins but these dolphins did not interact with the fishing vessels (Nitta 1999).

Sea Turtles

All sea turtles are designated under the Endangered Species Act as either threatened or endangered. The breeding populations of Mexico olive ridley turtles (*Lepidochelys olivacea*) are currently listed as endangered, as are leatherback turtles (*Dermochelys coriacea*) and hawksbill turtles (*Eretmochelys imbricata*). Loggerhead turtles (*Caretta caretta*) and green turtles (*Chelonia mydas*) are listed as threatened (note the green turtle is listed as threatened under the ESA throughout its Pacific range, except for the endangered population nesting on the Pacific coast of Mexico). These five species of sea turtles are highly migratory, or have a highly migratory phase in their life history, and therefore, are susceptible to being incidentally caught by fisheries operating in the Pacific Ocean. The Hawaii longline fleet is known to interact with all species, except the Hawksbill turtle. Recent regulations to protect turtles are found in section 3.3.2. "Pelagic Fisheries." Interactions with other Western Pacific pelagic FMP fisheries are unknown but believed to be quite rare. There have been no observed interactions between sea turtles and the bottomfish fishery.

Most sea turtle population estimates are generated from counts of nesting females. Sea turtles require between 14 (the assumed maturation time for the Mexican leatherback turtle) and 25 years to reach reproductive age, suggesting that there are an unknown number of juvenile and subadult turtles foraging the Pacific Ocean. Compounding the difficulties in estimating sea turtle populations is the fact that several life history characteristics and parameters—such as sex ratios, age-specific survival rates, and recruitment into the breeding populations—are also unknown.

For these reasons, turtle researchers can only submit estimates regarding the total population sizes figures for sea turtle species.

Population declines have occurred in several turtle species in the Pacific Islands as the result of nesting habitat loss and excessive and widespread harvesting for commercial and subsistence purposes (Eckert 1993). There are only two populations of loggerhead turtles in the Pacific, one originating in Australia where serious declines are occurring, and the other in southern Japan (Eckert 1993). Leatherback turtles inhabiting the Pacific mainly originate from nesting beaches in Mexico and Costa Rica where significant declines have been documented; from Indonesia where their status is uncertain but possibly stable; and from Malaysia where the nesting colony is nearly extinct despite 30 years of conservation measures (Eckert 1993).

Impacts to sea turtles in the western Pacific include: (1) legal harvest and illegal poaching of adults and their eggs; (2) incidental capture in fisheries (coastal and high-seas); (3) loss and degradation of nesting and foraging habitat as a result of coastal development, including predation by domestic dogs and pigs foraging on nesting beaches; (4) increased environmental contaminants (i.e., sewage); and, (5) entanglement or ingestion of marine debris.

Green Turtles

Green turtles (*Chelonia mydas*) are found throughout the western Pacific region. The genus *Chelonia* is composed of two taxonomic units at the population level, the eastern Pacific green turtle (or black turtle, *C. mydas agassizii*), which ranges from Baja California south to Peru and west to the Galapagos Islands, and the *C. mydas* in the remaining range (i.e., insular tropical Pacific, including Hawaii). The green turtle was listed under the ESA in 1978, due to its declining numbers associated with overexploitation for commercial and other purposes, habitat loss and degradation. Populations of green turtles in the Pacific region continued to be threatened by directed harvest (both legal and illegal) and negative impacts on essential habitats. The spread of fibropapilloma has also slowed the recovery of the green turtle population.

In the Hawaiian Archipelago, their distribution has been reduced in recent historical times, with breeding aggregations being eliminated and certain foraging areas no longer utilized in the main Hawaiian Islands. It is estimated that more than 90% of the Hawaiian population of the green turtle nests at French Frigate Shoals. Satellite tagging of these animals shows that most of them migrate to the MHI to feed and then return to French Frigate Shoals to breed.

The principal food sources for the green turtle are benthic marine algae of several genera. These algae are restricted to shallow depths where sunlight, substrate, and nutrients are conducive to plant growth. As a consequence, the feeding pastures used by green turtles are usually less than 10 m deep and frequently not more than 3 m deep, often right up to the shoreline (Balazs *et al.* 1987). The underwater resting sites include coral recesses, the undersides of ledges, and sand bottom areas that are relatively free of strong currents and disturbance from natural predators and humans. In the MHI, these foraging and resting areas for adults usually occur at depths greater than 10 m, but probably not normally exceeding 40 m. Available information suggests that the resting areas are in proximity to the feeding pastures.

An issue of concern with the Hawaiian green turtle is the increased interactions between the sea turtles and monofilament fishing line, believed to come from the recreational fisheries. Most of the sea turtles become entangled in the line with their front flipper, which severely strangulates the flipper and usually results in amputation.

Hawksbill Turtles

Hawksbill turtles (*Eretmochelys imbricata*) are circumtropical in distribution, generally occurring from 30° N to 30° S latitudes within the Atlantic, Pacific and Indian Oceans and associated bodies of water. The hawksbill turtle was listed as an endangered species on June 2, 1970, and in the Pacific, this species is rapidly approaching extinction primarily due to the harvesting of the species for its meat, eggs and shell, as well as the destruction of nesting habitat by human occupation and disruption.

Along the far western and southeastern Pacific, hawksbill turtles nest on the islands and mainland of southeast Asia, from China to Japan, and throughout the Philippines, Malaysia, Indonesia, to Papua New Guinea, the Solomon Islands (McKeown 1977) and Australia (Limpus 1992). Along the eastern Pacific rim, hawksbill turtles were common to abundant in the 1930s (Cliffton *et al.* 1982). By the 1990s, the hawksbill turtle was rare to nonexistent in most localities where it was once abundant, and there are no known nesting beaches remaining on the Pacific coast of Mexico or along the Pacific coast of Central America (Cliffton *et al.* 1982; Cornelius 1982). There are no population estimates for hawksbill turtles in Guam or CNMI, although it is known that the species nests on Rota, Saipan and Guam.

Within the State of Hawaii, hawksbill turtles are known to nest on the Hawaiian Islands of Maui, Molokai and Hawaii. Two nesting sites are located in the Hawaii Volcanoes National Park (NMFS 1992; Katahira *et al.* 1994). The peak nesting occurs from late July to early September (Katahira *et al.* 1994). There are no records of nesting hawksbill turtles or reported observations of their occurrence near the NWHI, although they may have occupied the region in the past. Hawksbill turtles appear to prefer nesting sites with steep beaches and coarse sand, and this may explain, in part, their presence in the MHI.

As a hawksbill turtle grows from a juvenile to an adult, data suggest that the turtle switches foraging behaviors from pelagic surface feeding to benthic reef feeding (Limpus 1992). The maturing turtle establishes foraging territory and will remain in this territory until it is displaced (Limpus 1992). As the life history of the hawksbill turtle suggests that the adult turtles tend to forage primarily in nearshore waters, this might offer an explanation as to why there are no reports of hawksbill turtles having been incidentally caught by the Hawaii-based longline fishery.

Leatherback Turtle

The leatherback turtle (*Dermochelys coriacea*) is the largest and most pelagic of the marine turtles and is listed as endangered throughout its range. In the Pacific, leatherback turtle populations are in severe decline. Primary threats to the species are the killing of nesting females and collection of eggs at the nesting beaches as well as incidental take in coastal and pelagic

fisheries. There are no nesting populations of the leatherback turtle in areas under U.S. jurisdiction in the Pacific; however, there are important foraging areas off the west coast of the continental U.S. and on the high seas near the Hawaiian Islands.

Leatherback turtles nest on exposed tropical beaches, and forage widely in temperate waters. Adult leatherback turtles are reported in the Pacific as far north as Alaska and the Bering Sea, and as far south as Chile and New Zealand. The largest known breeding populations of leatherback turtles occur on the Pacific coast of Mexico, notably in the states of Michoacan, Guerrero and Oaxaca. Other breeding sites are located on the shores of the Solomon Islands, Vanuatu, Fiji, China, Indonesia and Australia.

Reproduction is seasonal with females returning to breeding grounds every two or three years. Leatherback turtles reach maturity in about 13-14 years (Zug and Parham 1996). In Mexico, the nesting season extends from November to February, although some females arrive as early as August (Sarti *et al.* 1989). In the western Pacific, nesting peaks in May and June (Chu-Chien 1982), in peninsular Malaysia in June and July (Chan and Liew 1989) and in Queensland, Australia in December and January (Limpus 1984).

The diet of the leatherback turtle generally consists of cnidarians (i.e., medusae and siphonophores) in the pelagic environment (Bleakney 1965; Brongersma 1969; Davenport and Balazs 1991; Hartog and Nierop 1984). Hawaii fishermen in offshore waters commonly see leatherback turtles, generally beyond the 100-fathom curve but within sight of land. Two areas where sightings often take place are off the north coast of Oahu and the west coast of the Island of Hawaii.

On a few occasions leatherback turtles have been accidentally caught or entangled in fishing gear. Hawaii-based longline fishermen are known to incidentally catch leatherback turtles. Based on genetic analysis of mitochondrial DNA (mtDNA) leatherback stocks encountered in the Hawaii longline fishery are derived from two Pacific stocks: (1) the eastern Pacific region, which includes Mexico and Costa Rica originating leatherback stocks; and, (2) the western Pacific stock, which includes leatherback turtles which originate from nesting beaches in Malaysia, Indonesia and the Solomon Islands. There have been no reports of any interactions between the bottomfish fisheries and leatherback turtles in the region, although one leatherback turtle was entangled by a recreational fishing vessel off the island of Guam. In October of 1980, a leatherback turtle was found alive entangled in a lobster trap line near Kure Atoll. The turtle was released alive (NMFS 1996).

Loggerhead Turtles

The loggerhead turtle (*Caretta caretta*) is listed as a threatened species throughout its range. Major nesting grounds are generally located in warm temperate and subtropical regions, with some scattered nesting in the tropics. Nesting in the Pacific basin is restricted to the western region, primarily in Japan and Australia. There are very few records of loggerheads nesting on any of the many islands of the central Pacific, and the species is considered rare or vagrant on islands in this region (NMFS and USFWS 1998).

Tagging programs to study migration and movement of sea turtles provide evidence that the loggerhead turtles are highly migratory and capable of transpacific movement. Satellite telemetry studies show that loggerhead turtles tend to follow 17° C and 20° C sea surface isotherms north of the Hawaiian Islands (Polovina *et al.* 2000). Relationships between other turtle species and sea surface temperatures are likely but have not been documented.

Adult loggerheads nesting in Queensland, Australia, are primarily benthic feeders, preferring benthic invertebrates like gastropods, cephalopods, pelycepods, decapods, echinoderms and the occasional fish (Dodd 1988). Foraging also has been reported at sea off the west coast of Baja California, Mexico, where young juveniles were seen foraging on dense concentrations of a pelagic crab (*Pleuroncodes planipes*) (Bartlett 1989).

Based on genetic analysis of mitochondrial DNA (mtDNA) of loggerhead turtles encountered in the Hawaii longline fishery, the majority are derived from Japanese nesting populations. The loggerhead nests in the southern part of Japan, and the population is estimated at between 2,000 and 3,000. The data suggest the remainder of loggerheads encountered in the longline fishery are from the Australian stock. There have been no reported interactions of the bottomfish and crustacean fisheries with Loggerhead turtles.

Olive Ridley Turtles

The olive ridley (*Lepidochelys olivacea*) is one of the smallest living sea turtles (carapace length usually between 60 and 70 cm) and is regarded as the most abundant sea turtle in the world. The olive ridley turtle is listed as threatened in the Pacific, except for the Mexican nesting population, which is listed as endangered, primarily because of over-harvesting of females and eggs. Throughout the Pacific, this species has been exploited for food, bait, bone meal, fertilizer, oil and leather. Although the meat of the olive ridley turtle is palatable, its eggs are considered a delicacy.

The preferred nesting areas for the olive ridley occur in the Indian Ocean along the northeast coast of India (Mrosovsky 1993), and in the Pacific Ocean along the west coast of Mexico and Central America (Eckert 1993). In the eastern Pacific, the largest nesting concentrations occur in southern Mexico and northern Costa Rica, with very few turtles nesting as far north as southern Baja California (Fritts *et al.* 1982) or as far south as Peru (Brown and Brown 1982).

The olive ridley turtle is omnivorous and prey include a variety of benthic and pelagic prey items such as shrimp, jellyfish, crabs, snails, and fish, as well as algae and sea grass (Marquez 1990). It is also not unusual for olive ridley turtles in reasonably good health to be found entangled in scraps of net or other floating synthetic debris. Small crabs, barnacles and other marine life often reside on debris and likely attract the turtles. Olive ridley turtles also forage at great depths, as a turtle was sighted foraging for crabs at a depth of 300 m (Landis 1965). There have been no reported interactions between the bottomfish and crustacean fisheries and Olive Ridley turtles.

Seabirds

Although there are several seabird colonies in the MHI, the NWHI colonies harbor more than 90% of the total Hawaiian Archipelago seabird population. The NWHI provide most of the nesting habitat for more than 14 million Pacific seabirds. More than 99% of the world's Laysan albatross (*Phoebastria immutabilis*) and 98% of the world's black-footed albatross (*P. nigripes*) return to the NWHI to reproduce. Of the 18 species of seabirds recorded in the NWHI, only the short-tailed albatross (*P. albatrus*) and the Newell's shearwater (*Puffinus auricularis newelli*) are listed as endangered under the ESA, and there have been no reports of interactions between these species and Hawaii-based fishery operations. The short-tailed albatross population is the smallest of any of the albatross species occurring in the North Pacific with between 1,200-1,400 individuals. According to land-based sighting records, 15 short-tailed albatrosses have visited the NWHI over the past 60 years. Five of these visits were between 1994 and 1999 (NMFS 1999).

The black-footed and Laysan albatrosses that nest in the NWHI have occasionally been hooked by Hawaii pelagic longline fishing vessels. There are no reports of interactions between the fishery and the short-tailed albatross. Albatrosses are surface feeders and they tend to follow longline vessels and dive on the baited longline hooks as the vessels deploy or haul their fishing lines. To mitigate the harmful effects of fishing by Hawaii-based longline vessels on Laysan and black-footed albatrosses, the Council conducted a seabird mitigation study and an albatross population workshop in 1998. The Council also held several educational seminars with the fishermen to alert them to the issue. Several mitigation strategies to deter seabirds from fishing operations resulted from the mitigation study including dying squid blue, towing a buoy or tori line, and retaining offal. Longline fishermen can also reduce seabird interactions by setting at night or adding weight to their lines so they sink fast. Presently, the National Plan of Action for Seabirds (NPOA-s) provides guidance to the Councils, NMFS and the USFWS in reducing interactions between longline vessels and seabirds. The USFWS is the lead federal agency for the conservation of federally listed seabirds and consultation under section 7 of the ESA.

Only one seabird hooking event was observed on a bottomfish vessel when the vessel was trolling (Nitta 1999). A Laysan albatross dove on the trolling lure and became hooked. The bird was safely released alive. There have been no reports of the fishery interacting with either a short-tailed albatross or a Newell's shearwater. There have been no reported interactions between the crustacean fishery with either a short-tailed albatross or a Newell's shearwater.

In 1999, the Midway sport fishery reported nine interactions with Laysan albatrosses. Eight of the birds were entangled in fishing line and one bird was hooked by a recreational lure. All birds were released alive and no mortality was associated with the interactions. Even though the Midway sport fishery is small (five vessels in operation), there remains a possibility that the sportfishing vessels could incidentally capture an endangered short-tailed albatross, because the endangered seabird is known to frequent Midway Atoll. These recreational fishing vessels operate close to known seabird breeding colonies, and at times the seabird density surrounding their vessels may be great. Bottomfish vessels may also enter into areas of high seabird densities. At these times, and especially during trolling operations, all fishing vessels operating in these areas could reduce potential seabird interactions by towing seabird deterrent lines.

Threats to seabirds other than from fishing operations are introductions of invasive plants and animals, entanglement or ingestion of marine debris, collisions with aircraft and other human structures, lights, disease, human disturbance and urbanization.

Short-tailed Albatross

The short-tailed albatross (*Phoebastria immutabilis*) is the largest seabird in the North Pacific with a wingspan of more than 3 m (9 ft) in length. It is characterized by a bright pink bill with a light blue tip and defining black line extending around the base. The plumage of a young fledgling (i.e., a chick that has successfully flown from the colony for the first time) is brown and at this stage, except for the bird's pink bill and feet, the seabird can easily be mistaken for a black-footed albatross. As the juvenile short-tailed albatross matures, the face and underbody become white and the seabird begins to resemble a Laysan albatross. In flight, however, the short-tailed albatross is distinguished from the Laysan albatross by a white back and by white patches on the wings. As the short-tailed albatross continues to mature, the white plumage on the crown and nape changes to a golden-yellow.

Before the 1880s, the short-tailed albatross population was estimated to be in the millions and it was considered the most common albatross species ranging over the continental shelf of the United States (DeGange 1981). Between 1885 and 1903, an estimated five million short-tailed albatrosses were harvested from the Japanese breeding colonies for the feather, fertilizer, and egg trade, and by 1949 the species was thought to be extinct (Austin 1949). In 1950, ten short-tailed albatrosses were observed nesting on Torishima (Tickell 1973).

The short-tailed albatross is known to breed only in the western North Pacific Ocean, south of the main islands of Japan. Although at one time there may have been more than ten breeding locations (Hasegawa 1979), today there are only two known active breeding colonies, Minami Tori Shima Island and Minami-Kojima Island. On December 14, 2000, one short-tailed albatross was discovered incubating an egg on Yomejima Island of the Ogasawara Islands (southernmost island among the Mukojima Islands). A few short-tailed albatrosses have also been observed attempting to breed, although unsuccessful, at Midway Atoll in the NWHI.

Historically, the short-tailed albatross ranged along the coasts of the entire North Pacific Ocean from China, including the Japan Sea and the Okhotsk Sea (Sherburne 1993) to the west coast of North America. Prior to the harvesting of the short-tailed albatross at their breeding colonies by Japanese feather hunters, this albatross was considered common year-round off the western coast of North America (Robertson 1980).

In 1999, the breeding population of the short-tailed albatross was estimated at approximately 600 breeding age birds: 212 pairs on Torishima and 60 pairs on Minami-Kojima (65 FR 46643, July 31, 2000). Currently, short-tailed albatross have an annual survival rate of 96% and population growth rate of 7.8% (65 FR 46643, July 31, 2000). Because of the robust growth of the population at Torishima, and the fact that short-tailed albatrosses do not return to the colony until three or four years of age, a large number of these birds are dispersed at sea. Furthermore, at least 25% of the reproducing adults also remain at sea during each breeding season. As a

consequence, the exact number of individuals in the population is difficult to assess and at this time is estimated to be between 1,200-1,400 individuals.

The short-tailed albatross was first listed under the Endangered Foreign Wildlife Act in June 1970. On July 31, 2000, the USFWS extended the endangered status of the short-tailed albatross to include the species' range in the United States. The primary threats to the species are destruction of breeding habitat by volcanic eruption or mud and land slides, reduced genetic variability, limited breeding distribution, plastics ingestion, contaminants, airplane strikes, and incidental capture in longline fisheries.

Newell's Shearwater

The Newell's shearwater (*Puffinus auricularis newelli*) is listed as "threatened" under the ESA. and is considered to be in great jeopardy by the IUCN. Generally, the at-sea distribution of the Newell's shearwater is restricted to the waters surrounding the Hawaiian Archipelago, with preference given to the area east and south of the main Hawaiian Islands. The Newell's shearwater has been given this conservation status because of its small population size, approximately 14,600 breeding pairs, its isolated breeding colonies and the numerous hazards affecting them at their breeding colonies (Ainley *et al.* 1997). The Newell's shearwater breeds only in colonies on the main Hawaiian Islands (Ainley *et al.* 1997), where it is threatened by urban development and introduced predators like rats, cats, dogs, and mongooses. (Ainley *et al.* 1997).

Shearwaters are most active in the day and skim the ocean surface while foraging. During the breeding season, shearwaters tend to forage within 50-62 miles (80-100 km) from their nesting burrows (Harrison 1990). Shearwaters also tend to be gregarious at sea and only the Newell's shearwater is known to occasionally follow ships (Harrison 1990. Shearwaters feed by surface-seizing and pursuit-plunging (Warham 1990). Often shearwaters will dip their heads under the water to sight their prey before submerging (Warham 1990).

Shearwaters are extremely difficult to identify at sea, as the species is characterized by mostly dark plumage, long and thin wings, a slender bill with a pair of flat and wide nasal tubes at the base, and dark legs and feet. Like the albatross, the nasal tubes at the base of the bill enhances the bird's sense of smell, assisting them to locate food while foraging. The wedge-tailed shearwater may be more distinctive from the other species of shearwaters as it is slightly larger with flesh-colored legs and feet and has a long wedge-shaped tail (Harrison 1990). In addition, the wedge-tailed shearwater is also polymorphic, meaning that there are dark, light and intermediate plumage forms (Ainley *et al.* 1997).

Terrestrial-based Birds

Five terrestrial birds are species of particular concern: the Laysan duck (*Anas platyrhynchos laysanensis*), Laysan finch (*Telespyza cantans*), Nihoa millerbird *(Acrocephalus familiaris kingi*), Nihoa finch (*Telespyza ultima*), and the Micronesian megapode (*Megapodius laperouse*

laperouse). Although these land-based birds do not exist or depend upon the coral reef environment, per se, vessels transiting waters in the coral reef environment have the potential to introduce invasive species taxa like snakes, rats, rabbits, ants or other nuisance through the discard of floating debris or in the event of a vessel grounding.

Both snakes and rats (*Rattus spp.*) are known predators of birds, and rats can consume seeds or plants that the birds are dependent upon for food. The brown tree snake (*Boiga irregularis*) is present in Guam and has been sighted on Saipan. Laysan millerbirds (*Acrocephalus familiaris*), Laysan rails (*Porzanula palmeri*), and the Laysan honeycreeper (*Himotione sanuinea freethi*) became extinct sometime between 1915 and 1923 because of the introduction of rabbits to the island. Laysan millerbirds were also transplanted to Midway Atoll but were eliminated in 1944 when rats where introduced. Since then rats have been eradicated from Midway, and no rats are present on any of the NWHI. If rats were to become established in the NWHI, they would pose an enormous threat to the birds by preying on eggs and chicks, and by destroying vegetation. However, rats and mice (*Mus musculus*) are present on islands at other Pacific remote areas including Guam, the Mariana Archipelago, and American Samoa. There have been no reported interactions between the bottomfish and crustacean fisheries with any terrestrial-based birds or plants.

Laysan Duck

The Laysan duck (*Anas platyrhynchos laysanensis*) is also known as the Laysan teal because of its small size. It has a mallard origin, and is dark brown with a bright purple-green speculum (plumage surrounding the eye) bordered with white. The feet and legs are orange in both sexes, but the coloration is deeper in the males. Male Laysan ducks have a blue-green bill with black spots along the top. The females have a dull, brownish yellow bill with black spots along the outer boarders of the upper bill.

The Laysan duck is primarily insectivorous feeding on brine flies (*Neoscatella sexmaculata*) and brine shrimp (*Artemia* sp.). The species also search the sand for larvae and pupae of flies and beetles near seabird carcasses, and some feed on crustaceans and other littoral forms from the tidal pools.

Populations of Laysan ducks fluctuate naturally from 500-600 to less than 100 individuals (USFWS 1982). Between 1958 and 1972, a total of 545 Laysan ducks were banded: 36 were taken to the Honolulu Zoo; of the 388 adult Laysan ducks banded, 228 were males and 160 were females (USFWS 1982). Several banded ducks have been retrapped 10-12 years later but no band recoveries have been reported off of Laysan Island.

The Laysan duck was listed under ESA in 1964, due to the vulnerability of the species and its habitat to human disturbances, and to severe storms and possible introductions of rats. Because of the limited habitat of the island, and the vulnerability to natural and anthropogenic (human-caused) catastrophes, the Laysan duck will most likely always be considered a threatened species (USFWS 1982).

Laysan Finch

The Laysan finch (*Telespyza cantans*) has a distinctive, heavy conical bill which is blue to gray in color. The male adults of the species have a bright yellow head, throat and breast, with dark green to black streaking on the upper back blending to gray on the lower back. Females are brownish streaked all over with more black above and a faint wash of greenish-yellow on their breast. The Laysan finch was listed under the ESA on March 11, 1967.

By 1936, there were an estimated 1,000 Laysan finches on the island and by 1950, the population consisted of an estimated 5,000 birds (Brock 1951; Ely and Clapp 1973). In 1983, the population reached about 10,000 birds (USFWS 1984) and has remained relatively stable.

The Laysan finches are seed eaters, although they will forage on a variety of plant and animal material (USFWS 1984). They have been known to forage on seabird eggs and on dead seabird carcases for emerging fly larvae or for other invertebrates. The birds lay 2-4 eggs from late April to early June, with most chicks fledging by late July or early August.

In the past, the introduction of rabbits (*Oryctolagus cuniculus*) to Laysan Island caused the extinction of the Laysan rail (*Porzana palmeri*), Laysan millerbird (*Acrocephalus familiaris familiaris*), and the Laysan honeycreeper (*Himatione sanguinea freethi*). The rabbits were eradicated from Laysan in 1924 – but not until they had defoliated the island.

Nihoa Millerbird

The Nihoa millerbird (*Acrocephalus familiaris kingi*) is endemic to Nihoa Island and has never been transplanted to any other area. It is a relative of the Muscicapidae (thrushes), and has a thin dark-colored bill. The bird is small with dark gray-brown plumage on the back and buffy-white plumage on the breast. It was listed under ESA in 1967.

Compared to the Nihoa finches, the millerbirds are relatively secretive and encountered in dense, low shrubs (*Sida* and *Chenopodium*). They tend to hop, run, or fly about in the underbrush and scarcely ever leave cover.

The Nihoa millerbirds strictly eat terrestrial arthropods, and earned their name by eating the endemic "miller" moth (*Helicoverpa pallida hihoaensis*). The Nihoa millerbird nesting is linked to availability of terrestrial arthropods and consequently, variation in the weather can shift nesting periods by several weeks from year-to-year. Generally, the birds begin nesting between January and May, and the average clutch size is two eggs.
Due to their seemingly secretive behavior, the birds have been difficult to survey. From the late 1960s to the mid 1970s, the USFWS conducted line transect censuses for both the Nihoa finch and millerbird. These surveys demonstrated that about 200-600 millerbirds existed on Nihoa.

Nihoa Finch

The Nihoa finch (*Telespyza ultima*) is endemic to Nihoa Island and resembles the Laysan finch in many ways. The plumages of the two species are similar but the Nihoa finch is smaller overall than the Laysan finch.

The Nihoa finch was listed under ESA in 1967, and estimates from 1964 through to 1975 suggest that a population of 3,000-5,000 birds existed. The population estimate for the early 1980s was about 1,600 birds. However, the range of the population tends to change from year-to-year possibly due to changes in the carrying capacity of the habitat for Nihoa finches (USFWS 1984).

Nihoa finches are widespread over the island and are often seen near rocky outcroppings where they nest in holes in the rock. The birds prefer open and vegetated habitat, eating a wide variety of plant material (Conant 1983). Like the Laysan finch, the Nihoa finch are omnivorous and will forage on abandoned or unattended seabird eggs, and will congregate near the few seeps or freshwater pools on the island. Nesting may extend from early February to early July, with fledging occurring into August.

Micronesian Megapode

The Micronesian Megapode (*Megapodius laperouse laperouse*), commonly known as the *sasangat* (Chamorro) or *sasangal* (Carolinian), is a pigeon-sized bird that defends year-round territories to secure adequate foraging areas. A minimum territory size is about one hectare (2.47 acres) (Glass and Aldan 1988). The Micronesian megapode is present on 12 islands in the Mariana Archipelago. Small remnant populations exist on the southern Mariana Islands of Aguiguan, Tinian, Saipan, and Farallon de Medinilla while larger populations are present on the northern uninhabited Mariana Islands of Anatahan, Guguan, Sarigan, Alamagan, Pagan, Ascuncion, Maug, and possibly Agrihan (USFWS 1998a). The total number of individuals throughout the Mariana Archipelago is estimated to be between 1,400 and 1,975 birds (USFWS 1998a).

Megapodes are sometimes called incubator birds because they rely on alternative heat sources to incubate their eggs (Clark 1964). They tend to select nest sites in sun-warmed cinder fields or areas warmed by geothermal heat. Alternative nest sites include roots of rotting trees, logs, and in patches of rotting grasses. The birds lay a single large egg and may lay additional eggs during a five or six day period (Glass and Aldan 1988).
Megapodes are capable of flying over water for considerable distances, such that they could fly the 2.9 miles (4.6 km) between Saipan and Tinian, and the 5.5 miles (8.9 km) between Tinian and Aguiguan, but they would find the 18-37 miles (30-60 km) between adjacent northern islands difficult.

The megapode was listed as an endangered species on June 2, 1970, and the USFWS believes that the level of threat to the bird is moderate and that there is a high rate of recovery (USFWS 1998a). Current threats to the megapode include habitat degradation by feral ungulates and

urbanization, competition with introduced galliformes, military training activities, and predation by introduced monitor lizards, cats, rats, pigs, and dogs. The Micronesian megapode is also threatened by potential drought, typhoons, and volcanic activity. The greatest potential threat to the megapode is the establishment of brown tree snakes on the islands north of Guam.

Terrestrial Plants

Five land-based plants, four species on Nihoa Island and one on Laysan Island, are species of particular concern under ESA. It is suggested that vessels transiting waters in the coral reef environment have the potential to introduce invasive species taxa like snakes, rats, ants, or nuisance plants through the discard of floating debris or in the event of a vessel grounding. Currently, no rats are present on any of the NWHI, but rats (*Rattus spp.*) and mice (*Mus musculus*) are present on islands at other Pacific remote islands including Guam, the islands of CNMI, and American Samoa.

All of the plants of particular concern are located in the NWHI. *Sesbania tomentosa* (legume), *Schiedea verticillata* (fleshy root herb), *Pritchardia remota* (palm), *and Amaranthus brownii* (weedy herb) are plants of concern located on Nihoa Island. *Mariscus pennatiformes* (sedge) is a plant of particular concern on Laysan Island, as well as *Cenchrus agriminioides* (*kamanomano*), but the latter is now thought to be extinct (Morin and Conant 1998). Competition with alien plants like pigweed (*Portulaca oleracea*) are threatening *Amaranthus brownii* and *Schiedea verticillata* on Nihoa. Rabbits had totally defoliated Laysan Island by 1924, causing the extinction of three plants, five arthropods, and three bird species. *Mariscus pennatiformes* managed to return after the defoliation but is now threatened by alien plants like *Cenchrus echinatus* (weedy sand burr), *Pluchea indica* (woody plant), and *Conyza bonariensis* (weedy composite).

Sesbania tomentosa

Sesbania tomentosa is a perennial legume (Papilionoideae) endemic to the Hawaiian Islands. While generally recognized as a single species (Wagner *et al.* 1990), one author (Char 1983) split the taxon into seven distinct species with an additional two subspecies. Growth forms of the plant range from being low and sprawling to somewhat arborescent, reaching heights of up to 6 m. Flowers range from light yellow to deep scarlet and are lightly fragrant, emitting a "fruity" odor. While some flowers may be found within a population throughout the year, flowering peaks after winter rains (February-March) and declines throughout the summer and fall months with the onset of the dry season (Char 1983; D. Hopper, pers. comm.).

Sesbania tomentosa is most commonly associated with dry, coastal habitats, but can be found at elevations greater than 600 m. The species has declined throughout its range and the small scattered populations and individuals now present are relicts of what was once a widespread endemic species (Wagner *et al.* 1990).

Populations of *S. tomentosa* have declined throughout the state and this is exemplified on the most populated island, Oahu, which was recorded as having four known populations in the 1930s, but only a single population by 1990 (TNC (The Nature Conservancy of Hawaii) 1998). Frequently cited reasons for the decline of *S. tomentosa* include herbivory by introduced ungulates and arthropods (Howarth 1985; Wagner *et al.* 1990), encroachment by alien plants, damage from off-road vehicles, fire, and other sources of habitat destruction (Athens 1997). In 1994, *S. tomentosa* was listed by the federal government as endangered.

Schiedea verticillata

Schiedea verticillata is a member of the pink family (Caryophyllaceae), a short-lived perennial herb which dies back to an enlarged fleshy root, especially during the dry seasons. The species' stems are about 0.4 -0.6 m (1.3 -2 ft) in length which are upright or sometimes hanging. *Schiedea verticillata* was listed under ESA in 1996.

Schiedea verticillata typically grows in soil pockets and cracks on coastal cliff faces at elevations between 30 and 242 m (100-800 ft). In 1983, there were six populations containing a total of 385 - 414 individuals (Conant 1985). In 1992, only 170-190 plants remained in these six populations. However, in 1997 there were a total of 359 plants in ten populations (Rowland 1997).

Although the population numbers appear stable, this plant is particularly susceptible to landslides and rock slides (USFWS 1998b). It is unknown if alien plants and insects are posing a threat to the species, but fire and other human disturbance are potential threats. In addition, it is thought that this plant may be at greater risk of extinction if rats were introduced to Nihoa because of their fleshy root, a rich food source for rodents.

Pritchardia remota

Pritchardia remota or *loulu*, is a member of the palm family (Arecaceae), and stands up to 5 m (16 ft) in height with a ringed, wavy trunk about 15 cm (5.9 inches) in diameter. It is a long lived perennial and the populations on Nihoa have remained stable for several years (USFWS 1998a). The plant was first listed under ESA on August 21, 1996.

Most of the populations of *Pritchardia remota* are located in scattered small groves in two valleys. The means of pollination are unknown, but a variety of insects have been observed visiting the flowers (D. Hopper, pers. comm., as cited in USFWS (US Fish and Wildlife Service) 1998b). *Pritchardia remota* provides nesting and other habitat for red-footed boobies, and perching space for brown noddies (Conant 1985).

Due to the small numbers of populations and individuals, and its limited distribution, this species is threatened by stochastic extinction and/or reduced reproductive vigor (USFWS 1998b). Alien plant and insect species on the island may be posing threats. Rodent predation as well as flash floods, fire, and human disturbances are other threats (USFWS 1998b).

Amaranthus brownii

Amaranthus brownii is a member of the amaranth family (Amaranthaceae) and is endemic to Nihoa Island. It is an annual herb with leafy upright or ascending stems, 30-90 cm (1-3 ft) long. This species can be distinguished from other Hawaiian members of the genus by its spineless leaf axils, its linear leaves, and its fruit which does not split open when mature (Wagner *et al.* 1990). It is believed that fewer than 40 individuals exist (USFWS 1998b).

The plant typically grows in shallow soil on rocky outcrops and is found in fully exposed locations at elevations between 30 and 242 m (100-800 ft). It is easiest to find and identify in the winter and its growing season extends between December and June or July (Conant 1985). The means of pollination are unknown. In 1983, the two known colonies of *A. brownii* contained about 25 plants: one colony of about 23 plants near Miller's Peak and about 12 plants in three small colonies in Middle Valley. Although there have been annual surveys since 1983, no plants have been seen in either location since 1998. Even though seeds were collected before its disappearance, the resulting germination and survival rates of seedlings were very low, suggesting a reduction in the reproductive vigor of the species (Wagner *et al.* 1985; 1986; 1990). The plant may have disappeared in the known colonies due to the introduction of pigweed, an alien species that grows well in habitat similar to *A. brownii.*

Amaranthus brownii was listed as an endangered species on August 21, 1996. Currently, the USFWS plans to conduct winter surveys to get an accurate population count and to collect seeds and cuttings to establish *ex situ* populations (USFWS 1998b).

Mariscus pennatiformes

Mariscus pennatiformes (subspecies *bryanii*) is a very rare sedge endemic to Laysan Island. Since the defoliation of Laysan Island by rabbits in the early 1900s, the plant has had only small populations. Only 12 individual plants existed in 1980, and now there are about 100 plants (M. Bruegmann, pers. comm.). The plant was listed as endangered under ESA in 1994.

M. pennatiformes tends to prefer moist soil and so now it is confined to the south end of the lagoon (Morin and Conant 1998). It once was widely distributed across the island (Schauinsland 1899); and it may have been important habitat for the now extinct Laysan millerbird and the Laysan honeycreeper, and perhaps the Laysan finch (Morin and Conant 1998). The Laysan finches eat seeds from almost all species that occur on the island, and so the seeds of *M. pennatiformes* should be considered a food source for the Laysan finch (Morin and Conant 1998).

Due to the small numbers of populations and individuals, and its limited distribution, this species could be threatened by stochastic extinction and may have reduced reproductive vigor. The plant is also threatened by burrowing birds, and/or Laysan finches that feed on seedlings and young shoots (Morin and Conant 1998). The plant could also be threatened by the introduction of rodents or other alien plant species.

The USFWS recovery efforts include propagation of *M. pennatiformes* on-site in temporary greenhouses, and out-plant only after reaching a relatively bird-resistant size (Morin and Conant 1998). In addition, the Laysan Island Ecosystem Restoration Plan outlines a 20-year plan to eradicate at least 12 of the 13 nonnative plants on Laysan Island, replacing alien vegetation with appropriate native species (Morin and Conant 1998).

Invasive Species

Executive Order 11987 issued in 1977, directs federal agencies to restrict the introduction of exotic species into natural ecosystems under their jurisdiction and to encourage states to do the same. Executive Order 13112 issued February 1999, directs federal agencies to prevent the introduction of invasive species and provide for their control. It also established the Invasive Species Council and directed them to write an invasive species management plan within 18 months. In addition, the National Invasive Species Act of 1996 (NISA) directed the U.S. Coast Guard to promulgate voluntary guidelines for ballast water management and other ship's operations to reduce the number of alien species introduced to the waters of the US.

In general, alien species can be introduced to island ecosystems from fishing and non-fishing vessels in the Pacific region by: (1) ship wreck; (2) accidental discard of floating materials harboring alien species; (3) hull fouling; (4) live holding and bait wells; and (5) exchanging ballast water. A report by the Environmental Defense Fund shows that about 400 of the 1,177 species listed as threatened or endangered are at risk from invasive species. It is estimated that invasive species cost the U.S. $122 billion annually. Vessel ballast water is the most common pathway for marine species transfer throughout the world. It is estimated that 21 billion gallons of ballast water is dumped into U.S. ports each year, and this water can transport a wide variety of healthy species, including viruses, bacteria, protists, fungi and molds, plants and animals and their various life stages. Consequently, the U.S. and other nations around the world are requiring vessels to practice proper ballast water management measures when transiting from one region to another.

International attention has also been given to invasive species issues. On November 27, 1997, the International Maritime Organization developed guidelines which outline techniques for minimizing introductions from cargo ship ballast discharge. These guidelines are expected to become part of the International Convention for the Prevention of Pollution from Ships (MARPOL). This would require the U.S. Congress to enact legislation detailed in the guidelines.

Endemic plants and insects on small islands and atolls, and the predators they support, are known to be especially vulnerable to the introduction of competing or consuming species (Elton 1958). This primarily is due to their isolation, with some island ecosystems in extreme isolation like the NWHI. On-island ecosystems' niches usually occupied by species present on continents often are vacant, leaving ample opportunity for an opportunistic invader to become quickly established. Invasive species of special concern in the Pacific region are snakes, rodents, ants, and plant species. Interestingly, a study by Chown *et al.* (1998) shows that there is a clear relationship between the number of humans visiting an island and the number of alien species present.

Brown Tree Snake

The brown tree snake (*Boiga irregularis*) was accidentally introduced in the 1950s to the island of Guam from the Admiralty Islands in the South Pacific. The brown tree snake is native to the Solomon Islands, Papua New Guinea, and northern Australia. This nocturnal, mildly venomous snake quickly spread throughout Guam and decimated the island's bird, lizard and mammalian populations. By the 1980s, the brown tree snake had caused a decline in native fauna, and 11 of Guam's 13 native forest birds had disappeared (Mac *et al.* 1998).

Although regulations governing the prevention of brown tree snake infestation have been promulgated by the CNMI legislature, a high risk remains that the snake will be introduced to other areas because: (1) the high abundance of snakes on Guam; (2) the tendency of snakes to hide in all sorts of artificial objects including vehicles, cargo containers and buildings; and, (3) the large volume of ship and air traffic from Guam to other parts of the world. Brown tree snakes have been found in and near transportation facilities on three other islands in the Mariana Archipelago, elsewhere in the Federated States of Micronesia, the Republic of the Marshall Islands, Okinawa, Diego Garcia, the State of Hawaii, and Corpus Christi, Texas (Fritts and Rodda 1998). The brown tree snake has already successfully colonized the island of Saipan in the CNMI. Current prevention efforts include maintaining trap lines at the ports, conducting night searches, and investigating snake reports. A sniffer dog program was established in the CNMI in 1998, and the program still checks cargo at the ports (USFWS 1998a). The Guam Department of Agriculture is setting snake traps around the Guam airport for similar reasons.

Rodents

Dispersed by human commerce, omnivorous rodents like the rat (*Rattus* sp.) and the mouse (*Mus musculus*) have become widely established on many Pacific islands, where their presence has resulted in extinctions and reductions in populations of numerous native species. In the Western Pacific Region, rodents are present in all island areas except the NWHI, where they have been recently extirpated from Kure Atoll and Midway Islands due to efforts by the USFWS and the State of Hawaii. Rats must be prevented from spreading from the main Hawaiian Islands to the NWHI, and efforts must be taken to control or exterminate rats in other island regions where they now exist. DeGange *et al.* (1995) state that rats are usually spread to additional islands around the world through moored vessels and shipwrecks. The USFWS representatives in the State of Alaska consider invasive rats as the greatest threat to the Aleutian Islands and have mounted an extensive rat eradication and invasive rat prevention program.

Ants

The introduction of alien insects, especially ants, to island ecosystems often results in a dramatic loss of native invertebrate species (Cole *et al.* 1992). Ants are especially lacking in much of the insular regions of the Pacific when compared to the rest of the tropics (Jourdan 1997). In addition to potentially damaging native plants and seeds, introduced insect species like ants may reduce or eliminate native insects that serve as pollinators. There is no successful form of biological control for invasive ants (Man 1994).

Some of the invasive ant species of particular concern are the fire ants (*Solenopsis* sp.), the little fire ant (*Wasmannia auropunctata*), the Argentine ant (*Iridomyrmix humilis*), and the big-headed ant (*Pheidole megacephala*). Another ant, *Anoplolepis gracilipes*, has invaded Christmas Island in the Indian Ocean. In 1999, theses ants were reported to have killed and eaten three million crabs (*Gecarcoidea natalis*) in 18 months.

Plants

Alien plants can change the large-scale functioning of a native island ecosystem and alter the population dynamics and community structure of native species (Vitousek 1992). One of the primary modes of transportation of invasive plant species is by the spread of seeds in mud on people's shoes.

Among the most destructive invading plants are various grasses like beardgrass *(Schizachyrium condensatum)*, buffelgrass (*Cenchrus ciliaris*), fountain grass (*Pennisetum setaceum*), and molasses grass (*Melinis minutiflora*), as well as broomsedge (*Andropogon glomeratus*). Some of the harmful plant species of high concern for the USFWS in the NWHI are the *Verbesina encelioides* (golden crownbread), *Cenchrus echinatus* (weedy sand burr), and *Setaria verticillata*. *Clidemia* is also an aggressive invading plant in parts of India, Southeast Asia, and the Pacific Islands, including the Hawaiian islands, where it was introduced about 1940 (Mac *et al.* 1998).

Measures to Reduce Introductions of Invasive Species in Island Ecosystems

Increased awareness to the potential harm invasive species pose to fragile island ecosystems is the first and foremost step to developing measures to help reduce any future potential introductions by fishing vessels. Since all vessels have the right to passage in the Pacific EEZ, including foreign vessels, it may be more efficient to develop a set of universal measures for all vessels fishing or transiting the region. Some of these measures could include:

1. Education and outreach with posters and brochures being developed for distribution;
2. All vessel supplies and clothing should be packed in plastic buckets with fitted lids or other sealable metal or plastic containers;
3. No cardboard boxes;
4. Wooden boxes should be treated, and the inside and outside surfaces painted or varnished to provide a smooth, cleanable finish that seals all holes;
5. Everyone changes footwear at dockside (i.e., practice vessel shoes and "street shoes");
6. All equipment should be kept thoroughly clean;
7. Cooking items should be cleaned and food items frozen, if freezable;
8. Have annual vessel risk assessments for possible invasive species introductions; and,
9. Employ brown tree snake sniffer dogs checks for vessels departing Guam and Saipan.

It is noted that the FMP will contain broad frameworking procedures to facilitate rapid rule-making if necessary to deal with problems identified after the plan is in effect. This could include additional measures to protect listed/protected species from any potential direct or indirect effects from fishing activities.

Currently, fishermen are prohibited from landing on any of the NWHI unless they have obtained a Special Use Permit from the USFWS and the permission from the Refuge manager. Fishermen are permitted, however, to transit through areas (right-of-passage), as are pleasure craft and foreign vessels.

U.S. Coast Guard Ballast Water Measures

The U.S. Coast Guard interim rule on ballast water management was published on May 17, 1999. These measures are intended to limit the introduction and spread of aquatic nuisance species into the waters of the United States. The new U.S. Coast Guard rule establishes voluntary ballast water management guidelines for all waters (except the Great lakes and sections of the Hudson River) of the U.S. and establishes mandatory reporting and sampling procedures for nearly all vessels entering U.S. waters. Ballast water exchange should occur only in water beyond the EEZ or where the water depth exceeds 2,000 m. Otherwise, vessel owners are encouraged to retain the ballast water on board. If the U.S. Coast Guard determines that the voluntary program is ineffective at controlling the introduction or spread of invasive species, the guidelines will become mandatory and carry civil and criminal penalties.

U.S. Fish and Wildlife Service, Pacific Remote Islands NWR Complex NWHI Special Use Permit

Anyone wishing to obtain access within refuge boundaries must contact the USFWS for a detailed explanation of the required permits and regualtions. This includes permission from the Refuge manager and an appropriate Special Use Permit (USFWS 2000). Kure Atoll and Midway Atoll are exempt from these requirements.

With the exception of Tern Island, French Frigate Shoals, the following rules apply:

- Clothing and Soft gear: any person landing boats at any island should have clean clothes[3] and shoes.
- Any personnel going ashore at any island and moving inshore from the immediate area in which waves are breaking at the time of landing must have new footwear[4], new or island specific clothes and new or island specific soft gear[5] all frozen for at least 48 hours.

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[3] *Clothing* means all apparel, shoes, socks, over and under garments.

[4] *New footwear* means never used and clean off the distributor shelf.

[5] *Soft gear* means all gear such as day packs, fanny packs, camera bags, and all contents within.

- At the discretion of the local USFWS representative, personnel from the NOAA ship R/V *Townsend Cromwell*, or any other vessel servicing the Refuge, may be allowed on shore to visit predesignated areas for guided tours. For such tours, personnel must have new footwear, clean clothes, and clean soft gear all frozen for at least 48 hours.
- Otherwise, any personnel entering any vegetated area, regardless of how sparse the vegetation, must have new footwear, new clothes and new soft gear all frozen for at least 48 hours.

If there is clothing or gear coming off Kure Atoll and Midway Atoll, the clothing and gear should never be offloaded to any of the other islands in the NWHI. This also means that special care needs to be taken to avoid contaminating gear storage areas and quarters aboard transporting vessels. The primary goal is to avoid contaminating supplies with seeds or insects from other islands. Soil cannot be transported to or between islands.

Tern Island has less stringent rules because it already has a number of established alien species. Equipment and supplies are not required to be previously frozen or fumigated, and can be offloaded at Tern Island in cardboard boxes or wooden containers.

Food items like tomatoes, ray sunflower seeds, alfalfa, and mustard seeds cannot be brought onto any of the NWHI, but other items—like mung beans, soy beans, and radishes—would not likely survive on the islands and are allowed for fresh greens. Bulk dried fruits are allowed but should be frozen solid for at least one day to kill any insects.

There are also additional special requirements for anyone wanting to land on Nihoa Island. First, access to Nihoa by permittees will only be allowed under the accompaniment and supervision of a Refuge Representative, who has authority to disallow access to the island, or order an immediate departure if conditions are violated in some way. In addition, all field equipment made of wood or fabric must be new and never used before, and previously used equipment must be either frozen or fumigated. And last, all clothing and personal effects must be cleaned and thoroughly inspected and all footwear must be new.

A Strategic Plan to Protect Island Ecosystems in Alaska from the Introduction of Rodents, U.S. Fish and Wildlife Service, Region 7, Alaska

In response to the increased threat of Norway rats (*Rattus norvegicus*) to seabirds in Alaska, the USFWS launched an effort to prevent further introductions and began to eradicate rats from infested islands. Part of this effort was directed by a Strategic Plan developed by DeGange *et al.* (1995) to Protect Island Ecosystems in Alaska from the Introduction of Rodents. The strategic plan discussed establishing education and outreach programs, as well as a cross-program Service team (rat pack) to prevent rats from being introduced to additional islands in Alaska.

To achieve these goals, the Alaska Maritime National Wildlife Refuge staff have joined with the people of the Pribilof Islands and the fishing industry to conduct training and inspection of vessels and commercial facilities. The USFWS is also developing a training video to show how to inspect ships for rodents, and how to set up a prevention program, and brochures and posters.

Because local residents were not aware of the threats rats pose to island faunas, continued media support was recommended as an essential part of the education process. The plan also recommended that the Refuge and other USFWS staff develop a school curriculum on seabirds which includes the rat issue.

DeGange *et al.* (1995) also discuss the necessity to develop a plan that outlines how the government should respond in the event of a shipwreck on an important seabird nesting island. The plan called for a mechanism for observers to report on the status of rodent infestations on individual ships. The rodent surveys are to assist officials with vessel risk analyses in the event of a shipwreck. Since the State of Alaska requires individuals to be certified to use rodenticides, the plan suggests that a corps of trained individuals be located in coastal Alaska to respond to shipwrecks in their area.

As the USFWS may have to rely on the U.S. Coast Guard for transportation and access to shipwreck sites, the plan suggests that a Memorandum of Agreement be developed defining the roles of each agency in responding to shipwrecks. The USFWS also plans to conduct research on the life history of rats, and compile data on their biology and distribution in Alaska, as well as investigate other methods to control or eradicate rats.

3.3 The Fishery Context

3.3.1 Ex-vessel Value of Coral Reef Resources

Tables 3.2 and 3.3a-3.3f summarize the recent approximate total annual ex-vessel value for each of the domestic marine fisheries of the Western Pacific Region's island groups. They focus on fisheries for coral reef resources, but rough estimates of the crustacean and precious corals fisheries (categorized as deep-bottom), and pelagic fisheries, also appear. This allows these fisheries to be compared to coral reef fisheries. It also highlights the potential follow-on effects of the management measures in this FMP. Table 3.2 is a regional summary, while tables 3.3a-

3.3f break down the information by island area. Monetary value is expressed in 1999 dollars. Ex-vessel values are the estimated total annual gross value of landings from each fishery, whether sold or not. The ex-vessel values for the sport sector represent charter fees. The landings value for these fisheries are included in the food sector. It should be noted that there is a variable, and in some cases quite high, level of uncertainty as to the accuracy of values in Tables 3.3a-3.3f.

The total annual ex-vessel value of the region's fisheries for coral reef resources in recent years has been about $15 million, $14 million of this derived from food fisheries (mostly bottomfish and lobsters), $1 million from ornamentals (from 0.5 million pieces) and $0.6 million from sport fisheries (from 12,000 angler-trips). The deep bottom fisheries (mostly bottomfish and lobsters harvested from greater than 50 fm) realized an approximate annual ex-vessel value of $4 million annually. The value of the natural products and mariculture sectors are assumed to be minimal, but more in-depth investigation might reveal otherwise.

Hawaii's share of total coral reef resource harvests is about 77%, or $12 million, of which 88% comes from the main islands and 12% from the Northwestern Hawaiian Islands. The ex-vessel value of Guam's harvested coral reef resources is about $1.6 million, the CNMI's about $1.3 million, and American Samoa's about $0.7 million.

Overall, it is very roughly estimated that 10% of the total ex-vessel value of harvested coral reef resources is taken in federal waters (or the "management zone" of the CNMI). The estimated percentages of total ex-vessel value caught in the FMP area are 1% in American Samoa, 4% in the CNMI, 8% in Guam, and 11% in Hawaii.

Table 3.2: Summary of annual ex-vessel value for Western Pacific Region fisheries ($,1,000/year).

	Am. Samoa		CNMI		Guam		MHI		NWHI		Other islands		All islands	
	Total	FMP	Total	FMP	Total	FMP	Total	FMP	Total	FMP	Total	FMP	Total	FMP
Coral reef:														
Food	671	8	1,217	54	1,214	118	9,391	1,075	1,295	12	22	21	**13,809**	**1,287**
Sport	m	0	80	4	306	15	71	7	159	159	0	0	**616**	**186**
Ornamentals	10	0	m	0	48	0	1,004	0	0	0	m	m	**1,062**	**m**
Natural products	0	0	0	0	0	0	?	?	0	0	0	0	**?**	**?**
Mariculture	m	0	0	0	0	0	?	0	0	0	0	0	**m**	**0**
Total coral reef	**681**	**8**	**1,297**	**58**	**1,567**	**133**	**10,465**	**1,082**	**1,454**	**171**	**22**	**21**	**15,486**	**1,472**
Deep bottom:														
Food	64	0	166	0	158	0	1,455	0	1,161	0	0	0	**3,004**	
Sport	m	0	30	0	306	0	707	0	m	0	0	0	**1,043**	
Ornamentals	0	0	0	0	0	0	0	0	0	0	0	0	**0**	
Total deep bottom	**64**	**0**	**196**	**0**	**463**	**0**	**2,162**	**0**	**1,161**	**0**	**0**	**0**	**4,047**	
Pelagic:														
Food	444	0	950	0	858	0	48,200	0	8,764	0	10	0	**59,226**	
Sport	10	0	900	0	1,238	0	14,000	0	159	0	0	0	**16,307**	
Total pelagic	**454**	**0**	**1,850**	**0**	**2,096**	**0**	**62,200**	**0**	**8,923**	**0**	**10**	**0**	**75,533**	
TOTAL	**1,199**	**8**	**3,343**	**58**	**4,127**	**133**	**74,827**	**1,082**	**11,538**	**171**	**32**	**21**	**95,066**	**1,472**

Values are approximate, recent, annual gross values of the production side of these fisheries, expressed in 1999 dollars (x 1,000).
"m" means minimal and unquantifiable.

Table 3.3a: American Samoa fisheries by area, annual volume, and ex-vessel value.

	Annual Total		% of harvest from FMP area	FMP portion	
	Volume (lbs)	Value ($1,000)		Volume (lbs)	Value ($1,000)
Coral reef area harvests:					
Food					
Finfish:					
live	0	0	0	0	0
dead	216,000	393	2	4,000	8
Crustaceans:	7,000	26	0	0	0
lobster					
other crustaceans					
Echinoderms	43,000	87	0	0	0
Molluscs:	73,000	146	0	0	0
mother-of-pearl					
other molluscs					
Other invertebrates	2,000	20	0	0	0
Seaweeds	min	min	0	0	0
Sport	min	min	0	0	0
Ornamentals					
Fishes and other	5,000	10	0	0	0
Hermatypic coral/live	min	min	0	0	0
Black coral	0	0		0	0
Marine natural products	0	0		0	0
Mariculture	min	min	0	0	0
Total coral reef area		**681**			**8**
Deep bottom area harvests:					
Food	27,000	64	0	0	0
Sport	min	min	0	0	0
Ornamentals	0	0	0	0	0
Total deep bottom		**64**			**0**
Pelagic fisheries:					
Food	400,000	444	0	0	0
Sport	120	10	0	0	0
Total pelagic harvests		**454**			**0**
Total all fisheries		**1,199**			**8**

All volume figures are in pounds per year, except the sportfishing sectors, which are in number of angler-trips per year, and ornamentals (except black coral), which are in number of pieces or organisms per year. "min" means minimal.

Table 3.3b: Northern Mariana Islands fisheries by area, annual volume and ex-vessel value.

	Annual Total		% of harvest from FMP area	FMP portion	
	Volume (lbs)	Value ($1,000)		Volume (lbs)	Value ($1,000)
Coral reef:					
Food					
Finfish:					
live	0	0		0	0
dead	446,000	1,070	5	22,000	54
Crustaceans:					
lobster	4,000	19	0	0	0
other crustaceans					
Echinoderms	25,000	68	0	0	0
Molluscs:					
mother-of-pearl molluscs	20,000	60	0	0	0
other molluscs					
Other invertebrates					
Seaweeds	min	min	0	0	0
Sport	1,600	80	5	80	4
Ornamentals					
Fishes and other inverts	min	min	0	0	0
Hermatypic coral/live rock	min	min	0	0	0
Black coral	0	0		0	0
Marine natural products	0	0		0	0
Mariculture	0	0		0	0
Total coral reef		**1,297**			**58**
Deep bottom:					
Food	50,000	166	0	0	0
Sport	300	30	0	0	0
Ornamentals	0	0		0	0
Total deep bottom		**196**			**0**
Pelagic:					
Food	500,000	950	0	0	0
Sport	9,000	900	0	0	0
Total pelagic		**1,850**			**0**
Total all fisheries		**3,343**			

All volume figures are in pounds per year, except the sportfishing sectors, which are in number of angler-trips per year, and ornamentals (except black coral), which are in number of pieces or organisms per year; "min" means minimal.

Table 3.3c: Guam fisheries by area, annual volume and ex-vessel value.

	Annual Total		% of harvest from FMP area	FMP portion	
	Volume (lbs)	Value ($1,000)		Volume (lbs)	Value ($1,000)
Coral reef:					
Food					
Finfish:					
live	0	0		0	0
dead	400,000	1,176	10	40,000	118
Crustaceans:					
lobster	5,000	19	0	0	0
other crustaceans					
Echinoderms					
Molluscs:					
mother-of-pearl	3,000	6	0	0	0
other molluscs	4,000	9	0	0	0
Other invertebrates	1,000	2	0	0	0
Seaweeds	some	unknown	0	0	0
Sport	10,000	306	5	510	15
Ornamentals					
Fishes and other inverts	24,000	48	0	0	0
Hermatypic coral/live	min	min	0	0	0
Black coral	0	0		0	0
Marine natural products	0	0		0	0
Mariculture	0	0		0	0
Total coral reef		**1,567**			**133**
Deep bottom:					
Food	45,000	158	0	0	0
Sport	10,000	306	0	0	0
Ornamentals	0	0			0
Total deep bottom		**463**			
Pelagic:					
Food	660,000	858	0	0	0
Sport	21,000	1,238	0	0	0
Total pelagic		**2,096**			**0**
Total all fisheries		**4,127**			**133**

All volume figures are in pounds per year, except the sportfishing sectors, which are in number of angler-trips per year, and ornamentals (except black coral), which are in number of pieces or organisms per year. "min" means minimal.

Table 3.3d: Main Hawaiian Islands fisheries by area, annual volume and ex-vessel value.

	Annual Total		% of harvest from FMP area	FMP portion	
	Volume (lbs)	Value ($1,000)		Volume (lbs)	Value ($1,000)
Coral reef:					
Food	1,004,900	9,391		540,001	1,076
Finfish:					
live					
dead	443,900	7,571	10	439,000	750
Crustaceans:					
lobster	10,000	128	0	0	0
other crustaceans	100,000	417	41	41,000	173
Echinoderms	1,000	11	3	0	0
Molluscs:					
mother-of-pearl					
other molluscs	369,000	925	16	60,000	150
Other invertebrates					
Seaweeds	81,000	339	1	1	3
Sport	500	71	10	50	7
Ornamentals					
Fishes and other	430,000	937	0	0	0
Hermatypic coral/live	min	min	0	0	0
Black coral	3,000	66	0	0	0
Marine natural products	unknown	unknown	unknown	unknownnn	unknown
Mariculture	unknown	unknown	0	0	0
Total coral reef		**10,465**			**1,082**
Deep bottom:					
Food	418,000	1,455	0	0	0
Sport	5,000	707	0	0	0
Ornamentals	0	0		0	0
Total deep bottom		**2,162**			**0**
Pelagic:					
Food	22,000,000	48,200	0	0	0
Sport	99,000	14,000	0	0	0
Total pelagic		**62,200**			**0**
Total all fisheries		**74,827**			**1,082**

All volume figures are in pounds per year, except the sportfishing sectors, which are in number of angler-trips per year, and ornamentals (except black coral), which are in number of pieces or organisms per year.

Table 3.3e: Northwestern Hawaiian Islands fisheries by area, volume and ex-vessel value.

	Annual Total		% of harvest from FMP area	FMP portion	
	Volume (lbs)	Value ($1,000)		Volume (lbs)	Value ($1,000)
Food					
Finfish:					
live	0	0		0	0
dead	19,000	14	82	16,000	11
Crustaceans:					
lobster	246,000	1,280	0	0	0
other crustaceans	min	1	51	min	min
Echinoderms	0	0		0	0
Molluscs:					
mother-of-pearl molluscs					
other molluscs	0	0		0	0
Other invertebrates	0	0		0	0
Seaweeds	0	0		0	0
Sport	375	159	100	375	159
Ornamentals					
Fishes and other inverts	0	0		0	0
Hermatypic coral/live rock	0	0		0	0
Black coral	0	0		0	0
Marine natural products	0	0		0	0
Mariculture	0	0		0	0
Total coral reef		**1,454**			**171**
Deep bottom:					
Food	371,000	1,161	0	0	0
Sport	min	min	0	0	0
Ornamentals	0	0		0	0
Total deep bottom		**1,161**			**0**
Pelagic:					
Food	4,000,000	8,764	0	0	0
Sport	375	159	0	0	0
Total pelagic		**8,923**			**0**
Total all fisheries		**11,538**			**171**

All volume figures are in pounds per year, except the sportfishing sectors, which are in number of angler-trips per year, and ornamentals (except black coral), which are in number of pieces or organisms per year; "min" means minimal.

Table 3.3f: Other islands fisheries by area, annual volume and ex-vessel value.

	Annual Total		% of harvest from FMP area	FMP portion	
	Volume (lbs)	Value ($1,000)		Volume (lbs)	Value ($1,000)
Coral reef:					
Food					
Finfish:					
live	0	0		0	0
dead	10,000	20	100	10,000	20
Crustaceans:					
lobster	200	1	0	0	0
other crustaceans	200	min	100	200	min
Echinoderms	0	0		0	0
Molluscs:					
mother-of-pearl molluscs					
other molluscs	100	min	100	100	min
Other invertebrates	0	0		0	0
Seaweeds	0	0		0	0
Sport	0	0		0	0
Ornamentals					
Fishes and other inverts	min	min	100	min	min
Hermatypic coral/live rock	min	min	100	min	min
Black coral	0	0		0	0
Marine natural products	0	0		0	0
Mariculture	0	0		0	0
Total coral reef		**22**			**21**
Deep bottom:					
Food	min	min	0	0	0
Sport	0	0		0	0
Ornamentals	0	0		0	0
Total deep bottom		**0**			**0**
Pelagic:					
Food	5,000	10	0	0	0
Sport	0	0		0	0
Total pelagic		**10**			**0**
Total all fisheries		**32**			**21**

All volume figures are in pounds per year, except the sportfishing sectors, which are in number of angler-trips per year, and ornamentals (except black coral), which are in number of pieces or organisms per year; "min" means minimal.

3.3.2. Summary of Existing FMPs in the Western Pacific Region

This section describes the fisheries managed under the Council's four already-implemented FMPs.

Northwestern Hawaiian Islands Bottomfish and Seamount Groundfish Fisheries

Before the implementation of the Bottomfish and Seamount Groundfish Fishery Management Plan, annual commercial bottomfish landings in the MHI and NWHI were estimated at 1.4 million pounds. During the 1960s, bottomfish landings decreased to 400,000 lbs. annually, but consequently rose back to over one million pounds in the 1970s, due to expanded local market and strong interest in the NWHI stocks. As a result of this expanding fishery, the Council implemented the Bottomfish FMP for bottomfish and seamount groundfish fisheries in the Western Pacific Region in 1986 and has amended this plan six times. Currently, in the NWHI, a maximum of 17 permits are assigned in two limited entry zones, the Ho`omalu Zone, with seven permits, and the Mau Zone, with 10 permits, two of which are designated for a Community Development Program. These 17 vessels fish an area approximately a quarter the size of the mainland U.S. and provide the State of Hawaii with more than one-half of its fresh premium-quality bottomfish. The fishery currently harvests less than 55% of the maximum sustainable yield and is valued at approximately $1 million per year. Bottomfishing occurs year-round and each Ho`omalu Zone permit holder must make a minimum of three trips and land 2,500 lbs. of fish (half bottomfish) to retain the permit. The most productive bottomfishing grounds include Brooks Banks, Laysan Island, Maro Reef, and Necker Island, respectively. However, productivity varies at banks by year. The most productive bottomfish depths are generally found between 50 and 100 fm and between 50% and 90% of the total bottomfish in the NWHI are caught at these depths. In certain years up to 20% of the total bottomfish landings is comprised of uku (Aprion virescens), a bottomfish management unit species in the shallow-water species complex.

There are no known mortalities of Hawaiian monk seals attributed to the NWHI bottomfish fishery. Furthermore, data from a NMFS observer program in the early 1990s concluded that the NWHI bottomfish fishery is generally not taking fish that are considered prey for monk seals and that the bottomfish management unit species are healthy, with none being overfished.

In the main areas where the fishery occurs in the NWHI, interactions with coral reef resources and habitats are very minimal. Bottomfish fishing for the deep-water species complex (i.e., *onaga*, *opakapaka*) primarily occurs between 50 and 100 fm, while coral reef substrate is defined to 50 fm. There may be some anchor damage in waters less than 50 fm where there are steep drop-offs.

Summary of Regulations and Reporting

- The owner of any vessel used to fish for bottomfish management unit species in the NWHI must possess either a Mau Zone permit, or a Ho`omalu zone permit. A single vessel may not be registered in both zones concurrently.
- Possession and use of bottom trawls and bottom set gillnets is prohibited.
- Permits are non-transferrable.
- Establishes limited-entry into Hoomalu and Mau Zones based on prior qualified landings of bottomfish MUS.
- Implements a use-it-or-lose-it requirement for permit renewal of vessels.
- The possession and use of any poisons, explosives, or intoxicating substances for the purpose of harvesting bottomfish managed unit species is prohibited.
- The fishery is subject to mandatory logbook reporting using the State of Hawaii NWHI bottomfish forms.
- Permitted vessels may not exceed 60 ft in length, unless approved by the Regional Administrator in consultation with the Council.
- Each permit holder must attend a NMFS protected species workshop.
- Each permit holder must notify the Regional Director before fishing within any protected species study zone in the NWHI.

In addition to those regulations stated above, participants in the NWHI fishery are required to complete the State of Hawaii Daily Bottomfish Catch Report. This form includes space for recording the number of bottomfish MUS and other animals kept and discarded. This form includes the areas fished, weather conditions and the date and time the gear was deployed. There is also space for recording the numbers of Hawaiian monk seals, sea turtles, and other protected species observed in the area.

Habitat Impacts

Bottomfish gear has very limited impacts on habitat. Habitat damage may occur from deployment of anchors during deep water fishing activities. However, damage is highly localized because the total targeted fishing habitat is limited to the 100 fm contour in areas with high relief. Anchoring during fishing operations is generally conducted at depths from 40-60 fm, with depths ranging from 30 to 175 fm. Reef-building corals are generally not found below 50 fm, the lower extent of light attenuation. It is estimated that suitable bottomfish habitat where vessel anchoring might occur represents approximately 1% of the total bank habitat. Shallow-water bottomfishing activities are conducted while drifting or trolling therefore minimizing the potential for anchor damage. Submersible studies done in 2001 on bottomfishing banks in the NWHI have reported minimal evidence of fishing impacts to habitat (C. Kelley pers comm 2001).

Target Resources

The domestic bottomfish fishery in the Western Pacific Region primarily targets deep-sea snappers and groupers. Generally, the following deep-water snapper and grouper species are sought after because of their high market values: *kalekale (Prisipomoides seiboldi), opakapaka (P. Coruscanus), gindai (P. Zonatus), ehu* or red snapper *(Etelis carbunculus),* and sea bass *(Epinephelus quernus).* The fishery also targets a shallow-water bottomfish species, *uku (Aprion virescens)*, which is caught bottomfishing and trolling in waters between 15-30 fathoms.

Gear Description and Use

The standard bottomfish gear is a hydraulic or electric handline hauler with a 130-lb. test mainline and terminal rigs, to which the hooks and lead weight are attached. Generally, the terminal line consists of about twelve hooks spaced at 7-8 ft intervals with a 2- to 6-lb. lead weight attached at the end of the line. A chum bag is attached just above the last hook and filled with finely chopped fish. Each hook is baited with fish or squid, and the gear is lowered into the water.

Depending on species targeted, the gear is lowered at depths ranging from 50-150 fm. Using years of acquired knowledge and advanced electronic equipment, such as sonar fish finders and geographic positioning systems, target species are easily located and the gear can be accurately placed within a few meters above those substrates. Ideally, the gear is placed one fathom above the bottom in order to effectively attract target species. If the gear is set on the bottom, target species may not be enticed to take the bait. If set too high in the water column, it may deter target species wary of predation by larger predators. Once the gear is placed in its ideal location, it is jerked sharply to release the contents of the chum bag. The mainline is then hauled either by hand, hydraulic gurdy or electric reel. Vessels drift or anchor during gear deployment, depending on weather conditions, ocean currents, species targeted, and other variables. Because most of the target species are found in areas with a steep slope, vessels usually deploy gear close to the minimum depth contour and drift out to deeper water.

Incidental Catch and Bycatch

Being a hook-and-line rig, this gear is relatively selective, with the ability to successfully target particular species groups, depending on the skill of the fisher. Experienced vessel crews have the ability to catch the desired species with very little bycatch. Gear is deployed at specific depths and in areas of certain habitat characteristics (e.g., high relief). It is, however, impossible to completely avoid non-target species.

Logbook data and research programs conducted by the State of Hawaii and NMFS reveal that bycatch accounts for approximately 8-19% of the total catch in bottomfish fisheries in the Hawaiian archipelago. Sharks, oilfish, snake mackerel, pufferfish, and moray eels are the most numerous discard species; they are not kept by vessels because of their unpalatability. Some carangids (large jacks and amberjacks) are also discarded because of concerns about ciguatera

poisoning. It should be noted that a large percentage of the snappers and the groupers are included as bycatch because of damage from sharks.

Northwestern Hawaiian Islands Lobster Fishery

The Crustaceans FMP establishes management measures for the spiny and slipper lobster fishery in the NWHI, and is considered one of the most tightly regulated and conservative management plans for lobsters. The principal species targeted by this fishery are the spiny lobster, Panulirus marginatus, and the common slipper lobster, Scyllarides squammosus. Other management unit species include Panulirus penicillatus, another spiny lobster species; other slipper lobster species in the family Scyllaridae; and Kona crab, Ranina ranina. It was not until the late 1970s that development of the lobster fishery in the NWHI was fully realized, following surveys by NMFS that suggested its commercial potential. The FMP for the lobster fishery was adopted in 1983. Landings reached a record high by 1988. However, in the early 1990s lobster catches fell dramatically, but not due to overfishing. A long-term cyclic change in abundance resulted from a broad climate-induced reduction in overall oceanic productivity, which resulted in lower abundance of resources throughout the food web of the NWHI. The FMP was amended accordingly by limiting entry and imposing a fleet-wide seasonal harvest quota among other measures. Highlights of the NWHI lobster fishery include the following:

- The NWHI lobster fishery is a million-dollar industry in which commercial fishing vessels target red spiny and slipper lobsters.
- NWHI banks most important to the fishery include Necker, Maro, Gardner, Pearl and Hermes, Kure, Lisianski and Nihoa at depths between 10 and 35 fm.
- The fishery uses a "retain-all" strategy (where all lobsters caught are counted against the quota) since research suggested that more than 60% of lobsters that are released from the vessels die from predation or exposure.
- The annual harvest guideline for the NWHI fishery is determined based on 13% of the estimated exploitable lobster population (i.e., those lobsters taken in traps). This allows no more than a 10% risk of overfishing.
- Lobster populations in the NWHI are considered healthy. MSY for the NWHI is estimated to be about 220 mt (300,000 lobsters). The harvest guideline in recent years has been substantially less.

In 2000, NMFS closed the fishery due to uncertainties in their population assessment model. A recent NMFS declaration proposes to keep the fishery closed for up to two years more, while allowing research at the major banks.

Summary of Regulations

- Lobsters may only be taken by lobster trap or by hand. (Use of nets, chemicals, explosives, hooks or spears is prohibited.)
- Escape panels with a specified minimum opening size are required in traps.
- Assembled traps are limited to 1,100 per vessel (1,200 total traps).
- Traps may not be left unattended in the water except in the event of an emergency.
- Closed areas include a 20-nm protected species zone around Laysan Island and all federal waters shallower than 10 fm. (Federal waters 0-50 fm around French Frigate Shoals and the northern half of Midway would also be closed under the Coral Reef Ecosystem FMP.)
- The NWHI fishery is closed from January to June, but it typically only lasts one to a few months a year.
- Logbooks are mandatory and data collectors or observers can be required, if requested by NMFS.
- The limited entry program allows at most 15 permits, of which only about half are active in a given year.
- A retain-all fishery is required, due to low survival of released lobsters.
- Fleet-wide harvest guidelines, with bank-specific quotas for Necker, Maro, Gardner and all other NWHI areas (known as Area 4), apply.
- Harvest quotas are recalculated based on a constant harvest rate and risk to overfishing in order to lower risk.
- Lobster permitted vessels are required to have VMS to transit through NWHI lobster grounds during closed season. (Voluntary VMS also facilitates enforcement.)

Habitat Impacts

Typically, traps are set in areas of relatively low structural relief, away from coral reef habitat. If traps are set too close to coral reef and other high relief habitats, lobsters cannot be enticed to enter the traps. Interactions of the lobster fishery with coral reef resources and habitats are limited and poorly known. Anecdotal reports suggest that some coral pieces have been observed in trap-hauls, but this remains unquantified and additional research is needed. Members of the Council's Crustacean Plan Team and Advisory Panel report that this may be attributed to lobster vessels being forced to fish in exploratory banks, and it may have been exacerbated by the inexperience of one vessel's captain. Vessel groundings are another potential habitat impact of the NWHI fishery, but in the past two decades only one permitted lobster vessel has run aground. A survey two years later found only limited damage. The FMP's existing management measures (e.g., gear restrictions, closed areas) help mitigate potential adverse impacts to essential fish habitat.

Gear Description and Use

All vessels participating in the NWHI lobster fishery use traps manufactured by Fathoms Plus. The trap is dome-shaped and molded from black polyethylene. Their dimensions are approximately 2.5' x 3.2' x 1'. To ensure that they deploy upright on the bottom, lead weights are secured inside the trap. Each trap has two entrance cones located on opposite sides of the trap. They also have two escape vents composed of four circular holes at least 2½ inches in diameter; these allow undersized lobsters and other incidental catch, such as octopus, to escape. This gear restriction has resulted in significant reduction in the incidental take of non-target species. Trap opening sizes are specified by regulation. Traps are set in strings of several hundred (typically about 800 per day) and baited with chopped mackerel.

Incidental Catch and Bycatch

Bycatch, as determined by experimental traps without escape vents includes (in decreasing order of abundance) hermit crabs, reef fish, other crabs, moray eels, other lobsters, molluscs, and small sharks. The amount of bycatch is much less in commercial traps with mandatory escape vents. Some lobster traps are lost each year. A 1992 NMFS report found that while lobsters may enter these traps, they were also able to exit and there was no observed mortality associated with ghost fishing. The study concluded that lobsters may use the traps as shelter.

Reporting

Participants in the NWHI fishery are required to complete the NMFS Daily Lobster Catch Report after each set. The form includes space for recording the number of spiny lobsters, slipper lobsters, Kona crab, octopus, and other animals kept, and the number discarded. There is also space for recording the number of Hawaiian monk seals, sea turtles, and other protected species observed in the area. While lobster have been recorded in the diet of the endangered Hawaiian monk seal, no conclusive evidence exists about the importance of lobsters to seals. The areas fished, weather conditions, and date and time of gear set and haul are also recorded. A Hawaii Division of Aquatic Resources Crustaceans Trip Report is also required, which summarizes the number and weight of lobsters caught and weight sold.

Precious Corals Fishery

Before Congress passed the Magnuson Act in 1976, precious corals had been fished in the U.S. EEZ of the western Pacific region by foreign vessels. In 1975, Japanese vessels reportedly harvested about 100 mt of precious corals within 200 nm of Midway, Wake, Yap, and Saipan Islands. In 1977, a Taiwanese precious coral vessel entered Midway Island and reported that 30 vessels would dredge around Milwaukee bank, outside the U.S. EEZ.

The Precious Corals FMP was implemented in 1983, and has been amended four times. In the FMP, precious coral beds are treated as distinct management units because of their widely separated and patchy distribution and the sessile nature of individual colonies. Beds are

classified as Established, Conditional, Refugia, or Exploratory. Established and Conditional Beds have specific harvest quotas. Refugia Beds are areas set aside for baseline studies and possible reproductive reserves, with no commercial harvesting allowed. Exploratory areas make up the remainder of the EEZ, where precious corals may exist but have not been discovered. Each island area—Hawaii, American Samoa, Guam, and the PRIAs—have individual Exploratory areas with a 1,000 kg annual quota. An amendment has been drafted to include the CNMI under this same regime. The Hawaiian Exploratory area contains many times more precious coral habitat than the other Exploratory areas. Of the potential habitat in the Hawaiian EEZ, 99.7% is unexplored, with most of it in the NWHI. The major potential banks are off Brooks Banks and the area around Midway Atoll.

Interaction between fisheries managed under the Precious Corals FMP and coral reef resources and habitats are non-existent for pink, red, gold, and bamboo coral, because these fisheries occur much deeper than 50 fm. However, black coral is harvested from 30-50 fm in the main Hawaiian Islands. Harvesting black coral removes habitat itself, but it is unknown if this is a significant ecosystem effect, if harvested at sustainable levels. Bottomfish abundance has been shown to correlate with black coral habitat, but this correlation may be obscured by the long-term effects of fishing on the stocks. More research is needed.

Target Resources

The precious corals fishery in the Western Pacific Region has only occurred in the EEZ and state waters surrounding Hawaii. Much of the black coral (*Antipathes dichotoma, A. grandis, and A. ulex*) is harvested in state waters. Most of the pink and red coral (*Corallium secundum, C. regale,* and *C. laauense)* and gold coral (*Gerardia* spp., *Narella* spp., and *Calyptrophora* spp.) are harvested in deep waters (175-250 fm) of the EEZ. Bamboo coral (*Lepidisis olapa* and *Acanella* spp.) is also found at these depths, but is not currently exploited.

Gear Description and Use

Black coral harvesters use scuba and mixed gas to achieve greater depths, hatchets or sledges to harvest colonies, and float bags to send colonies to the surface for retrieval. Red, pink, and gold coral harvesters use one-man submersibles certified to dive 2,000 ft (333 fm) equipped with manipulator arms and collecting baskets, on-board GIS, streaming video cameras, and computers with graphical software. Black coral harvesters scuba dive from a small vessel located directly above the bed, while deeper coral harvesters employ a mothership and two submersibles.

Incidental Catch and Bycatch

Only organisms growing directly on the coral are potential bycatch. These include sponges, polychaetes, and other lower invertebrates. Free-swimming fauna inhabiting the corals, such as eels and bottomfish, would invariably abandon their shelter as it is harvested.

Habitat Impacts

Selective harvest minimizes potential impacts on habitat. Precious corals are habitats for some species of animals, including juvenile bottomfish and arrowtooth eels. Hawaiian monk seals are believed to forage for bottomfish and arrowtooth eels. Minimum size restrictions and a quota of 5% of the standing stock protect the habitat. While the largest colonies will be harvested, a twenty-year age distribution will remain for all beds.

Reporting Requirements

Harvesters submit daily harvest reports by radio; these include weight by species and position of the mothership. Harvesters fill out a NMFS daily precious coral harvest logbook, which must be submitted within 72 hours of landing at port. Logbook requirements include harvest method, hours fished, depth, and area fished, and weight of coral by species. Additional data reporting has been proposed.

Current Regulations

- The five defined beds and the four Exploratory areas have area-specific permits.
- No vessel can have more than one permit valid at any one time.
- Permits are issued for one year, except for the Makapuu bed, which has a two-year time span.
- Each bed has a specific quota for each species; quotas apply only to live coral.
- Exploratory areas have a 1,000 kg per year quota for all species combined.
- There is a 10" minimum size restriction to harvest pink coral.
- Non-selective gear is prohibited in the MHI, but allowed in all other areas of the EEZ.

Proposed Regulations

As this fishery has recently emerged from a 20-year hiatus, many proposed measures are being considered to adapt to new technology and other management concerns.

- Only selective gear would be allowed in all permit areas.
- Size restrictions for pink corals would apply to all permit areas. There would be a 48" minimum height and 1" minimum base size for black coral.
- Harvest of gold coral would be suspended at Makapuu bed, and throughout the entire NWHI.
- New reporting requirements would include the submission of video tape logs. Specific locations of all dives, including dives where no harvest occurred, and damaged but not harvested coral would also have to be reported.

- There would be no quota for the Hawaiian Exploratory area. However, fishing there would be subject to the following restrictions: (1) a maximum of 1,000 kg harvested at any given site; and, (2) gold coral could not be taken in the NWHI.
- A precious coral mega-reserve would be established in the NWHI. It would encompass precious coral habitat to a depth of 750 fm, including the existing Wespac Refugia and stretching approximately 250 miles to the southeastern edge of Brooks Banks. Within this area, the harvest of gold, pink, and red corals would be prohibited.

Pacific Pelagic Fisheries

The original Pelagics FMP became effective on March 23, 1987. The plan addressed several immediate issues, such as the regulation of foreign fishing vessels in U.S. Pacific insular EEZ waters through fishing permits and area closures, the prohibition of drift gill net fishing except for experimental purposes, observer requirements, catch reporting and definition of pelagic management unit species.

The plan also created a framework for the future management of pelagic fisheries within the EEZ of the Western Pacific Region. The Pelagics FMP has been amended eight times and the following is a summary of each of the FMP amendments and related Council activity.

Amendment 1 to the Pelagics FMP was implemented by regulation published in the Federal Register on March 7, 1991. It was drafted in response to the Secretary of Commerce's Guidelines for the MSFCMA National Standards requiring a measurable definition of recruitment overfishing for each species or species complex in a FMP. The overfishing index expressed the current spawning population as a percentage of the original un-fished spawning population in the virgin stock, or spawning potential ratio (SPR). For pelagic teleost fish the SPR was set at 20% of the original un-fished spawning population. For sharks, however, the Council recognized that these species were on the whole less resilient to fishing pressure and established a higher SPR of 35%. The optimum yield (OY) for pelagic management unit species was also defined as the amount of fish that can be harvested by domestic and foreign vessels in the EEZ without causing local overfishing or economic overfishing.

Amendment 2 was implemented on May 31, 1991, and required domestic longline vessels to have federal permits and maintain federal fishing logbooks. It also authorized the placement of observers on those vessels wishing to fish within 50 nm of the NWHI. Amendment 2 also implemented the application of the Pelagics FMP to the Northern Mariana Islands.

Amendment 3 was implemented on October 18, 1991, and established a 50 nm longline exclusion zone around the NWHI to protect endangered Hawaiian monk seals. Amendment 3 abrogated Amendment 2 but contained framework provisions through which a mandatory observer program was implemented to collect information on sea turtle-longline interactions.

Amendment 4 came into effect on October 16, 1991. It established a three-year moratorium on new entries into the Hawaii-based domestic longline fishery. The moratorium expired on April 22, 1994. A provision to impose a mandatory VMS policy for domestic longline fisheries in the Western Pacific Region was implemented under the framework process of Amendment 4.

Amendment 5 was added on March 4, 1992, and established a longline exclusion zone around the MHI ranging from 50 to 75 nm and a similar 50 nm exclusion zone around Guam and its offshore banks. This zone was established to prevent gear conflicts and vessel safety issues arising from interactions between longliners and smaller fishing boats. A seasonal reduction in the size of the closure was implemented on October 6, 1992. Between the months of October and January, longline fishing is prohibited within 25 nm of the windward shores of all islands except Oahu, where longline fishing is prohibited within 50 nm from the shore.

Amendment 6 was implemented on October 27, 1992, and specified that all tuna species were now designated as fish under the United States management authority. Amendment 6 included tuna and related species of the genera *Allothunnus* spp., *Auxis* spp., *Euthynnus* spp., *Gymnosarda* spp., *Katsuwonus* spp., *Scomber* spp., and *Thunnus* species. It also proposed application of the longline exclusion zones of 50 nm around the island of Guam and associated seamounts, and the 50/75 nm zone around the MHI to foreign longliners, purse seiners, and baitboats. Before this amendment the foreign longline exclusion zones around Guam and the MHI/NWHI extended to 150 nm. The original foreign longline exclusion zones around American Samoa remained unchanged but applied equally to foreign purse seiners and baitboats.

Amendment 7 came into effect on May 25, 1994, and instituted a limited entry program for the Hawaii-based domestic longline fishery. It limits the number of vessels in the fishery to 164 longline boats and these must not exceed 94 ft in length, the size of the largest vessel in the fleet prior to the moratorium period specified under Amendment 4.

Amendment 8 was part of a collective document that, besides the Pelagics FMP, included amendments to other Council FMPs. It was drafted in 1998, but only partially approved on April 19, 1999. Parts of the amendment that were not approved included sections on pelagic bycatch and overfishing.

Proposed Amendment 9, would implement an annual fleet-wide precautionary harvest guideline for sharks in the Hawaii-based longline fishery. Initially the harvest guideline was set at 50,000 sharks, based on the average retained catch between 1996 and 1998. The proposed amendment will also contain a framework by which the harvest guideline can be rapidly adjusted from year-to-year, depending on blue shark stock assessments or other performance indices. However, these guidelines may be affected on the new laws regarding shark finning. The amendment will also ban demersal or bottom longline fishing that targets Pelagic Management Unit Species, and specifically sharks in the federal waters of the Hawaiian Islands.

3.4 The Social Context

This section contains two topic areas. The next section describes the economic setting and use of coral resources in each of the island jurisdictions in the Council's region. The second part of this section reviews the legal context of jurisdiction over marine resources in the region. In addition to jurisdiction by states, federal agencies have overlapping responsibilities in some areas.

3.4.1 Use of Coral Reef Resources

American Samoa

Socio-economic Overview

American Samoa is an unincorporated territory of the U.S. comprising seven islands with a total land area of only 77 square miles. Because most of the islands are mountainous, there is very little area suitable for agriculture. The Territory's population is about 60,000, and is growing rapidly, with a doubling time of only 20 years (Craig *et al.* in press). Of all the U.S. Pacific Islands, American Samoa has the lowest gross domestic product and highest donor aid per capita (Adams *et al.* 1999).

American Samoa has a small developing economy, dependent mainly on two primary income sources: the American Samoa Government, which receives income and capital subsidies from the federal government, and two tuna canneries on the island of Tutuila. These two income sources have given rise to a third: a services sector that derives from and complements the first two. In 1993, the latest year for which the American Samoa Government has compiled detailed labor force and employment data, the local government employed 4,355 people, or 32.2% of total employment, followed by the two canneries with 3,977 people (29.9%) and the rest of the services economy with 5,211 workers (38.4%). Altogether, the three segments employed 13,543 workers, while 2,718 people were registered as unemployed (that is, actively seeking employment). This gives a total labor force of 16,621 and an unemployment rate of 16.7%. A large proportion of the territory's workers are from Samoa, formerly Western Samoa. While Samoans working in the territory are legally alien workers under U.S. law, they share a common culture, history, and family ties.

Because of its tuna canneries, Pago Pago is the leading U.S. port in terms of dollar value of fish landings. Star-Kist Samoa has become the largest tuna cannery in the world. Ancillary businesses associated with the tuna processing industry also contribute significantly to American Samoa's economy. Pago Pago Harbor supports mostly large fishing vessels, tankers, and container ships. Shoreside infrastructure for small domestic fishing vessels is minimal. Commercial fisheries for bottomfish and reef fish make a minor contribution to the Territory's overall economy. The social and cultural importance of coral reef resources in American Samoa dwarfs their commercial value.

With a total population estimated in 1993 at 52,900, the labor force represented 30.7% of the population, which is very low when compared with the overall U.S. labor force ratio (well over 50%) but typical of the smaller developing Pacific Island economies. Of the 31,822 residents 16 years or older, the total labor force was equivalent to 51.1%. That half of the 16 years-plus population is not in the labor force is explained by American Samoa's lack of major industry other than government and fish canning. Work opportunities are certainly limited, but not having a job in the money economy does not necessarily equate with unemployment because subsistence activity contributes to the extended family's total well-being.

Official data notwithstanding, by many measures American Samoa is not a poor economy. Its estimated per capita income of $5,000 is almost twice the average for all the Pacific Island economies (at $2,700) (Bank of Hawaii 1997a). Per capita income in American Samoa does not represent the same market basket and value as it would, for example, in Honolulu. There are aspects of work and the creation of value in communal societies of the Pacific Islands that are not captured by market measures. For instance, American Samoa's tightly organized *aiga* (extended family) system helps to keep young people from becoming economically unproductive and socially disruptive. Unlike the vast majority of youth in the Pacific Islands, American Samoan youth can emigrate to the United States, where an estimated 70,000 Samoans live, 20,000 of them in Hawaii.

The policy of the American Samoa Government, as expressed in the Revised Constitution (1966), is "... to protect persons of Samoan ancestry against ... the destruction of the Samoan way of life ... [and] to protect the lands, customs, culture, and traditional Samoan family organization of persons of Samoan ancestry, and to encourage business enterprises by such persons...."

Historical and Present Coral Reef Uses

Coral reef fishes and invertebrates are harvested in subsistence and small-scale commercial fisheries. In 1994, the only year when both components of this fishery were measured, catches were 86 mt and 76 mt, respectively, and consisted primarily of surgeonfish, parrotfish, groupers, octopus and sea urchins (Craig *et al.* in press). Sixty-nine different taxa were harvested in 1991. The migratory *atule* (*Selar crumenophthalmus*, or bigeye scad) is an important catch component (Green 1997).

As recently as 20 years ago, the harvest of reef fish and invertebrates from reef flats fronting the most densely populated section of coast on Tutuila was as high as 26.6 mt/km^2 per year (Wass 1982). A decreasing trend in reef-related fish catches was observed in the early 1990s. Giant clams, and perhaps other favored invertebrates, have been overfished in most areas, except Rose Atoll (Craig *et al.* in press). In general, the reefs adjacent to population centers on Tutuila Island appear to be in worse condition than those near less populated or unpopulated islands (Green and Craig 1996).

Most of the coral reef fisheries in American Samoa occur in nearshore waters. Much of the bottomfishing activity by small boats is conducted on banks in the EEZ, and some of the

shallow-water snappers and emperors they catch can be considered reef fish species. At present, the catch from this fishery is minor (Green 1997). Ornamental fish collection has occurred on a small scale in recent years. Live rock taken from shallow reef areas was exported during 1999, but this fishery has since been prohibited by the *fono* (American Samoa Legislature).

Fisheries statistics show that in recent years coral reef fisheries have accounted for 62% of the annual catch of 154 mt and 70% of the $619,000 annual catch value. This estimate is low because it does not include the shoreline subsistence harvest, which is assumed to be substantial. Nor does the estimate include shallow-water species of bottomfish, which are taken in a commercial small-boat fishery. The annual harvest of the latter fishery has been small in recent years (11 mt valued at $46,000), so the contribution to the total reef fish harvest is insubstantial.

Most of the landings in the known reef-related fisheries in American Samoa are fish (98 mt/year), molluscs (33 mt/year) and echinoderms (19 mt/year), but small amounts of crustaceans (3 mt/year) are also reported (Green 1997). A much smaller commercial fishery, using ten-meter boats, catches bottomfish (principally emperors and snappers) around the islands and offshore banks, using hook-and-line. In 1997, this fishery harvested 12 mt (Craig *et al.* 1999). Chambered nautilus has occasionally been taken by researchers and public aquaria at depths of about 200 m on offshore reef slopes. Virtually nothing is known about the reefs on these offshore banks because they are relatively inaccessible. It is assumed, however, that they are in better condition than the nearshore reefs because they are deep and remote from most human activities.

Coral reefs around American Samoa are recovering from a series of natural disturbances that occurred over the past two decades: a crown-of-thorns invasion (1978), three hurricanes (1986, 1990, 1991), and mass coral bleaching (1994), as well as chronic human-induced impacts along the populated coasts. Beaches, wetlands, and coral reefs have been extensively altered due to highway construction and urban expansion, particularly along the south shore of Tutuila. Coastal erosion is amplified by the removal of large quantities of beach sand and coral rubble from the shoreline for use around homes. Together, these shoreline alterations have largely eliminated the use of the central south coast by nesting sea turtles. Direct losses of coral reef habitats are related to dredging for harbors and filling to build the international airport runway.

Possible degradation of reefs has also occurred due to chronic water quality and sedimentation problems. Because of the main islands' steep terrain and high rainfall, hillside runoff causes heavy sedimentation in adjacent coastal waters. Landfills, sewage disposal, and—in Pago Pago Harbor—discharges from shoreside industries and spills from vessels in port have also had a major impact on the reef environment (Craig *et al.* in press). Remote Rose Atoll, protected as a National Wildlife Refuge (established through a cooperative agreement between the Territory of American Samoa and the U.S. Fish and Wildlife Service in 1973), was damaged in 1993 by a ship grounding and related oil spill.

The condition of nearshore reefs around American Samoa varies according to location. Reefs on the main island of Tutuila are in the worst condition because of a combination of natural and

human effects (hurricanes, coral bleaching, pollution, sedimentation), whereas the reefs on the more remote and less populated islands tend to be in good condition (Green 1997). Evidence from recent fisheries statistics, scientific resource surveys, and interviews with village elders and fishermen suggests that the more accessible coral reefs are seriously overfished. Scuba-assisted fishing is a major contributor to this problem, especially at night. Green sea and hawksbill turtle populations have seriously declined due to harvesting of sea turtles and eggs, and degradation of nesting and inshore habitats.

Commonwealth of the Northern Mariana Islands

Socio-economic Overview

The Northern Mariana Islands was part of the former Trust Territory of the Pacific Islands, administered by the US, before becoming a commonwealth by plebiscite in 1998. It has a total land area of 176.5 square miles spread over 264,000 square miles of ocean and consists of three main islands, Saipan, Tinian, and Rota, and several small islands and atolls. The southernmost island, Rota, lies some 50 miles northeast of Guam and 430 miles south of CNMI's northernmost island, Uracus. The small islands of the northern part of the chain are lightly populated. In 1990, the population of the northern islands was 36, and was further reduced in 1992. The main islands are grouped together in the southern part of the chain. The Commonwealth's capital is Saipan, but no locality on that island is recognized specifically as the capital; several government offices are located on Capital Hill, but the legislature meets in Susupe. Ninety percent of its 79,429 residents live on the island of Saipan, and almost all the rest on Tinian and Rota. Chamorro is the most commonly spoken native language.

The Bureau of the Census estimates that the population of the Northern Mariana Islands grew by 25,179 persons between the 1990 census and 1999 to an estimated 69,216 persons. Of this increase, 59% (14,803 persons) resulted from migration to the islands, principally from Asian countries (Bureau of Census, International Data Base, 12/29/99). The Chamorro and Carolinan ethnic groups native to the islands represented some 27% of the CNMI's 1999 population.

The early history of the Northern Mariana Islands parallels that of Guam. Spanish and other explorers first visited the islands in the sixteenth century, and they were colonized by Spain in the seventeenth century. Spain sold the islands in 1899 to Germany, following the end of the Spanish-American War. In 1914, Japan entered World War I on the side of the Allies and took possession of the islands. After the war, Japan retained the islands under a League of Nations Mandate. In 1944, the United States gained control of the islands from Japan and in 1947, along with other parts of US-controlled Micronesia, these islands became a United Nations Trust Territory under U.S. administration. The islands were administered by the Defense Department until 1961. However, administrative authority was vested in the Department of the Interior in 1951. In 1978, a separate government for the Northern Mariana Islands was established and Commonwealth status was granted in 1986.

The main islands are each organized as a single municipality, with its own elected mayor and municipal council. Saipan's municipal council also serves the Northern Islands municipality. In 1990, there were 16 Community Development Plan's (CDP) identified at the time of the Census. Each of these communities had locally recognized boundaries, a population of more than 300 people, and was enumerated in the decennial and economic censuses.

The aboriginal people of the CNMI include the indigenous Chamorros, original inhabitants of the islands, and the Carolinians, who are Micronesians that resettled on Saipan during the 1840s. Carolinians are a small minority of the population, but they are known for their seafaring and fishing skill. Their fishing activity largely centered on the harvest of lagoon and reef species, but small paddling canoes were sometimes used to fish a short distance outside the reef (Amesbury *et al.* 1989). In the two decades since these islands achieved commonwealth status their demographic, economic, and social structure has changed dramatically. When the CNMI opened to foreign capital and labor, it was transformed from a small economy supported largely by subsistence and government to a large regional tourist destination and a garment-manufacturing haven. Although tourism has been CNMI's largest income source, the Asian financial crisis of the late 1990s caused visitor arrivals from Japan and Korea to drop by one-third. At present, garment production is CNMI's fastest growing industry and is credited with preventing an economic depression following the decline of the tourist industry.

The development of tourism and garment industries based on foreign labor has had a dramatic impact on CNMI's population growth, which increased from 16,780 in 1980, to 79,429 in early 1999 (Bank of Hawaii 1997b). The majority of the current population are non-resident workers from the Philippines and other parts of Asia. There are also workers from the Republic of Belau and the Federated States of Micronesia. Early 1999 data reveal that on Saipan only 28% of the population, and 22.6% of the labor force, are U.S. citizens. In addition to the garment industry, foreign workers hold most jobs in the construction, hotel, and retail sectors. The government provides approximately 12% of the jobs, and U.S. citizens make up most of this work force. They also make up 55% of the unemployed. The unemployment rate among Saipan's U.S. citizen labor force in early 1999 was 13.4%, compared to 3.2% among foreign workers (Bank of Hawaii 1997b). With the exception of a now defunct purse seine support base on the island of Tinian, CNMI has never had very much infrastructure dedicated to commercial fishing. Commercial domestic fisheries for reef fish and bottomfish make a minor contribution to the overall economy. The social and cultural importance of coral reef resources in the CNMI dwarfs their commercial value.

Historical and Present Coral Reef Uses

Before World War II, the Japanese exploited sea cucumbers, trochus (topshell), precious corals and many other coral reef resources in the Japanese Mandated Islands, which included the present Commonwealth of the Northern Mariana Islands. Commercial fisheries for trochus and sea cucumbers were re-opened during the mid-1990s for the first time in recent history. Over an 18-month period in 1995-1996, 268,000 sea cucumbers were collected (Green 1997).

It is difficult to assess the total harvest of present-day coral reef fisheries in the CNMI because of shortcomings in fisheries statistics. Virtually no recent information is available for inshore subsistence and recreational catches of coral reef resources. This harvest is assumed to be substantial, especially in the more accessible areas like Saipan Lagoon. Coral reef fisheries in the CNMI are mostly limited to nearshore areas, especially off the islands of Saipan, Rota, and Tinian. Finfish and invertebrates are the primary targets but small quantities of seaweed are also taken. All of the recent data are for commercial landings: 62 - 80 mt/year of reef fish and 1-1.5 mt/year of spiny lobster. An unknown proportion of the bottomfish landings in the CNMI are shallow-water snappers, emperors, and groupers, which may be considered part of the coral reef fishery (Green 1997).

Little is known of the coral reef fisheries in the northern islands of CNMI, but the catch by domestic fishermen is believed to be minor. The exception was in 1995, when the nearshore reefs around six of the northern islands (especially Anatahan and Sarigan) were fished commercially for several months. During that time, these areas yielded a harvest of 15 mt of reef fish and 380 pieces of spiny lobster. Poaching by foreign fishing boats may occur in some places (Green 1997).

Coral reefs near some heavily populated areas in the southern islands of the CNMI have been degraded by heavy fishing, sedimentation, and tourist recreation (Green 1997). Limited information suggests that most of the nearshore reefs elsewhere in the CNMI are in good condition. Reefs off the southern islands experienced a massive starfish outbreak in the late 1960s, but corals recovered rapidly from this disturbance. Reefs around the northern islands are in good condition because of their isolation from human activities. Local damage, on Pagan and Farallon De Medinilla for example, may have been caused by storm waves, volcanic eruptions, or military activities (Birkeland 1997c; Green 1997).

Virtually nothing is known about the condition of offshore reefs, but they are assumed to be in good condition because of their isolation. Offshore reefs generally receive little fishing pressure because of the limited range of the small boat fishery. The exceptions are banks that are relatively close to the main islands, like Esmeralda, and the extensive bank off Farallon de Medinilla, where a fishery for shallow water bottomfish is conducted by small boats.

Guam

Socio-economic Overview

Guam and the Mariana Islands were first settled about 3,000 years ago, but their present social and demographic structure is largely the result of colonial experiences of the last 300 years. Guam's total population is estimated to have reached 163,000 in 1999, nearly doubling the 1970 total of 85,000. Of the total reported labor force of 72,700 (June 1999), 61,460 were employed and 11,060 were unemployed, for an official jobless rate of 15.2%. In September 1997, at the beginning of the current economic and employment downturn on Guam, the unemployment rate was only 9.2% (Bank of Hawaii 1997c).

Guam's economy has become so dependent on tourists from East Asia, particularly Japan, that any significant economic, financial and foreign exchange development in the region has had an immediate impact on the territory. During the mid- to late-1990s, as Japan experienced a period of economic stagnation and cautious consumer spending, visitor arrivals from Japan dropped, and the impact was felt as much on Guam as in Japan. The U.S. military presence on Guam has diminished to the lowest level in decades. Nevertheless, the military remains a vital stabilizing economic factor for Guam, particularly in times of regional economic crises. The Government of Guam currently supplies more than 20% of all civilian jobs in the territory. Recent deficits have resulted from a steady rise in government spending without a concomitant increase in tax revenues due to a stagnant tax base (Bank of Hawaii 1997c).

Guam's most significant commercial fishing attribute is its status as a regional tuna transshipment center and re-supply base for foreign tuna fleets (Hamnett and Pintz 1996). Guam is the fourth leading U.S. port in terms of the dollar value of fish landings, which are mostly for transshipment to tuna markets in Japan. Commercial domestic fisheries for reef fish and bottomfish make a relatively minor contribution to the Guam economy. The social and cultural importance of coral reef resources in Guam dwarfs their commercial value.

Historical and Present Coral Reef Uses

Since World War II, Guam's coral reef fisheries have shifted from an exclusively subsistence focus to an artisanal fishery that blends subsistence, recreational, and commercial purposes (Hensley and Sherwood 1993). The more accessible reefs are considered overfished because of declining catch rates, declining size of target fish species, and greater prevalence of less desirable species (Birkeland 1997c; Green 1997; Katnik 1982).

Prior to World War II, trochus was taken in large quantities for food and jewelry work. By the 1970s, the trochus population had recovered sufficiently to allow a limited fishery that is currently regulated by size restrictions. Stony and precious corals have been harvested in the past for ornamental use and jewelry work. Residents and visitors, including foreign fishing crews, collect stony corals and mollusks as curios. Coral harvesting is illegal on Guam without a permit and several violators have been convicted (Green 1997).

Since the late 1970s, the percentage of live coral cover on Guam's reefs and the recruitment of small corals have decreased. This trend has been attributed to poor recruitment by coral larvae, increased sedimentation of reef habitat, and domination of reef habitat by fleshy algae. Corals have also been affected by natural disturbances (Birkeland 1997c). Pervasive events include starfish predation between 1968 and 1970, and exposure of corals due to extreme tides during El Niño events. Heavy wave action, associated with typhoons, has had more localized effects.

Shore-based fishing accounts for most of the fish and invertebrate harvest from coral reefs around Guam. In recent years, the estimated inshore harvest has ranged from 38 to 108 mt. This estimate excludes highly variable catches of juvenile rabbitfish and bigeye scad by traditional fisheries that are still practiced seasonally (Myers 1993). While spearfishing is the principal

method of harvesting, it is highly seasonal because of weather conditions. In the fiscal years from 1985 to 1991, spearfishers mostly landed parrotfishes (36%), surgeonfishes (17%), and wrasses (7%) (Myers 1993).

The coral reef fishery harvests more than 100 species of fish, including the families Acanthuridae, Carangidae, Gerreidae, Holocentridae, Kyphosidae, Labridae, Lethrinidae, Lutjanidae, Mugilidae, Mullidae, Scaridae, and Siganidae (Hensley and Sherwood 1993). Myers (1997) noted that seven families (Acanthuridae, Mullidae, Siganidae, Carangidae, Mugilidae, Lethrinidae, and Scaridae) were consistently among the top ten species in any given year from FY91 to FY95 and accounted for 45% of the annual fish harvest. Approximately 40 taxa of invertebrates are harvested by the nearshore fishery, including 12 crustacean taxa, 24 mollusc taxa, and 4 echinoderm taxa (Hensley and Sherwood 1993; Myers 1997). Species that became rare on shallow reefs due to heavy fishing include bumphead parrotfish (*Bolbometopon muricatum*), humphead wrasse (*Cheilinus undulatus*), stingrays, parrotfish, jacks, emperors, and groupers (Green 1997).

Many of the nearshore reefs around Guam appear to have been badly degraded by a combination of natural and human impacts, especially sedimentation, tourist overuse and overharvesting. In the last few years, there has been an increase in commercial spearfishing using scuba at night. Catch rates have increased because of improved technology (high capacity tanks, high tech lights, and bang sticks) that allows spearing in deeper water (30-42 m). As a result, many larger species that have already been heavily fished in shallow water—such as bumphead parrotfish, humphead wrasse, stingrays, and larger scarid species—are now reappearing in the fishery catch statistics (Green 1997).

Virtually no information exists on the condition of the reefs on offshore banks. On the basis of anecdotal information, most of the offshore banks are in good condition because of their isolation. Observations by divers suggest that anchor damage is having a major impact on branching coral formations on some of the offshore banks. Anchors dragged by small boats dig small furrows, but anchors from large fishing vessels leave large craters.

According to Myers (1997), less than 20% of the total coral reef resources harvested in Guam are taken from the EEZ, primarily because they are associated with less accessible offshore banks. Finfish make up most of the catch in the EEZ. Most offshore banks are deep, remote, shark infested, and subject to strong currents. Generally, these banks are only accessible during calm weather in the summer months (May to August/September). Galvez Bank is the closest and most accessible and, consequently, fished most often. In contrast, the other banks (White Tuna, Santa Rose, and Rota) are remote and can only be fished during exceptionally good weather conditions (Green 1997). Local fishermen report that up to ten commercial boats, with two to three people per boat, and some recreational boats, use the banks when the weather is good (Green 1997).

At present, the banks are fished using two methods: bottomfishing by hook-and-line and jigging at night for bigeye scad (*Selar crumenophthalmus*) (Myers 1997). In recent years, the estimated annual catch in these fisheries has ranged from 14 to 22 mt of shallow bottomfish and 3 to 11 mt

of bigeye scad (Green 1997). The shallow-water component accounted for almost 68% (35,002 of 65,162 lbs.) of the aggregate bottomfish landings in FY92–94 (Myers 1997). Catch composition of the shallow-bottomfish complex (or coral reef species) is dominated by lethrinids, with a single species (*Lethrinus rubrioperculatus*) alone accounting for 36% of the total catch. Other important components of the bottomfish catch include lutjanids, carangids, serranids, and sharks. Holocentrids, mullids, labrids, scombrids, and balistids are minor components. It should be noted that at least two of these species (*Aprion virescens* and *Caranx lugubris*) also range into deeper water and some of the catch of these species occurs in the deepwater fishery.

The majority of bigeye scad fishing occurs in territorial waters, but also occasionally takes place in federal waters. Estimated annual offshore landings for this species since 1985 have ranged from 6,393 to 44,500 lbs., with no apparent trend (Myers 1997). It is unclear how much of this offshore bigeye scad fishery has occurred in the EEZ.

Hawaii

Socio-economic Overview

Ocean resources are very important to Hawaii's economy. For example, tourism, the largest industry in Hawaii, is heavily dependent on oceanic resources. As important, both the indigenous and non-indigenous populations depend upon the ocean and oceanic resources for recreation and social interactions. As a result, the State of Hawaii is broadly engaged in management of the ocean and ocean resources. However, Hawaii's economic situation changed dramatically in the 1990s. Several major economic sectors—such as plantation agriculture, tourism, and the military—suffered downturns. As a consequence, Hawaii never entered the period of economic prosperity that many U.S. mainland states experienced. Since 1998, Hawaii's tourism industry has recovered substantially, mainly because the strength of the national economy promoted growth in visitor arrivals from the continental United States. Efforts to diversify the economy, and thereby render it less vulnerable to future economic downturns, have met with little success to date (Bank of Hawaii 1998). Commercial fishing has historically represented a small share of Hawaii's total economic activity. In contrast to the sharp decline in some industries of long-standing importance in Hawaii, however, the fishing industry has been fairly stable during the past decade. More importantly, fishery resources, especially coral reef resources, represent an important source of subsistence, providing food, income, opportunity for social interaction, and cultural exchange for Hawaii's residents during periods of economic recession. As a result of the rise in tourism-related ocean recreation in Hawaii, a premium has been placed on non-consumptive uses of nearshore marine resources (Pooley 1993).

In 1998, Hawaii's ethnic makeup was 22% Caucasian, 21% Hawaiian or part Hawaiian, 18% Japanese, 13% Filipino, 7.3% Hispanic (1990), 3% Chinese, and 1% African-American; other ethnicities made up the balance (DBEDT 1999). (However, Office of Hawaiian Affairs data reveals that a significant part of the population lists their ethnicity as "other/unknown.")

Hawaii's population has been growing at the rate of 7% during the past decade, and was estimated to be 1,193,001 in 1998.

By most statistical measures, people of Native Hawaiian ancestry have the lowest incomes and poorest health of any ethnic group in the State (OHA 1998). Federal, state, and private programs have been established to benefit Hawaiians. There is also an active cultural renaissance among Native Hawaiians, with efforts to restore the language, arts, and subsistence activities, including traditional fishing practices. As part of this renaissance, Native Hawaiians continue to assert their rights of access to oceanic resources. In Hawaii, all shoreline to the highwater mark and undeveloped areas *mauka* (inland, toward the mountains) are public areas that can be accessed for cultural and traditional practices, a holdover from the days of the kingdom (Mackenzie 1991). These Native Hawaiian gathering rights, including shoreline access, have been reaffirmed in court decisions.

The islands of the State of Hawaii were discovered and settled by Polynesians between the third and seventh centuries A.D. Captain James Cook, the first European to reach Hawaii, arrived in 1778. Europeans and Asians began to settle on the islands in the nineteenth century with the development of pineapple and sugar plantations. In 1898, the islands were ceded to the United States and Hawaii became the fiftieth state in 1959.

Hawaii is a string of 137 islands extending in an arc across the Pacific Ocean from the northwest to the southeast. The eight largest islands—measured by size, population, and economic activity—are at the southeastern end of the arc, some 2,400 miles from the United States. They are divided into four municipal counties: Hawaii County; Maui County; City and County of Honolulu; and, Kauai County. The land area of the island chain is estimated to be 6,423 square miles.

Historical and Present Coral Reef Uses

In recent decades, there has been a notable decline in nearshore fishery resources in the main Hawaiian Islands (Shomura 1987). Overfishing is considered to be one of the major causes of this decline (Grigg 1997; Harman and Katekaru 1988), but coastal construction, sedimentation, and other effects of urbanization have caused extensive damage to coral reefs and benthic habitat near the populated islands.

Fishing gear types that mainly target inshore and coastal pelagic species accounted for about 10% (or 1.5 million lbs.) of the mean annual commercial fish catch in the State of Hawaii from 1990 to 1995. Recreational and subsistence catches are not reported in Hawaii, but creel surveys at Kaneohe, Hanalei, and Hilo Bays suggest that the total inshore catch from reef areas is at least equivalent to the reported commercial catch, and may be two or three times greater than that (Friedlander 1996).

The majority of the total commercial catch of inshore fishes, invertebrates, and seaweed comes from nearshore reef areas around the MHI. The exceptions are crustaceans: over 90% of the

spiny lobster landings come from the NWHI and over 50% of Kona crab landings come from Penguin Bank. Nearshore reefs in the MHI are the focus for commercial reef ornamentals harvesting and black coral collecting (Friedlander 1996).

The collection of black coral from depths of 30-100 m by scuba divers has continued in Hawaii since black coral beds were discovered off Lahaina, Maui, in the late 1950s, although harvest levels have fluctuated with changes in demand. Since 1980, virtually all of the black coral harvested around the Hawaiian Islands has been taken from a bed located in the Auau Channel. Most of the harvest has come from State of Hawaii waters and no black coral diver has ever received a federal permit to harvest precious coral in the EEZ. However, a substantial portion of the black coral bed in the Auau Channel is located in the EEZ. Recently, with the growing popularity of household marine aquaria, the demand for small, immature black coral colonies has increased. In 1999, concern about the potential for greater harvesting pressure on the black coral resources led the State of Hawaii to prohibit taking from state waters black coral with a base diameter less than 3/4 inches. The Council has recommended that a minimum size limit also be established for black coral harvested in the EEZ (WPRFMC 1999a).

After two decades of minimal activity, the domestic fishery for pink, gold and bamboo precious corals in the EEZ of Hawaii resumed in December 1999. One company uses two one-man submersibles to survey and harvest the resource at depths between 400-500 m. These technologically advanced devices are capable of diving to 700 m, with a maximum bottom time of six hours. To date, they have only surveyed and begun harvesting in areas around two of the seven known beds between the islands of Oahu and Hawaii. The company has plans to search for additional beds in both the MHI and NWHI.

The deep-slope bottomfish fishery in Hawaii concentrates on species of eteline snappers, carangids, and a single species of grouper concentrated at depths of 30-150 fm. The fishery can be divided into two geographical areas: the inhabited main Hawaiian Islands, with their surrounding reefs and offshore banks, and the NWHI. In the MHI about 80% of the bottomfish habitat lies in state waters. Bottomfish fishing grounds within federal waters include Middle Bank, most of Penguin Bank, and approximately 45 nm of 100-fathom bottomfish habitat in the Maui-Lanai-Molokai complex.

Historically, Penguin Bank has also been one of the most important bottomfish fishing grounds in the MHI, because it is the most extensive shallow shelf area in the MHI, and it is within easy reach of major population centers. Penguin Bank is particularly important for the MHI catch of *uku* (*Aprion virescens*, or gray snapper), one of the few bottomfish species available in substantial quantities to Hawaii consumers during summer months. Table 3.4 compares bottomfish landings at Penguin Bank during two periods as a percentage of total MHI commercial landings, for five major bottomfish species. It shows that the bank has increased in importance over the years.

For the period 1991 to 1995, 8% of the licensed commercial fishermen who participated in the MHI bottomfish fishery reported catches from Penguin Bank (WPRFMC 1996). Penguin Bank

has long been known to support a productive bottom "handline" fishery for snappers and groupers. It is also a popular bottomfish fishing ground for recreational anglers. However, the magnitude and value of the recreational landings, while significant, are poorly documented (Friedlander 1996). However, Holland (1985 in Friedlander 1996) noted that the Kewalo Basin charter fishing fleet uses Penguin Bank as one of its major fishing areas. Offshore and inshore fishing gear are used on Penguin Bank in about equal importance. Table 3.5 lists, in decreasing order of catch, offshore gear and inshore gear. Table 3.6 lists the most common reef/inshore fish species reported in commercial landings from Penguin Bank over the past decade, by five-year periods. Catches for most species are generally comparable for both periods with slightly less taken in the last period (1995-2000). Sharks appear to have been under-reported in the earlier period (1991-1995).

Table 3.4: Mean annual catch (lb) of the most common reported inshore fish species from Penguin Bank (2-200 nm) based on reported DAR commercial fisheries catch statistics from 1991-1995 (modified from Friedlander 1996) and from 1996-2000 (D. Hamm, pers. comm).

Species/Taxa	1991-1995	1996-2000
Bigeye scad (Selar crumenophthalums)	537	474
Goatfish (Mulloidichthys vanicolensis)	264	165
Surgeonfish (Acanthurus xanthopterus)	204	65
Scad (Decapterus spp.)	152	41
Wrasse (Bodianus bilunulatus)	149	62
Barracuda (Sphyraena helleri)	111	56
Wrasse (Xyrichthys pavo)	111	176
Sharks (misc.)	65	3605
Other goatfish (Parupeneus spp.)	37	6
Big-eye-fish (Priacanthus spp.)	28	30
Parrotfish (Scarid spp.)	22	-
Trumpetfish (Aulustoma chinensis)	14	1
Soldierfish (Myripristis spp.)	12	31
Leatherback (Scomberoides lysan)	5	6
Surgeonfish (Acanthurus dussumieri)	4	1
Surgeonfish (A. olivaceus)	4	-
Goatfish (Parupeneus porphyreus)	2	1
Unicornfish (Naso spp.)	1	1
Threadfin (Polydactylus sexfilis)	1	-
Wrasse (Coris spp.)	1	3
Flyingfish (Exocoetus spp.)	-	1

Table 3.5: Mean actual catch (lbs) by gear type from Penguin Bank (2-200 nm), based on data from DAR reported commercial fishery catch statistics from 1991-1995 (modified from Friedlander 1996).

Gear Type	Catch (lbs/yr)
Offshore gear	
Aku pole & line	67,486
Trolling	26,607
Tuna handline	1,295
Subtotal	95,388
Inshore gear	
Deep handline	83,517
Net	14,191
Inshore handline	2485
Other	573
Trap	493
Diving	22
Subtotal	101,281
Total	**196,670**

Table 3.6: Average percentage of total MHI commercial catch and average commercial catch of major bottomfish species harvested from Penguin Bank. Sources: WPRFMC (1996); and unpublished data from HDAR.

	Average annual percent of total MHI catch		Average annual catch (lbs.)
	1980-1984	**1991-1995**	**1997-1999**
Opakapaka	9.63	16.11	20,609
Uku	12.06	44.04	28,785
Onaga	14.87	20.24	9,277
Ehu	12.15	17.60	3,380
Hapuupuu	4.31	6.64	905

Limited information is available on coral reef fish community structure at Penguin Bank. An investigation of deepwater artificial reefs on the bank, using manned submersibles, recorded 62 taxa (25 families), of which 32 were considered resident, 25 transient, and five incidental (Friedlander 1996). Estimates of mean biomass ranged from 3-290 mt/km^2 for resident

species to 90-2,460 mt/km^2 for transient species. However, these estimates are considered high for the area, since several studies have shown that artificial reefs tend to support a higher biomass than natural reefs under similar circumstances.

An investigation of the deepwater macroalgal community, using a manned submersible, provides information on algae at Penguin Bank (Norris *et al.* 1995). The bank consists of a broad carbonate platform (~60m deep) covered with loose carbonate rubble and coarse sediments from the calcareous green alga, *Halimeda.* The algal community, comprising 54 species, is characterized by two deepwater species and many species that occur in shallow water. The deeper areas of the bank (182 m) are dominated by crustose coralline algae.

When reef-associated species that are presently managed under other Council FMPs are excluded from the analysis, almost all of the coral reef fisheries in Hawaii take place in inshore (state) waters in the MHI (Friedlander 1996). For example, in Hawaii less than 12% of the inshore fishes are caught in federal waters, based on reported commercial catch from 1991-1995. Similarly, only 18% of molluscs, 1% of seaweeds, and no echinoderms are harvested in federal waters. Of the crustaceans, less than 50% of the reported commercial catch of Kona crab—or 14,191 lbs. valued at $57,436—were taken in federal waters on Penguin Bank. Overall, only 1% of total catch, measured either by weight or value, comes from EEZ waters.

The top species by weight and value in the DAR inshore fish category were soldierfishes (*Myripristis* spp.), parrotfish (*Scarid* spp.), surgeonfishes (including *Acanthurus dussumieri, A. trostegus* and *Naso* spp.) and goatfishes (including *Mulloidichthys* spp.). Inshore fishermen target some of these species (especially the goatfishes *Parupeneus porphyreus* and *P. cyclostomus*), since they can fetch a high price in some seasons (Friedlander 1996). *Tilapia* spp. ranked high in terms of catch, but because it sells for a low price, it does not rank very high in terms of value. In the MHI, 89% of the catch of these species came from state waters.

Crabs are also an important group for commercial, recreational, and subsistence fishermen in Hawaii, with a mean annual commercial value of $182,182 (Friedlander 1996). The dominant species in the catch is Kona crab (*Ranina ranina*) with more than 28,000 lbs. caught annually. By weight, 51% of Kona crab are caught on Penguin Bank, which has long been an important location for kona crab net harvests of (Onizuka 1972). In contrast, almost all of the other crab species were caught less than 2 nm from shore in the MHI.

Surveys of the NWHI demonstrate that coral reefs are in good condition with high standing stocks of many reef fish. Nearshore coral reefs receive little human use because of their remoteness, exposure to harsh seasonal ocean conditions, and their protected status as part of a national wildlife refuge. Most of the shallow reefs of the NWHI lie within the boundaries of the State of Hawaii, where access and resource use are controlled by special permit.

There is a long history of fishing in the NWHI. Iverson *et al.* (1989) found ample evidence of fishing by the ancient Hawaiians as far northwest as Necker Island. Starting in the 1920s, a handful of commercial boats ventured into the NWHI to fish for shallow and deepwater bottomfish, spiny lobsters, and other reef and inshore species. Black-lipped pearl oysters at Pearl and Hermes Reef in the NWHI were overfished in the late 1920s and recent surveys show that stocks have still not recovered, due to lack of suitable oyster shell habitat (Green 1997). As discussed in the previous section, from the late 1940s to the late 1950s, there was a fishery for *akule* and reef fish around French Frigate Shoals and Nihoa Island.

During the 1960s, and as recently as 1978, Asian fleets harvested tuna, billfish, precious corals, and groundfish in and around the NWHI using longliners, pole-and-line vessels, draggers, and trawlers. Foreign fleets were not excluded from the 200-mile EEZ surrounding the islands until after the Fishery Conservation and Management Act was signed into law in 1976, and the Council began developing management plans for domestic fisheries in 1978. Even so, over the two decades from 1965 to the late 1980s, dozens of foreign vessels intermittently and illegally harvested precious corals in the waters around the NWHI. Because they used tangle-net bottom dredges, much deepwater habitat was destroyed (Grigg 1993).

As discussed in the previous section, both the deepslope bottomfish and lobster fisheries grew rapidly, beginning in the early 1980s. Both fisheries have declined from peaks late in that decade. They are now managed by the Council under limited access programs that fix the number of permits. The lobster trap fishery is also subject to a harvest quota, set annually at 13% of MSY, and it is one of the most intensively managed U.S. EEZ fisheries. Conservative management measures reduce the risk of overfishing and help prevent protected species interactions. The lobster fishery is managed for low fishing mortality, which is spread across a wide geographic region. However, the population structure of the lobster population in the region as a whole and the magnitude of oceanographic changes on the recruitment dynamics of the population are not fully understood. Spiny and slipper lobsters are harvested at many banks and on reefs deeper than 10 fm. The lobster trap fishery catches octopus and hermit crabs incidentally. But the incidental catch of reef fish is minimal because the lobster traps have escape vents. Bank-by-bank allocation of the 1999 harvest guideline caused permit holders in the lobster trap fishery to distribute effort into new trapping sites, including some areas where retrieval of trap lines may damage live coral.

Currently, there are no other major fisheries in the NWHI. Commercial trolling for *ono* occurs seasonally in some areas of the NWHI. For a short time in 1999, experimental fishing for coastal sharks was permitted. Many of the shallow reefs in the NWHI are within waters of the State of Hawaii. Section 5.4 discusses documented and potential fisheries interactions with protected species in the NWHI. Occasional visitors, including federal government personnel and contract workers at Midway Atoll, fish recreationally in the NWHI. However, Midway is considered part of the PRIAs and recreational development is discussed in that section.

The most serious problems in the NWHI at present are accumulation of marine debris, vessel groundings, and oil spills. Most of the debris is derelict gear lost from North Pacific fisheries. In addition to the physical damage to coral reefs, the debris entangles protected species, ghost fishes, and may introduce alien marine species (Green 1997). Prior military occupation has resulted in significant impacts at Kure Atoll, Midway Atoll, and French Frigate Shoals due to dredging, filling, and contamination by the release of toxins from dumped transformers (Green 1997).

Pacific Remote Island Areas

Socio-economic Overview

During the nineteenth century, the United States and Britain actively mined guano deposits on Howland, Jarvis, and Baker Islands. They became possessions of the U.S. in 1936 and have been under the jurisdiction of the Department of the Interior since that time. From 1935 to 1942, the three islands were occupied by Hawaiians, sent to consolidate U.S. claims. They were used as weather stations and military outposts during World War II, and debris from that period remains. The three atolls are presently National Wildlife Refuges administered by the U.S. Fish and Wildlife Service. They are uninhabited but visited periodically by scientists, researchers and, occasionally, expeditions of ham radio operators. Entry is controlled by special permit.

Palmyra was claimed by the American Guano Company in 1859. It was annexed to the Kingdom of Hawaii in 1862, but became privately owned in 1911. In 1922, the Fullard-Leo family purchased it. It was later annexed to the United States, but specifically excluded from the Territory and State of Hawaii. In the late 1930s, in preparation for World War II, a seaplane base and other defense facilities were constructed on Palmyra. The U.S. Navy or other federal installations continuously occupied the atoll until 1949. It was also used for nuclear testing programs in 1962. The Navy's attempt to regain control of Palmyra after World War II ended with a U.S. Supreme Court decision to return the atoll to the private owners, the Fullard-Leo family, who also claim ownership of Kingman Reef. In January 2001, The Nature Conservancy negotiated exclusive purchasing rights to Palmyra Island with the Fullard-Leo family. They report that two-thirds of the island will be designated a National Wildlife Refuge, run by the USFWS, and one-third will be used for ecotourism. On January 18, 2001, the Secretary of the Interior, through Secretarial Order 3223, declared Kingman Reef and the surrounding submerged lands and waters a national wildlife refuge out to a distance of 12 nm. Secretarial Order 3224, issued the same day, declared the tidal lands and the submerged lands waters of Palmyra Atoll as a national wildlife refuge out to a distance of 12 nm. However, certain tidal lands and submerged lands were excluded from this Order. The MSFCMA establishes the Council's jurisdiction over EEZ waters surrounding Palmyra to the mean high water mark, including the waters of the lagoon. This also includes waters within these refuge boundaries.

The written historical record provides no evidence of prehistoric populations on Wake atoll, but Marshall Islanders occasionally visited Wake, giving it the name Enenkio. The island was

annexed by the United States in 1899. Before the 1930s the only visitors were scientists and survivors of shipwrecks. The Navy received administrative control of Wake in 1934, and established an air base on the atoll in January 1941. Wake Island figured prominently in World War II. The U.S. re-occupied the atoll after the war, and administrative authority was held by the Federal Aviation Administration until 1962, when it was transferred to the Department of the Interior, which in turn assigned authority to the U.S. Air Force.

In 1858, both Hawaii and the U.S. claimed Johnston Atoll. Guano deposits found on the island were exploited for a short period in the nineteenth century. In 1926, President Calvin Coolidge, through Executive Order 4467, declared Johnston Atoll a breeding ground and refuge for seabirds. The atoll was later designated a national wildlife refuge where the U.S. Fish and Wildlife Service manage a recreational fishing program. Johnston Atoll is still controlled by the U.S. military. Starting in the late 1940s, Johnston Atoll played an important role in the U.S. nuclear testing program. In 1962, three rockets accidentally exploded on or above Johnston Island. Chemical munitions have been stockpiled on Johnston for storage and destruction by means of a specially designed chemical munitions incinerator.

A recently established eco-tourism operation in the Midway Atoll National Wildlife Refuge has improved public access to the NWHI. An agreement between Midway Phoenix Corporation and the USFWS allows up to 100 people to visit the atoll each week. These visitors normally get to Midway by air, on charter flights from Honolulu. Typical activities include charter fishing, diving, and wildlife observation. The company emphasizes this last activity in its promotional material, promoting wildlife tours that let visitors "gain first hand knowledge of the albatross, resident seabirds, migrant shorebirds, threatened green turtles and endangered Hawaiian monk seals." The Public Use Plan for the Refuge outlines other outdoor recreational activities—including shoreline fishing, lobstering, night diving, night fishing, kayaking tours, and glass-bottom boat excursions—that could be offered to visitors in the future (USFWS 1997). These activities should result in increased recreational use of NWHI marine resources.

Because of their location and history, no genuine community participation in coral reef fisheries can be identified for the PRIAs. The next section discusses coral reef resource use by part-time residents on these islands and atolls.

Historical and Present Coral Reef Uses

Little is known about the present status of coral reefs in most of the remote U.S. island possessions, although anecdotal reports suggest that they are mostly in good condition. Localized impacts on coral reefs have occurred due to coastal construction and pollution on some islands occupied by the U.S. military. Hurricanes and starfish infestations have occasionally affected some areas.

Fishing is light in most areas. Hawaii-based vessels have been reported to make sporadic commercial fishing trips to Palmyra and Kingman Reef for bottom fishing and harvesting coastal sharks for finning. The past extent of harvesting by passing yachts or poaching by

foreign fishing vessels is unknown (Green 1997). Since May 2000, The Nature Conservancy has been conducting small scale experimental ecotourism activities, including, diving, snorkeling, kayaking, fishing, and wildlife photography. The Nature Conservancy has also proposed establishing an inshore/offshore sportfishing operation. It would include a catch-and-release program for pelagic species, bonefish (*Albula* spp.), and other reef fish, particularly the giant trevally (*Caranx ignoblis*). The proposal also includes monitoring of fish stocks, and conducting biological investigations on the migratory, reproductive, and recruitment patterns of those stocks. Data on catch and effort from the recreational fishing will also be recorded (Cook pers. comm.). In addition, pursuant to a license agreement with The Nature Conservancy, Palmyra Pacific Seafoods, LLC has established and is currently operating a commercial fishing operation on Palmyra Atoll. Palmyra Pacific Seafoods, LLC is operating under rights granted to it by the Fullard-Leo family, and its existing fishing areas and business interests include the resources in the vicinity of Kingman Reef (Frank Sorba pers. comm at 108th Council Meeting).

There are no permanent residents on any of these islands, although on Wake and Johnston there are temporary work forces who have a long history of recreational fishing and shell collecting. The fishery at Johnston Atoll was described over a six-year period (1985–1990), based on the results of a creel census by Irons *et al.* (1990). They found that long-term 'residents' —almost all employees of the prime contractor for Johnston Atoll operations—did most of the fishing and thus produced a large proportion of the catch. These residents fished for enjoyment, to add fresh fish to their diet, and to accumulate fish to take home on leave. The remainder of the catch was harvested by 'transients,' military personnel and contractors stationed on the island for one or two years. However, through cooperative management between the USFWS and military management, the practice of shipping coolers of fish back to Hawaii by workers stationed on the atolls was stopped. Likewise, the collection and shipment of live corals by recreational divers were also stopped.

Irons *et al.* (1990) reported that the soldierfish (*Myrispristis amaenus*) composed the largest proportion of reef fish catch at Johnston (see Table 72 in Green 1997). Other important fish species included bigeyes (*Priacanthus cruentatus*), flagtails (*Kuhlia marginata*), mullet (*Chaenomugil leuciscus*), goatfishes (*Mulloides flavolineatus, Pseudupeneus bifasciatus, P. cyclostomus*, and *P. multifasciatus*), jacks (*Caranx melampygus* and *Carangoides orthogrammus*), parrotfish (*Scarus perspicillatus*), surgeonfishes (*Acanthurus triostegus* and *Ctenochaetus strigosus*), and bigeye scad (*Selar crumenophthalmus*). Gear types varied with the target species and included hook-and-line fishing, spearfishing and throw nets. All of the more heavily fished areas at Johnston are located in nearshore waters. Irons *et al.* (1990) also noted that recreational divers at Johnston collected pieces of coral for souvenirs. *Acropora cytherea* and the red coral *Distichopora violacea* were the two main species collected, although smaller quantities of *Acropora valida, Millepora* and *Fungia* were also collected. However, the U.S. Fish and Wildlife Service has since banned this activity at Johnston Atoll.

The original Johnston Atoll has been extensively modified by dredging and filling. An estimated four million square meters of coral were destroyed by construction, and an additional 25 million square meters were damaged by the resulting sedimentation. By 1964,

dredge and fill operations had enlarged the original island by over tenfold and had added two man made islands.

Fishing regulations have changed at Johnston Atoll in recent years because of concerns that fish were being exported and that coral collecting had become excessive and was incompatible with the philosophy of the refuge (Green 1997). Current Department of the Interior (DOI) rules, with cooperation from the U.S. military, prohibit coral collecting and the export of any reef fish or invertebrates from the island. No recent fisheries statistics are available for the area.

National Wildlife Refuges have been established at Baker, Howland and Jarvis Islands, Johnston Atoll, Midway Atoll and most recently, Palmyra Atoll and Kingman Reef. Natural resources are managed by the USFWS and access is by special permit only.

3.4.2 Jurisdictional Issues

Introduction

This section reviews the complex issues surrounding marine boundaries in the Western Pacific Region. Delineation of current marine boundaries is discussed and specific areas of contention between various federal and state authorities are summarized.

Exclusive Economic Zone

The 1976 Fishery Conservation and Management Act (the Magnuson Act, and later, after amendments, the MSFCMA)[6] established U.S. jurisdiction from the seaward boundary of the territorial sea out to 200 miles for the purpose of managing fishery resources. Passage of the Magnuson Act was the first unilateral declaration of jurisdiction over a 200-mile zone by a major power. Presidential Proclamation 5030 of March 10, 1983, expanded Magnuson Act jurisdiction by establishing the U.S. exclusive economic zone; it declared, "to the extent permitted by international law ... sovereign rights for the purpose of exploring, exploiting, conserving and managing natural resources, both living and non-living, of the seabed and subsoil and the superjacent waters" in the 200-mile zone. The assertion of jurisdiction over the EEZ of the United States provided a basis for economic exploration and exploitation, scientific research, and protection of the environment under the exclusive control of the U.S. government. Congress confirmed presidential designation of the EEZ in 1986 amendments to the Magnuson Act. Under the Magnuson Act, fishery management authority in the EEZ off American Samoa, Guam, Hawaii, the Northern Mariana Islands, and other U.S. islands in the central and western Pacific is the responsibility of the Western Pacific Regional Fishery Management Council.

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[6]The MSFCMA was initially referred to as the Magnuson Fishery Conservation and Management Act, which was changed to the Magnuson-Stevens Fishery Conservation and Management Act by the 1996 amendment to the Act.

The EEZ is measured from the "baseline" of U.S. states and overseas territories and possessions out to 200 nautical miles. Under the Magnuson Act, the shoreward boundary of the EEZ is a line coterminous with the seaward boundary, baseline, of each "state." (As used elsewhere in this document, U.S. territories and possessions in the Western Pacific fall within the definition of state under the Magnuson Act (16 U.S.C. 1802, MSFCMA § 3 104-297). In the case of the CNMI and the PRIAs, the EEZ extends to the shoreline (Beuttler 1995).

Seaward boundaries (territorial seas) for states are recognized as extending out to a distance of three miles from the ordinary low-water mark, as established by the Submerged Lands Act (SLA) of 1953.[7] The Territorial Submerged Lands Act (TSLA) of 1960 was enacted to convey to the governments of American Samoa, Guam and Virgin Islands the submerged lands from the mean high-tide line out to three geographical miles from their coast lines (Beuttler 1995).

The CNMI was part of the United Nations Trust Territory of the Pacific Islands (administered by the U.S.) until 1984 when its citizens by plebiscite chose to be become a U.S. commonwealth and it was agreed to by Congress and the United Nations. Although title of the emergent land was conveyed to the Commonwealth, the U.S. government withheld title to the submerged lands of the archipelago.[8] Submerged lands and underlying resources adjacent to CNMI remain owned by the federal government and subject to its management authority (Beuttler 1995).

In the PRIAs, for which there are no sovereign entities similar to states or territories, various federal agencies have jurisdictional authority. Authority is often established through statutes, Executive Orders, and Presidential Proclamations, and marine boundaries are often unclear. For this reason, the extent to which an agency exercises its jurisdictional authority is subject to legal interpretation.

Territorial Seas

State of Hawaii

The State of Hawaii consists of all islands, together with their appurtenant reefs and territorial waters, which were included in the Territory of Hawaii under the Organic Act of 1900. Under the Admissions Act of 1959, Congress granted to Hawaii the status of statehood and all amenities of a state, which included the reversion of title and ownership of the lands beneath the navigable waters from the mean high-tide line seaward, out to a distance of three miles, as

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[7]Under the SLA, the term "boundaries"' or the term "lands beneath navigable waters"' is interpreted as extending from the coastline to three geographical miles into the Atlantic Ocean or the Pacific Ocean, or three marine leagues (9 miles) into the Gulf of Mexico.

[8] The Territorial Submerged Lands Act was enacted for CNMI on October 5, 1974 (Beuttler 1995). Congress approved the mutually negotiated "Covenant to Establish a Commonwealth of the Northern Marianas (CNMI in political union with the U.S.)". However, the Covenant was not fully implemented until 1986, pursuant to Presidential Proclamation number 5564, which terminated the trusteeship agreement (Beuttler 1995).

stated by the SLA of 1953. Congress excluded Palmyra Atoll, Kingman Reef, and Johnston Atoll, including Sand Island, from the definition of the State of Hawaii in 1959. The federal government also retained 1,765 acres of emergent land in the NWHI, which had been set aside by Executive Order 1019 in 1909, establishing the Hawaiian Islands Reservation (HIR). The HIR was later renamed the Hawaiian Islands National Wildlife Refuge (HINWR) after it was transferred from the Department of Agriculture to the Department of the Interior in 1939 (Yamase 1982).

Territories of Guam and American Samoa

Pursuant to the TSLA of 1960, the Territories of Guam and American Samoa own and have management responsibilities over the marine resources out to three "geographic" miles. In general, the authority of the MSFCMA begins at three nautical miles from the shoreline at Guam and American Samoa. There are, however, exceptions to the management authority in the Territories. For example, the federal government administers waters in National Wildlife Refuges (NWR) and naval defense sea areas (NDSA)(see below).

U.S. Fish and Wildlife Refuges and Units

The USFWS has been given authority to manage a number of NWRs in the Western Pacific Region. The USFWS asserts the authority to manage marine resources and activities, including fishing activities within Refuge boundaries pursuant to the National Wildlife Refuge System Administration Act (NWRSAA) of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997, and other authorities (Gillman 2000). The USFWS asserts that NWRs are closed to all uses until they are specifically opened for such uses. They also claim that the USFWS is "solely" charged with making decisions whether to open NWRs for specific purposes that are compatible with the refuge's primary purposes and mission (Smith 2000a).

Executive Order 1019 reserved and set apart Laysan and Lisanski Islands, and Maro and Pearl and Hermes Reefs, excluding Midway Atoll, "as a preserve and breeding ground for native birds" to be administered by the Department of Agriculture. The HIR was transferred to the DOI in 1939 and in 1940, renamed the HINWR through Presidential Proclamation 2466, with control transferred to the USFWS. Within the HINWR, the USFWS asserts management authority over coral reef resources to a depth of 10 fm around all islands with the exception of Necker Island, where it asserts a 20 fm boundary. The USFWS acknowledges that all HINWR islands are part of the State of Hawaii, but asserts that the islands are federally owned and administered as a NWR by the USFWS (Smith 2000b; USFWS 1999a).

Kure Atoll was initially included in Executive Order 1019 in 1909, which established the HIR. However, Kure Atoll was returned to the Territory of Hawaii in 1952 by Executive Order 10413 (Yamase 1982). Kure Atoll is the only State Wildlife Refuge in the NWHI and extends out three miles, to the State's seaward boundary.

In the PRIAs, the USFWS—based on interpretation of Executive Order 7358—asserts that its refuge boundaries extend to the extent of the NDSA, which was administered by the Department of Defense before the transfer of surplus land to the USFWS. The USFWS currently manages seven wildlife refuges in the PRIAs: Palmyra Atoll; Kingman Reef; Jarvis Island; Baker Island; Howland Island; Johnston Atoll; and, Midway Atoll (Smith 2000b).

On January 18, 2001, the USFWS, through Secretarial Order 3223, declared Kingman Reef and the surrounding submerged lands and waters a National Wildlife Refuge out to a distance of 12 nautical miles. Additionally, Secretarial Order 3224, issued the same day, declared the tidal lands and submerged lands and waters of Palmyra Atoll as a National Wildlife Refuge out to a distance of 12 nautical miles. Certain tidal and submerged lands were excluded from this order.[9]

Midway Atoll NWR, established under Executive Order 13022 in 1996, is located in the NWHI and has a refuge boundary that is within a 22 by 22 mile quadrant surrounding the atoll (the exact boundary is disputed). The U.S. Navy established a Naval Air Facility at Midway Atoll in 1941. The USFWS established an overlay refuge in 1988, to manage the fish and wildlife on the Atoll. Through the Base Alignment Closure Act of 1990, as amended, the Naval Air Facility closed in 1993, and the property was transferred to the USFWS in 1996 (USFWS 1999b). The mission of the refuge is to protect and restore biological diversity and historic resources of Midway Atoll, while providing opportunities for compatible recreational activities, education and scientific research (Shallenberger 2000). Through a long-term cooperative agreement with a private company (i.e., Midway Phoenix Corp.), the refuge has been open to the public for marine recreation and education (Shallenberger 2000).

Johnston Atoll NWR is managed cooperatively with the Navy. The atoll was first established as a federal bird refuge on June 29, 1926, through Presidential Executive Order 4467 to be administered by the Department of Agriculture. In 1934, through Executive Order 6935, the atoll was placed under the jurisdiction of the Navy for administrative purposes and has been used as a military installation since 1939. In 1941, Executive Order 8682 designated Johnston and other Pacific atolls NDSAs. Since 1976, the USFWS, under agreement with the military, assists in management of fish and wildlife resources on the atoll. The USFWS manages a recreational fishing program in the NWR (Smith 2000b).

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[9]A September 15 2000, legal opinion by Randolph Moss, Assistant Attorney General, U.S. Department of Justice, states that they are "unconvinced that the President has the authority to establish or expand a wildlife refuge within the U.S. territorial sea (12 miles) or the EEZ using presidential authority recognized in *Midwest Oil*." Because the National Wildlife Refuge System Administration Act does not itself contain a provision authorizing the President to withdraw land for a wildlife refuge, the DOI argues that the President could rely on the implied authority to reserve public lands recognized in *United States v. Midwest Oil Co.* 236, U.S. 459 (1915). The Federal Land Policy and Management Act (FLPMA) of 1976 repealed the President's authority, effective on and after approval of the Act, to make withdrawals and reservations resulting from acquiescence of Congress (*U.S. v. Midwest Oil Co.*). Moss continued by stating that they find "it likely that a court would find that §704(a) of the FLPMA prohibits the President from relying on the implied *Midwest Oil* authority to withdraw lands, regardless of where those lands are located." Also, he notes that "they do not think history makes it clear that the President may continue to make *Midwest Oil* withdrawals in the territorial sea or EEZ following the enactment of the FLPMA."

Administration of Jarvis, Howland, and Baker Islands was transferred from the Office of Territorial Affairs to the USFWS in 1936 to be run as NWRs. The USFWS asserts refuge boundaries out to three nautical miles, and it prohibits fishing and any type of unauthorized entry (Smith 2000b). The USFWS acknowledges the Council's fishery management authority, in coordination with the NMFS, within the "200-nautical mile EEZ" (Smith 2000b).

Rose Atoll NWR, located in American Samoa, was established through a cooperative agreement between the Territory of American Samoa and the USFWS in 1973. Presidential Proclamation 4347 exempted Rose Atoll from a general conveyance of submerged lands around American Samoa to the Territorial Government. The boundary of the refuge extends out to three miles around the atoll and is under the joint jurisdiction of the Departments of Commerce and Interior, in cooperation of the Territory of American Samoa. Here too, the USFWS acknowledges fishery management authority of the Council, in coordination with the NMFS, within the "200-nautical mile EEZ" (Smith 2000b).

In the Ritidian Unit of the Guam National Wildlife Refuge, USFWS has fee title, which includes 371 acres of emergent land and 401 acres of submerged lands down to the 100-foot bathymetric contour. The submerged lands adjacent to Ritidian were never transferred to the Territory of Guam pursuant to the TSLA by the federal government. In 1993, the USFWS acquired the emergent land of the Ritidian Unit and the surrounding submerged lands from the Navy at no cost (Smith 2000b).

Department of Defense Naval Defensive Sea Areas

A number of Executive Orders have given administrative authority over territories and possessions to the Army, Navy, or the Air Force for use as military airfields and for weapons testing. In particular, Executive Order 8682 of 1941 authorizes the Secretary of the Navy to control entry into NDSAs around Johnston, and Midway Atolls, Wake Island, and Kingman Reef. The NDSA includes "territorial waters between the extreme high-water marks and the three-mile marine boundaries surrounding" the areas noted above. The objectives of the NDSA are to control entry into naval defensive sea areas; to provide for the protection of military installations; and to protect the physical security of, and ensure the full effectiveness of, bases, stations, facilities, and other installations (32 CFR Part 761). In addition, the Navy has joint administrative authority with the USFWS of Johnston Atoll and has recently transferred administrative authority over Kingman Reef to the USFWS. In 1996, Executive Order 13022 rescinded the Midway Atoll NDSA. Additionally, the Wake Island NDSA has also been suspended until further notice.

The Navy exerts jurisdiction over Farallon de Mendinilla in the CNMI and Kaula Rock in the MHI, which are used as military bombing ranges. The Navy also exerts jurisdiction over a variety of waters offshore from military ports and air bases in Hawaii, the PRIAs, Guam, and the CNMI.

Issues

Claims between "state" and federal resource management agencies involving marine boundaries over individual islands, reefs and atolls, continue to be unresolved in the Western Pacific Region. These agencies also have also established or propose to establish management over marine resources within various depths. Tables 3.7 -3.9 summarize these various claims.

Northwestern Hawaiian Islands

The NWHI are primarily uninhabited atolls, islands, banks and shoals and are currently under multi-agency jurisdiction including the State of Hawaii, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service and the Western Pacific Regional Fishery Management Council. Overlaps in jurisdiction and the varying regulatory authorities embodied in the management of this area can create numerous challenges and have led to contention regarding access and use for the region.

The State of Hawaii claims jurisdiction of all submerged lands from the shoreline to the extent of the State's jurisdiction in the NWHI. In accordance with the Hawaii Organic Act of April 30, 1900, c 339, 31 Stat 141 Section 2, and the Hawaii Admissions Act of March 18, 1959, Pub Law 86-3, 73 Stat 4 Section 2, the Islands of the Hawaiian Archipelago, together with their appurtenant reefs and territorial waters, with the exception of Midway Atoll, are part of the territory of Hawaii and are managed by the State of Hawaii including all submerged lands and marine resources. The State of Hawaii, Department of Land and Natural Resources has stewardship responsibility for managing, administering and exercising control over the coastal and submerged lands, ocean waters and marine resources under State jurisdiction around each of the Northwestern Hawaiian Islands under Title 12, Chapter 171.3 Hawaii Revised Statutes. Under an Executive Order issued by President Truman, the emergent lands at Kure Atoll are also managed as a State Wildlife Refuge.

In addition to the State of Hawaii, the USFWS also claims jurisdiction over atolls, islands, banks and shoals in the NWHI. Following the Hawaii Admissions Act of March 18,1959, federal agencies were directed to inventory all lands for which there was a continuing need. The USFWS in 1963, reported a continuing need of 1,765 acres of land in the NWHI. This area consisted of only the emergent land in the NWHI as was claimed by the Department of Agriculture as the original boundary of the Hawaiian Island Refuge (Yamase 1982). More recently however, the USFWS claims that the HINWR includes 252,000 acres of submerged lands based on their interpretation of the terms "reef and inlets" contained in Executive Order 1019 (U.S. Fish and Wildlife Service 1986). Within the HINWR, the USFWS asserts management authority over coral reef resources to a depth of 10 fathoms around all islands with the exception of Necker Island where it asserts a 20 fathom boundary. The USFWS acknowledges that all HINWR islands are part of the State of Hawaii, but asserts that the islands are federally owned and administered as a NWR by the USFWS (U.S. Fish and

Wildlife Service 1999a, Smith 2000). Other jurisdictional disputes also involve East and Tern Islands in French Frigate Shoals [10] [11]

Issues have developed from a series of directives from President Clinton that focused public attention on protection of U.S. coral reef ecosystems. Executive Order 13089, Coral Reef Protection, issued in June 1998, requires agencies to: (1) identify actions that may affect U.S. coral reef ecosystems; (2) use their programs and authorities to protect and enhance the condition of such ecosystems; and (3) ensure that any actions they authorize, fund, or carry out will not degrade the conditions of coral reef ecosystems. Agencies whose actions affect U.S. coral reef ecosystems must provide for implementation of measures needed to research, monitor, manage and restore affected ecosystems, including, but not limited to, measures reducing impacts from pollution, sedimentation, and fishing. The EO also established the U.S. Coral Reef Task Force composed of the heads of 11 federal agencies and the Governors of the seven states, territories, or commonwealths with responsibilities for coral reefs. In March 2000, the Task Force issued the National Action Plan to Conserve Coral Reefs, which presents a cohesive national strategy to implement EO 13089.

In May 2000, the President issued a Memorandum stating that it is time to implement the Coral Reef Task Force's recommendations in order to comprehensively protect the coral reef ecosystem of the NWHI.[12] The Memorandum directed the Secretaries of Interior and Commerce, in cooperation with the State of Hawaii, and in consultation with the WPRFMC, to develop recommendations for a new, coordinated management regime to increase protection for the NWHI coral reef ecosystem and provide for sustainable use. After considering their recommendations and comments received during the public visioning

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[10] In 1940, Territorial Governor Poindexter, issued an Executive Order in concurrence with the President of the U.S. to set aside East Island, for the use and purpose of the United States as a radar station communication base under the DOC (Yamase 1982). Prior to statehood, the DOC returned East Island to the Territory of Hawaii (Yamase, 1982). However, the DOI contends that East Island was part of the HIR as established by Executive Order 1019 in 1909 and later transferred to the DOI in 1939. Therefore, East Island remains included in the HINWR and under authority of DOI.

[11] Tern Island was expanded from 11 to 37 acres in 1942 by military dredging (Yamase 1982). In 1948, the Navy conveyed Tern Island to the Territory of Hawaii which then permitted the U.S. Coast Guard in 1952 to establish a navigational Loran station (Yamase 1982). In 1979, USCG operations were terminated and the Hawaii State Legislature adopted resolutions requesting the Governor to take immediate action to acquire and return Tern Island for use as a fishing base to support commercial activities (Yamase 1982). The Federal government asserts that it retains jurisdiction over Tern Island based on Executive Order 1019 and that the Navy did not have the authority to legally convey title to the Territory of Hawaii, therefore, the conveyance is void (Yamase 1982).

[12] The President's directive coincided with Executive Order 13158, which requires federal agencies to establish a comprehensive national network of marine protected areas throughout US marine waters. The Executive Order calls for expansion of the nation's MPA system to include examples of all types of marine ecosystems. According to the executive order, a MPA means any area of the marine environment that has been reserved by federal, state, territorial, tribal, or local laws or has regulations to provide lasting protection for part or all of the natural and cultural resources therein.

process on this initiative, President Clinton issued Executive Order 13178 on December 4, 2000, establishing the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve, pursuant to the National Marine Sanctuaries Amendments Act of 2000 (NMSA). The EO was revised and finalized by Executive Order 13196, issued January 18, 2001. Pursuant to Executive Order 13178 and the NMSA, NOAA is initiating the process to designate the Reserve as a national marine sanctuary (66 FR 5509, January 19, 2001). These actions to protect the coral reef ecosystem of the NWHI and provide for sustainable use of the area underscore the immediate need for a comprehensive assessment of the impacts of fishing activity on this ecosystem. (For more details on these Executive Orders and a description of its conservation measures, see section 9.2 of the FMP.)

Because the final rules for the CRE Reserve have not yet been published, and an EIS will be prepared for the marine sanctuary, a comprehensive analysis of the impact of the Reserve cannot be made at this time. Preliminary potential impacts to the human environment are addressed in the environmental consequences section of this EIS. Two alternatives considered by this EIS (3 and 4, described in Chapter 2) are consistent with the concept of establishing marine reserves in the NWHI, as described in the CRE-FMP.

The USFWS and the Council have different opinions about primary fishery management responsibilities in EEZ waters within NWR boundaries. Since the late 1960s, citing USFWS interim administrative policy and interpretation of Executive Order 1019, the USFWS has asserted that they would enforce refuge regulations within the *"de facto"* boundaries of the HINWR, which include all emergent land and their surrounding waters out to a depth of 10 fm for all islands and later 20 fm around Necker Island (Smith 2000b). Under the authority of the MSFCMA, the Council promulgated fishery regulations within federal waters that correspond with USFWS refuge boundaries of 0-10 fathoms within NWHI federal waters, except at Necker where it is 20 fm (WPRFMC 1986). The Council recognizes state waters in the NWHI from 0-3 miles and asserts management authority over fishery resources in all federal waters (3-200 miles), except at Midway Atoll where it asserts authority from 0-200 miles (Gillman 2000).

Main Hawaiian Islands

The State of Hawaii claims jurisdiction beyond its territorial seas of 0-3 nautical miles by claiming archipelagic status over channel waters between the main Hawaiian islands (MacDonald and Mitsuyasu 2000). The federal government does not recognize the State's claim of archipelagic jurisdiction, but interprets the State's seaward authority to stop at three nautical miles from the baseline (Feder 1997; MacDonald and Mitsuyasu 2000). The authority of the MSFCMA, therefore, begins at three miles from the shoreline around all main Hawaiian islands in the State of Hawaii. However, the State of Hawaii does not agree with this interpretation.

American Samoa

The legal relationship between the Territory of American and the U.S. with regard to fisheries management is unresolved due to a discrepancy in the wording of the deeds of cession signed by the chiefs of what is now American Samoa and the law enacted by Congress which extended U.S. sovereignty over the eastern Samoa islands in 1900. Language contained in the deeds of cession signed by the chiefs of Tutuila district state that they ceded, transferred and yielded up "all these islands of Tutuila and Aunu'u and all other islands, rocks, reefs, foreshores and waters lying between the 13th degree and the 15th degree of south latitude and between the 171st degree and 167th degree of west longitude...." Likewise, the chiefs of the Manu'a Islands also ceded to the U.S. "the whole of eastern portion of the Samoan Islands lying east of 171 degrees west of Greenwich and known as Tau, Olosega, Ofu and Rose Islands, and all other , the waters and property adjacent thereto...."

In contrast, Title 48 United States Code, Section 661, by which Congress accepted, confirmed and ratified these cessions by the chiefs, refer only to the islands, and not to the reefs, foreshores and waters or property adjacent to or lying between the referenced coordinates. Whether Congress deliberately or unintentionally failed to extend sovereignty over reef and ocean waters transferred by the chiefs of Tutuila and Manu'a is uncertain. However, many American Samoans assert that management over the waters and submerged lands surrounding the islands, including submerged lands within the EEZ, should remain with the territorial government.

A central premise for ceding eastern Samoa to the U.S. was to preserve the rights and property of the islands' inhabitants. Additionally, American Samoa's constitution makes it government policy to protect persons of Samoan ancestry from the alienation of their lands and the destruction of the Samoan way of life and language and to encourage business enterprise among persons of Samoan ancestry. Therefore, any federal actions within the EEZ waters of American Samoa that would stymie these rights, including restriction on fishing, may be perceived to be contrary to American Samoa's constitution.

CNMI

Currently, the EEZ includes all waters surrounding CNMI from the shore out to 200 miles. However, through the legal system CNMI is pursuing a claim that the Commonwealth is vested authority out to 12 miles from the archipelagic baseline. The Council, for the purposes of fisheries management, defers management in waters 0-3 nm off shore to the CNMI while managing fishery resources 3-200 nm.

Guam

The Territory of Guam questions the legality of the transference of the Ritidian Unit from the Navy to the USFWS. In its property inventory to the General Services Administration the Navy listed the Ritidian Unit as excess lands, not of continual need and available for reversion

to the Territory. The area formerly used by the Navy had been claimed as ancestral lands by Chamorro families. Therefore, the Territory asserts that the fee title should not have been transferred to the USFWS (J. Guthertz pers. comm.). With respect to fisheries management, this area geographically within the three mile territorial boundary. However, the United States, through the Territorial Submerged Lands Act of 1974 retained certain lands and mineral rights within the three mile territorial boundary (Beuttler 1995).

In 1976, the Federal Fishery Conservation Zone (later known as the EEZ) was extended to 200 nm around Guam which allowed the federal government authority in managing federal fishery resources within the EEZ. In 1980, the Guam Legislature passed and the Governor signed legislation providing for a 200 mile territorial limit for Guam (DOI 1993). The purpose of this legislation, reportedly was to allow the government of Guam to sell foreign fishing rights within Guam's EEZ. In 1996, changes to the MSFCMA authorized the Secretary of State to establish foreign fishing agreements for fishing within the EEZ around Guam. However, in addition to the "state" waters around Guam, the government has also expressed a continuing interest in obtaining greater authority in managing the EEZ surrounding Guam.

PRIAs

In the PRIAs, primary jurisdiction over nearshore fisheries is an ongoing issue between the USFWS and the Council. Management authority is currently unresolved because no clear baseline boundary has been designated from which the seaward boundary of the PRIAs are measured. Seaward boundaries are not clearly defined because some islands in the PRIAs do not appear to have a seaward boundary as defined by U.S. law (i.e., MSFCMA) (Beuttler 1995). For this reason, jurisdictional boundaries have been claimed by federal agencies in terms of fathoms, miles, or the territorial sea. Furthermore, it is recognized that various Executive Orders have given administrative authority of the PRIAs to either the Department of Defense (DOD) or DOI. However, Executive Orders themselves do not convey title of submerged lands, unless specifically stated. In any case, based on tentative interpretation by the NOAA legal counsel, MSFCMA authority applies to all marine waters around federally owned possessions (i.e., PRIAs), including marine resources within bays, inlets, and other marine waters to the shoreline (Beuttler 1995).

Additionally, because the National Wildlife Refuge System Administration Act (NWRSAA) does not explicitly authorize the President to withdraw land for a wildlife refuge, the DOI argues that the President could rely on the implied authority to reserve public lands recognized in *United States v. Midwest Oil Co.* 236, U.S. 459 (1915). However, since the Federal Land and Policy Act of 1976 (FLPMA) repealed the President's authority, effective on and after approval of the Act, to make withdrawals and reservations resulting from the acquiescence of Congress (*U.S. v. Midwest Oil Co.*), it appears that since 1976 the President has not had the authority to establish or expand a wildlife refuge within the U.S. territorial sea (12 miles) or the EEZ using presidential authority recognized in *Midwest Oil* (Moss 2000). This could call into question asserted marine boundaries of any NWRs established after enactment of the FLPMA.

Table 3.7 : Marine boundary claims by various jurisdictions in the Western Pacific Region. Note: a dashed line (-) indicates no jurisdiction.

Island or Area	State/Commonwealth/ Territory	Department of Commerce	Department of the Interior and Department of Defense (as noted)
PRIAs			
Howland I.	-	WPRFMC/NMFS 0-200 nm	USFWS: 0-3 nm
Baker I.	-	WPRFMC/NMFS 0-200 nm	USFWS: 0-3 nm
Jarvis I.	-	WPRFMC/NMFS 0-200 nm	USFWS: 0-3 nm
Johnston I.*	-	WPRFMC/NMFS 0-200 nm	USFWS/US Navy: 0-3 nm
Kingman R.	-	WPRFMC/NMFS 0-200 nm	USFWS: 0-12 nm[1]
Palmyra A.*	-	WPRFMC/NMFS 0-200 nm	USFWS: 0-12 nm[2]
Wake I.***	-	WPRFMC/NMFS 0-200 nm	DOI/USArmy: 0-3 nm
Midway A.*	-	WPRFMC/NMFS 0-200 nm	USFWS: 22x22 nm quad
Hawaii			
MHI	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	
Nihoa I.	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	USFWS: 0-10 fm**
Necker I.	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	USFWS: 0-20 fm**

[1] Boundary formerly 0-3 miles under the jurisdiction of the U.S. Navy. Secretarial Order 3223 extended Department of the Interior's jurisdiction to 12 nm.
[2] Secretarial Order 3224 (Palmyra Atoll) extended USFWS administrative authority from 3 to 12 nm.
*At Palymyra, Johnston, and Midway special permit fishing is only for recreational and on-island consumption; at Midway, the northern half of the atoll would be a no-take MPA and the southern half a low-use MPA.
**USFWS boundary begins at the shoreline; legally defined outer boundary of the Hawaiian Islands NWR is unresolved.
*** As of 1962, the jurisdiction over Wake Island has been vested with the Department of the Interior. Since 1994, the Department of the Army has maintained administrative use of Wake Island.

Table 3.7 (cont.)

Island or Area	State/Territory/Commonwealth	Department of Commerce	Department of the Interior and Department of Defense (as noted)
FFS	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	USFWS: 0-10 fm**
Gardner Pinnacles	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	USFWS: 0-10 fm**
Maro R.	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	USFWS: 0-10 fm**
Laysan I.	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	USFWS: 0-10 fm**
Lisanski I.	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	USFWS: 0-10 fm**
Pearl and Hermes R.	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	USFWS: 0-10 fm**
Kure A.	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	-
Guam	Guam: 0-3 nm	WPRFMC/NMFS 3-200 nm	
Ritadan Unit			USFWS: 100 ft. isobath
CNMI	CNMI: 0-3 nm***	WPRFMC/NMFS 3-200 nm	
American Samoa	American Samoa: 0-3 nm	WPRFMC/NMFS 3-200 nm	
Rose Atoll		WPRFMC/NMFS 0-200 nm	USFWS: 0-3 nm[3]

[3]At Rose Atoll, the Department of the Interior/U.S. Fish and Wildlife Service has a cooperative agreement with the Territory of American Samoa to manage the atoll as a national wildlife refuge, and shares jurisdiction with the Department of Commerce.
**USFWS boundary begins at the shoreline; legally defined outer boundary of the Hawaiian Islands NWR is unresolved.
***The CRE-FMP proposes to defer management in 0-3 nm to the CNMI while managing fisheries 3-200 nm.

Table 3.8 : Comparison of No-take and Low-use Marine Protected Areas of the Coral Reef Ecosystem FMP with the NWHI Reserve Preservation Areas (RPAs), U.S. Fish and Wildlife Service and State/Commonwealth/Territory (a dash (-) indicates no jurisdiction).

Island or Area	CRE-FMP	NWHI Reserve	USFWS	State/Commonwealth/Territory
PRIAs				
Howland I.	No-take zone 0-50 fathoms.	–	Howland Island NWR to 3 nm; No fishing allowed.	–
Baker I.	No-take zone 0-50 fathoms.	–	Baker Island NWR to 3 nm; No fishing allowed.	–
Jarvis I.	No-take zone 0-50 fathoms.	–	Jarvis Island NWR to 3 nm; No fishing allowed.	–
Johnston I.	Low-use special permit zone 0-50 fathoms.	–	Johnston Atoll NWR/Navy (Overlay Refuge) to 3 nm; Recreational fishing program.	–
Kingman R.	No-take zone 0-50 fathoms.	–	Kingman Reef NWR to 12 nm; No fishing allowed.	–
Palmyra A.	Low-use special permit zone 0-50 fathoms.	–	Palmyra Atoll NWR to 12 nm; Recreational fishing allowed.	–
Wake I.	Low-use special permit zone 0-50 fathoms.	–	DOI/US Army to 3 nm; Fishing allowed.	–
Midway A.	No-take zone 0-50 fathoms around northern half of Midway. Low-use special permit zone around southern half of Midway.	–	Midway Atoll NWR between 28°5' and 28°25'; 177°10' and 177°30'; following fishing allowed within Refuge boundaries: 1 lobster/person/day; pelagic rec and charter fishing allowed; no bottomfishing; catch and release ulua fishing.	–

Table 3.8 (cont)

Island or Area	CRE-FMP	NWHI Reserve	USFWS	State/Commonwealth/Territory
Hawaii				
MHI	Special permits for "potentially harvested" species.	–	10 wildlife refuges (none with marine boundaries)	State of Hawaii bottomfish area closures (20 closures across MHI); 10 Marine Life Conservation Districts and 14 Marine Fishery Management Areas in MHI (rules and regulations vary with location)
Nihoa I.	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms around Nihoa and nearby banks.	RPA extends from the seaward boundary of Hawaii State waters (3nm) out to a mean depth of 100 fathoms. Bottomfish and recreational trolling for pelagics permitted seaward of 25 fathoms.	HINWR 0 to 10 fathoms. No fishing allowed.	State of Hawaii proposed NWHI Marine Fisheries Management Area (NWHI FMA) 0-3 miles.
Misc. banks around Nihoa and Necker (8)	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	no current restrictions	HINWR 0 to 10 fathoms. No fishing allowed.	–
Necker	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA extends from the seaward boundary of Hawaii State waters (3nm) out to a mean depth of 100 fathoms. Bottomfish and recreational trolling for pelagics permitted seaward of 25 fathoms.	HINWR to 20 fathoms. No fishing allowed.	State of Hawaii proposed NWHI Marine Fisheries Management Area (NWHI FMA) 0-3 miles.
Unnamed bank east of French Frigate Shoal	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA to 12 nm from geographic center. No fishing allowed.	HINWR 0 to 10 fathoms. No fishing allowed.	–

Table 3.8 (cont)

Island or Area	CRE-FMP	NWHI Reserve	USFWS	State/Commonwealth/Territory
FFS	No-take zone 0-50 fathoms.	RPA extends from the seaward boundary of Hawaii State waters (3nm) out to a mean depth of 100 fathoms. No fishing allowed.	HINWR to 10 fathoms. No fishing allowed.	State of Hawaii proposed NWHI Marine Fisheries Management Area (NWHI FMA) 0-3 miles.
Brooks Banks (2)	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms around three banks southeast of St. Rogatien including two Brooks Banks and one bank NW of St. Rogatien.	RPA to 12 nm from geographic center of southeast Brooks Bank, but not closer than 3 nm to the next bank west (northwest Brooks Bank). No fishing allowed.	HINWR 0 to 10 fathoms. No fishing allowed.	–
St. Rogatien Bank	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA to 12 nm from geographic center, but not closer than 3 nm to the next bank east. Bottomfish and recreational trolling for pelagics permitted.	HINWR 0 to 10 fathoms. No fishing allowed.	–
Unnamed bank between Gardner Pinnacles and St. Rogatien Bank	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA to 12 nm from geographic center. Bottomfish and recreational tolling for pelagics allowed for 5 years from order.	HINWR 0 to 10 fathoms. No fishing allowed.	–
Gardner Pinnacles	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA extends from the seaward boundary of Hawaii State waters (3nm) out to a mean depth of 100 fathoms. Bottomfish and recreational trolling for pelagics permitted seaward of 25 fathoms.	HINWR to 10 fathoms. No fishing allowed.	State of Hawaii proposed NWHI Marine Fisheries Management Area (NWHI FMA) 0-3 miles.

Table 3.8 (cont)

Island or Area	CRE-FMP	NWHI Reserve	USFWS	State/Commonwealth/Territory
Raita Bank	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA to 12 nm from geographic center. Bottomfish and recreational trolling for pelagics allowed for 5 years from order.	HINWR 0 to 10 fathoms. No fishing allowed.	–
Maro R.	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA extends from the seaward boundary of Hawaii State waters (3nm) out to a mean depth of 100 fathoms. Bottomfish and recreational trolling for pelagics permitted seaward of 25 fathoms.	HINWR to 10 fathoms. No fishing allowed.	State of Hawaii proposed NWHI Marine Fisheries Management Area (NWHI FMA) 0-3 miles.
Laysan I.	No-take zone 0-50 fathoms. (Crustaceans FMP: Lobster fishing prohibited to 20 nm from geographic center)	RPA extends from the seaward boundary of Hawaii State waters (3nm) out to a mean depth of 100 fathoms. Bottomfish and recreational trolling for pelagics permitted seaward of 50 fathoms.	HINWR to 10 fathoms. No fishing allowed.	State of Hawaii proposed NWHI Marine Fisheries Management Area (NWHI FMA) 0-3 miles.
Misc banks near (SW of) Laysan (4)	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	No current restrictions.	HINWR 0 to 10 fathoms. No fishing allowed.	–
Pioneer Bank	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	Preservation Area to 12 nm from geographic center. Bottomfish and recreational trolling for pelagics permitted.	HINWR 0 to 10 fathoms. No fishing allowed.	–

Table 3.8 (cont)

Island or Area	CRE-FMP	NWHI Reserve	USFWS	State/Commonwealth/Territory
Lisanski I.	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA extends from the seaward boundary of Hawaii State waters (3nm) out to a mean depth of 100 fathoms. Bottomfish and recreational trolling for pelagics permitted seaward of 25 fathoms.	HINWR to 10 fathoms. No fishing allowed.	State of Hawaii proposed NWHI Marine Fisheries Management Area (NWHI FMA) 0-3 miles.
Misc banks near (W of) Lisianski (2)	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	No current restrictions.	HINWR 0 to 10 fathoms. No fishing allowed.	–
Pearl and Hermes R.	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA extends from the seaward boundary of Hawaii State waters (3nm) out to a mean depth of 100 fathoms. No fishing allowed.	Hawaiian Islands NWR (HINWR) to 10 fathoms. No fishing allowed.	State of Hawaii proposed NWHI Marine Fisheries Management Area (NWHI FMA) 0-3 miles.
Misc. banks in the vicinity of Kure, Midway and Pearl and Hermes (4)	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	No current restrictions.	HINWR 0 to 10 fathoms. No fishing allowed.	–
Kure A.	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA extends from the seaward boundary of Hawaii State waters (3nm) out to a mean depth of 100 fathoms. No fishing allowed.	–	State of Hawaii Wildlife Refuge shoreline to 3 nm. Fishing not prohibited.

Table 3.8 (cont)

Island or Area	CRE-FMP	NWHI Reserve	USFWS	State/Commonwealth/Territory
American Samoa				
Rose Atoll	No-take zone 0-50 fathoms.	–	Rose Atoll NWR to 3 nm; no fishing allowed.	DOI has a cooperative agreement with the Territory of American Samoa to manage Rose Atoll as a national wildlife refuge and shares jurisdiction with DOC
Guam				
Ritadan Unit	–	–	Ritidian Unit to 100 foot contour. Recreational fishing allowed	–
CNMI	–	–	–	–

Table 3.9: Comparison of Resource Management Authorities and Fishery Management Measures for Coral Reef Ecosystems in Federal Waters of the Western Pacific Region.

NIHOA, NECKER, GARDNER, MARO, LISIANSKI (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
NWHI Coral Reef Ecosystem Reserve (Reserve) (Federal waters to 50 miles around all islands)	No fishing portion of RPA: Federal waters 0-25 fm.	No fishing.	None.
	Bottomfishing/trolling portion of RPA: Federal waters 25-100 fm.	Limited commercial bottomfishing by permit holders and limited commercial and recreational pelagic trolling (all subject to fishing caps based on catch history).	No anchoring in areas where mooring is available; no discharging of any material except cooling water or engine exhaust.
	Other Reserve waters: Federal waters 100 fm-50 miles.	Limited commercial and recreational fishing (all subject to fishing caps based on catch history).	No increase in level of effort or take; no change in gear type or species targeted.
CRE FMP Federal waters to 200 miles	No-take MPA: Federal waters 0-10 fm.	No fishing.	Insurance requirement.
	Low-use MPA: Federal waters 10-50 fm.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders.	CRE special permit needed to target <u>any</u> coral reef ecosystem resources, insurance requirement.
	Non-MPA: Federal waters 50 fm-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS Federal waters to 10 fathoms [0-20 at Necker]	Refuge: Federal waters 0-10 fathoms [0-20 at Necker].	Activities consistent with Refuge mission- no commercial fishing.	USFWS special use permit required to enter.

Distinguishing Characteristics (this is the most common scenario):

<u>NWHI Reserve</u>	**<u>CRE FMP</u>**	**<u>USFWS</u>**
Reserve Preservation Area (RPA)	Marine Protected Area (MPA)	Refuge 0-10 fm, 0-20
No fishing RPA 0-25 fm	No-take MPA 0-10 fm	fm at Necker (no fishing)
Fishing RPA 25-100 fm	Low-take MPA 10-50 fm	
Recreational fishing 100 fm - 50 miles	Non-MPA 50 fm-200 miles	

NIHOA, NECKER, GARDNER, MARO, LISIANSKI (details)			
Federal waters	**NWHI Reserve**	**CRE FMP**	**USFWS**
0-10 fathoms	No fishing (RPA).	No fishing, insurance requirement (No-take MPA).	No fishing (Refuge). Beyond 10 fathoms, no current restrictions.
10-25 fathoms	No fishing (RPA).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target any coral reef ecosystem resources, insurance requirement (Low-use MPA).	No fishing 0-20 fm at Necker (Refuge). Beyond 20 fm no current restrictions.
25-50 fathoms	Limited bottomfish and pelagic trolling by current permit holders; limited recreational trolling for pelagic (RPA).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target any coral reef ecosystem resources, insurance requirement (Low-use MPA).	No current restrictions.
50-100 fathoms	Limited bottomfish and pelagic trolling by current permit holders; limited recreational trolling for pelagic (RPA).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
100 fm-50 miles	Recreational fishing commercial fishing by bottomfish permit holders; all pelagic trollers (Reserve).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
50 - 200 miles	Outside of Reserve.	Lobster, bottomfish, precious corals, troll/handline and longline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.

FRENCH FRIGATE SHOALS (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
NWHI Coral Reef Ecosystem Reserve (Federal waters to 50 miles)	Entire no fishing RPAs: Federal waters 0-100 fm.	No fishing.	None.
	Other Reserve Areas: Federal waters 100 fm to 50 miles.	Limited commercial bottomfishing by permit holders and limited commercial and recreational pelagic trolling (all subject to fishing caps based on catch history).	No anchoring in areas where mooring is available; no discharging of any material except cooling water or engine exhaust.
CRE FMP Federal waters to 200 miles	No-take MPA: Federal waters 0-50 fm.	Limited commercial and recreational fishing (all subject to fishing caps based on catch history).	No increase in level of effort or take; no change in gear type or species targeted.
	Non-MPA: Federal waters 50 fm-50 miles.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
	Non-MPA: Federal waters 50-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS Federal waters to 10 fathoms	Refuge: Federal waters 0-10 fm.	Activities consistent with Refuge mission-no commercial fishing.	USFWS special use permit required to enter.

Distinguishing characteristics:

CRE FMP

(1) No-take MPA from 0-50 fathoms.

NWHI Reserve

(2) No fishing RPAs extend from 0-100 fathoms.

FRENCH FRIGATE SHOALS (details)			
Federal waters	**NWHI Reserve**	**CRE FMP**	**USFWS**
0-10 fathoms	No fishing (RPA).	No fishing, insurance requirement (No-take MPA).	No fishing (Refuge).
10-50 fathoms	No fishing (RPA).	No fishing, insurance requirement (No-take MPA).	No current restrictions beyond 10 fm.
50-100 fathoms	No fishing (RPA).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
100 fm-50 miles	Recreational fishing, commercial fishing by bottomfish permit holders, and all pelagic trollers (Reserve).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
50 - 200 miles	Outside of Reserve.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.

S.E. BROOKS BANK, 1ST BANK EAST OF FFS, ST. ROGATIEN, 1ST BANK WEST OF ST. ROGATIEN*, RAITA*, PIONEER (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
NWHI Coral Reef Ecosystem Reserve (Federal waters to 50 miles around all islands)	Bottomfishing/trolling RPA: Federal waters 0 - 12 miles. (All fishing is prohibited within 12 miles around S.E. Brooks Banks, and the 1st bank west of FFS).	Limited commercial bottomfishing by permit holders and limited commercial and recreational pelagic trolling (all subject to fishing caps based on catch history).	No anchoring in areas where mooring is available; no discharging of any material except cooling water or engine exhaust.
	Other Reserve waters: Federal waters 12-50 miles.	Limited commercial and recreational fishing (all subject to fishing caps based on catch history).	No increase in level of effort or take; no change in gear type or species targeted.
CRE FMP Federal waters to 200 miles	No-take MPA: Federal waters 0-10 fm.	No fishing.	Insurance requirement.
	Low-use MPA: Federal waters 10-50 fm.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders.	CRE special permit needed to target <u>any</u> coral reef ecosystem resources, insurance requirement.
	Non-MPA: Federal waters 50 fm-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS Federal waters to 10 fathoms	Refuge: Federal waters 0-10 fm.	Activities consistent with Refuge mission-no commercial fishing.	USFWS special use permit required to enter.

Distinguishing characteristics:

<u>NWHI Reserve</u>

(1) The NWHI EO fishing RPA extends from 0-12 miles;
(2) All fishing is prohibited within 12 miles around S.E. Brooks Banks, and the 1st bank east of FFS.

* Under the NWHI EO, the fishing RPAs at these banks will be reviewed after five years.

S.E. BROOKS BANK, 1ST BANK EAST OF FFS, ST. ROGATIEN, 1ST BANK WEST OF ST. ROGATIEN, RAITA, PIONEER (details)			
Federal waters	**NWHI Reserve**	**CRE FMP**	**USFWS**
0-10 fathoms	Limited bottomfish and pelagic trolling by current permit holders; limited recreational trolling for pelagic (RPA).	No fishing, insurance requirement (No-take MPA).	No fishing (Refuge).
10 - 50 fathoms	Limited bottomfish and pelagic trolling by current permit holders; limited recreational trolling for pelagic (RPA).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target any coral reef ecosystem resources, insurance requirement (Low-use MPA).	No current restrictions beyond 10 fm.
50 fm-12 miles	Limited bottomfish and pelagic trolling by current permit holders; limited recreational trolling for pelagic (RPA).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
12 - 50 miles	Recreational fishing, commercial fishing by bottomfish permit holders, and all pelagic trollers (Reserve).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
50 - 200 miles	Outside of Reserve.	Lobster, bottomfish, precious corals, troll/handline and longline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.

Note: All fishing is prohibited within 12 miles around S.E. Brooks Banks, and the 1st bank east of FFS.

LAYSAN (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
NWHI Coral Reef Ecosystem Reserve (Federal waters to 50 miles around all islands)	No fishing portion of RPA: Federal waters 0-50 fm.	No fishing.	None.
	Bottomfishing/trolling portion of RPA: Federal waters 50-100 fm.	Limited commercial bottomfishing by permit holders and limited commercial and recreational pelagic trolling (all subject to fishing caps based on catch history).	No anchoring in areas where mooring is available; no discharging of any material except cooling water or engine exhaust.
	Other Reserve waters: Federal waters 100 fm-50 miles.	Limited commercial and recreational fishing (all subject to fishing caps based on catch history).	No increase in level of effort or take; no change in gear type or species targeted.
CRE FMP Federal waters to 200 miles	No-take MPA: Federal waters 0-50 fm.	No fishing.	Insurance requirement.
	Non-MPA Federal waters 50 fm-20 miles.	Bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders (no lobster fishing).	CRE special permit needed to target potentially harvested coral reef taxa.
	Non-MPA: Federal waters 50 fm-50 miles.	Lobster*, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
	Non-MPA: Federal waters 50-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS Federal waters to10 fathoms	Refuge: Federal waters 0-10 fm.	Activities consistent with Refuge mission- no commercial fishing.	USFWS special use permit required to enter.

Distinguishing characteristics:

CRE FMP

(1) no-take MPA from 0-50 fathoms.

(2) *Crustacean FMP prohibits lobster fishing from 0- 20 miles.

USFWS

(1) assert HINWR also includes State waters 0-10 fm.

LAYSAN (details)			
Federal waters	**NWHI Reserve**	**CRE FMP**	**USFWS**
0-10 fathoms	No fishing (RPA).	No fishing, insurance requirement (No-take MPA).	No fishing (Refuge).
10-50 fathoms	No fishing (RPA).	No fishing, insurance requirement (No-take MPA).	No current restrictions beyond 10 fm.
50-100 fathoms	Limited bottomfish and pelagic trolling by current permit holders; limited recreational trolling for pelagic (RPA).	Bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
100 fm-50 miles	Recreational fishing, commercial fishing by bottomfish permit holders, and all pelagic trollers (Reserve).	Lobster*, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
50 - 200 miles	Outside of Reserve.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.

*Crustacean FMP prohibits lobster fishing from 0- 20 miles at Laysan.

PEARL & HERMES REEF (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
NWHI Coral Reef Ecosystem Reserve (Federal waters to 50 miles)	Entire no fishing RPA: Federal waters 0-100 fm.	No fishing.	None.
	Other Reserve waters: Federal waters 100 fm-50 miles.	Limited commercial and recreational fishing (all subject to fishing caps based on catch history).	No increase in level of effort or take; no change in gear type or species targeted.
CRE FMP Federal waters to 200 miles	No-take MPA: Federal waters 0-10 fm.	No fishing.	Insurance requirement.
	Low-use MPA: Federal waters 10-50 fm.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders.	CRE special permit needed to target <u>any</u> coral reef ecosystem resources, insurance requirement.
	Non-MPA: Federal waters 50 fm-50 miles.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
	Non-MPA: Federal waters 50-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS Federal waters to 10 fathoms	Refuge: Federal waters 0-10 fm.	Activities consistent with Refuge mission-no commercial fishing.	USFWS special use permit required to enter.

Distinguishing characteristics:

<u>NWHI Reserve</u>

(1) No fishing RPAs extend from 0-100 fathoms.

PEARL & HERMES REEF (details)			
Federal waters	**NWHI Reserve**	**CRE FMP**	**USFWS**
0-10 fathoms	No fishing (RPA).	No fishing, insurance requirement (No-take MPA).	No fishing (Refuge).
10-50 fathoms	No fishing (RPA).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target any coral reef ecosystem resources, insurance requirement (Low-use MPA).	No current restrictions beyond 10 fathoms.
50-100 fathoms	No fishing (RPA).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa , insurance requirement (Non-MPA).	No current restrictions.
100 fm-50 miles	Recreational fishing, commercial fishing by bottomfish permit holders, and all pelagic trollers (Reserve).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
50 - 200 miles	Outside of Reserve.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.

MIDWAY (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
NWHI Coral Reef Ecosystem Reserve (0-50 miles around all islands)	Midway Atoll NWR: approximately 22 x 22 miles around islands (not part of Reserve).	No restrictions.	None.
	Other Reserve waters: Federal waters approximately 22-50 miles.	Limited commercial and recreational fishing (all subject to fishing caps based on catch history).	No increase in level of effort or take; no change in gear type or species targeted.
CRE FMP 0 - 200 miles	No-take MPA: 0-50 fm in northern half of Refuge waters.	No fishing.	Insurance requirement.
	Low-use MPA: 0-50 fm in southern half of Refuge waters.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders.	CRE special permit needed to target <u>any</u> coral reef ecosystem resources - will be issued for recreational fishing for on-island consumption only, insurance requirement.
	Non-MPA: 50 fm-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permits.	CRE special permit needed to target potentially harvested coral reef taxa, insurance requirement.
USFWS approximately 22 x 22 mile square around islands	Refuge: approximately 22 x 22 miles around Midway.	Pelagic and lobster recreational and charter fishing permitted within refuge boundaries.	One lobster per person/day, all other catch and release unless record setting, USFWS special use permit required to enter.

Distinguishing characteristics:

<u>USFWS</u>

(1) Refuge waters extend to 22 miles x 22 miles delineated by specific latitude/longitude coordinates;
(2) Midway Atoll NWR not included as part of the NWHI CRE Reserve;
(3) No State claims to territorial waters.

MIDWAY (details)			
Waters	**NWHI Reserve**	**CRE FMP**	**USFWS**
0-50 fathoms in northern half of Refuge waters	No restrictions.	No fishing, insurance requirement (No-take MPA).	Pelagic and lobster recreational and charter fishing (Refuge).
0-50 fathoms in southern half of Refuge waters	No restrictions.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target any coral reef ecosystem resources - will be issued for recreational fishing for on-island consumption only, insurance requirement (Low-use MPA).	Pelagic and lobster recreational and charter fishing (Refuge).
50 fm - 22 miles	No restrictions.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	Pelagic and lobster recreational and charter fishing (Refuge).
22-50 miles	Recreational fishing, commercial fishing by bottomfish permit holders, and all pelagic trollers (Reserve).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	Outside of Refuge.
22 - 200 miles	No restrictions.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	Outside of Refuge.

KURE (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
NWHI Coral Reef Ecosystem Reserve (Federal waters to 50 miles around all islands)	Entire no fishing RPA: Federal waters 0 - 100 fm.	No fishing.	None.
	Other Reserve waters: Federal waters 100 fm-50 miles.	Limited commercial and recreational fishing (all subject to fishing caps based on catch history).	No increase in level of effort or take; no change in gear type or species targeted.
CRE FMP Federal waters to 200 miles	No-take MPA: Federal waters 0-10 fm.	No fishing.	Insurance requirement.
	Low-use MPA: Federal waters 10-50 fm.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders.	CRE special permit needed to target any coral reef ecosystem resources, insurance requirement.
	Non-MPA: Federal waters 50 fm-50 miles.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
	Non-MPA: Federal waters 50-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS None	None.	No restrictions.	No restrictions.
State of Hawaii 0-3 miles	State Wildlife refuge: 0-3 miles from shore.	Fishing with a NWHI Taking Permit.	Hand harvest of lobsters permitted.

Distinguishing characteristics:

State of Hawaii

(1) Kure Atoll State Wildlife refuge, 0-3 miles.

KURE (details)			
Waters	**NWHI Reserve**	**CRE FMP**	**State of HI**
0-3 miles	Not part of Reserve.	No restrictions.	NWHI Taking Permit requirement.
0-10 fathoms (outside of state waters)	No fishing (RPA).	No fishing, insurance requirement (No-take MPA).	No current restrictions.
10-50 fathoms (outside of state waters)	No fishing (RPA).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target any coral reef ecosystem resources, insurance requirement (Low-use MPA).	No current restrictions.
50 - 100 fm (outside of state waters)	No fishing (RPA).	Lobster, bottomfish, precious corals, troll/handline and longline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
100 fm-50 miles (outside of state waters)	Recreational fishing, commercial fishing by bottomfish permit holders, and all pelagic trollers (Reserve).	Lobster, bottomfish, precious corals, troll/handline and longline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
50 - 200 miles	Outside of Reserve.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.

Howland, Baker, Jarvis and Kingman Reef (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
CRE FMP 0 - 200 miles	No-take MPA: 0-50 fm.	No fishing.	Insurance requirement.
	Non-MPA: 50 fm-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS 0 - 3 miles (0-12 miles at Kingman Reef)	Refuge: 0-3 miles 0-12 miles (Kingman).	Activities consistent with Refuge mission - no commercial fishing.	USFWS special use permit required to enter.

Howland, Baker, Jarvis and Kingman Reef (details)		
Waters	**CRE FMP**	**FWS**
0-50 fathoms	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target any coral reef ecosystem resources will be issued for recreational fishing for on-island consumption only, insurance requirement (Low-use MPA).	No fishing (Refuge).
50 fm - 3 miles	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No fishing (Refuge).
3-12 miles	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No fishing (Kingman Reef NWR only).
12 - 200 miles	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	Outside of Refuge.

PALMYRA (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
CRE FMP 0 - 200 miles	Low-use MPA: 0-50 fm.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target any coral reef ecosystem resources - will be issued for recreational fishing for on-island consumption only, insurance requirement.
	Non-MPA: 50 fm-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS 0 - 12 miles	Refuge: 0-12 miles.	Activities consistent with Refuge mission- no commercial fishing.	USFWS special use permit required to enter.

Distinguishing characteristics:

CRE FMP Low-use MPA 0-50 fathoms, harvest of CRE species w/special permit for recreational fishing for on island consumption only.

PALMYRA (details)		
Waters	**CRE FMP**	**FWS**
0-50 fathoms	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target any coral reef ecosystem resources will be issued for recreational fishing for on-island consumption only, insurance requirement (Low-use MPA).	No commercial fishing (Refuge).
50 fm - 12 miles	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No commercial fishing (Refuge).
12 - 200 miles	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	Outside of Refuge.

Johnston and Wake Atoll (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
CRE FMP 0 - 200 miles	Low-use MPA: 0-50 fm.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target any coral reef ecosystem resources - will be issued for recreational fishing for on-island consumption only, insurance requirement.
	Non-MPA: 50 fm-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS 0 - 3 miles	Refuge: 0-3 miles.	Recreational fishing, activities consistent with Refuge mission- no commercial fishing.	USFWS special use permit required to enter.

Distinguishing characteristics:

CRE FMP Low-use MPA 0-50 fathoms, harvest of CRE species w/special permit for recreational fishing for on island consumption only

Johnston and Wake Atoll (details)		
Waters	**CRE FMP**	**FWS**
0-50 fathoms	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target any coral reef ecosystem resources will be issued for recreational fishing for on-island consumption only, insurance requirement (Low-use MPA).	No commercial fishing at Johnston Atoll (Refuge).
50 fm - 3 miles	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No commercial fishing at Johnston Atoll (Refuge).
3 - 200 miles	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	Outside of Refuge.

AMERICAN SAMOA (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
Government of American Samoa (Territorial waters 0-3 miles)	None.	Local regulations.	None.
CRE FMP Federal waters to 200 miles	No-take MPA: Federal waters 0-50 fathoms around Rose Atoll.	No fishing.	Insurance requirement.
	Non-MPA: Federal waters 3-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS Cooperative Agreement with American Samoa (0-3 miles at Rose Atoll NWR)	Refuge: (1) The area inside of the extreme low-water line around the seaward side of the atoll reef; (2) The lands and waters from the Refuge boundary out to 3 miles.	No fishing.	USFWS special use permit required to enter.

Distinguishing characteristics:

The USFWS has a cooperative agreement with the Territory of American Samoa to manage Rose Atoll as a National Wildlife Refuge, and the submerged lands and waters out to 3 miles around the refuge. MSFCMA jurisdiction begins at the shoreline at Rose Atoll. Under the CRE-FMP Rose Atoll is designated as a no-take MPA from 0-50 fathoms.

AMERICAN SAMOA (details)			
Waters	**GOV'T OF American SAMOA**	**CRE FMP**	**USFWS**
0-3 miles (except at Rose Atoll)	Local regulations.	No restrictions.	-
3-200 miles	No restrictions.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	-
0-50 fathoms around Rose Atoll	No fishing.	No fishing, insurance requirement (no-take MPA).	No fishing (Refuge).
50 fm-3 miles around Rose Atoll	No fishing.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No fishing (Refuge).

COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
CRE FMP 0-200 miles	Non-MPA: 0-3 miles.	No restrictions.	None.
	Non-MPA: 3-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.

Distinguishing characteristics:

There are no "state" (territorial) waters around CNMI. However, the CRE FMP will not impose any management measures within 0-3 miles from shore.

COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS (details)	
Federal waters	**CRE FMP**
0-3 miles	No restrictions (Non-MPA).
3-200 miles	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).

GUAM (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
Government of Guam 0-3 miles	None.	Local regulations.	None.
CRE FMP Federal waters to 200 miles	Non-MPA: Federal waters 3-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
	Non-MPA: Guam's Southern Banks.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa , no anchoring by vessels greater than 50' in length.
USFWS Federal waters to 100 ft at Ritidian	Refuge: Federal waters 0-100 foot isobath.	Recreational fishing.	USFWS special permit required to enter.

Distinguishing characteristics:

There are no CRE MPAs around Guam, but there is an anchoring restriction for the Southern Banks for vessels larger than 50 ft in length.

GUAM (details)			
Federal Waters	**GOV'T OF GUAM**	**CRE FMP**	**USFWS**
0-3 miles	Local regulations.	No restrictions.	None.
0-10 fathoms (at Ritidian, outside of Guam waters)	No restrictions.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No commercial fishing (Refuge).
10 fathoms-200 miles (outside of Guam waters)	No restrictions.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	-

CHAPTER 4

THE PUBLIC SCOPING PROCESS AND POTENTIALLY SIGNIFICANT ENVIRONMENTAL, SOCIAL AND ECONOMIC ISSUES

4.1 Development of the EIS

Federal regulations promulgated by the Council on Environmental Quality define the EIS preparation process and their contents (40 CFR 1501-1502). First, the lead agency must publish a Notice of Intent (NOI) in the Federal Register. Next, the lead agency begins scoping. Scoping is "an early and open process for determining the scope of issues to be addressed and for identyifying the significant issues related to a proposed action" (40 CFR 1501.7). It can also be used to identify new alternatives that will be considered in the EIS. Scoping is generally accomplished through written communications, statements at public meetings, or formal and informal consultation with agency officials, interested individuals, organizations, and groups.

The EIS is prepared in two stages. A draft EIS (DEIS) is prepared, based on the scope of issues identified during the scoping proces. The DEIS should to the fullest extent possible conform to the required content for an EIS, as summarized in federal regulations. Therefore, it must evaluate the important social, economic, and environmental impacts that may result from the proposed action and the alternatives. It focuses on cause and effect relationships, providing sufficient evidence and analysis to determine the magnitude of impacts and ways to minimize harm to the environment. The DEIS should include a full and fair discussion of significant environmental impacts and inform decision-makers and the public of the reasonable alternatives that would avoid or minimize adverse impacts, or enhance the quality of the human environment.

Upon publication of the DEIS, the lead agency must publish a notice of availability (NOA) in the Federal Register summarizing the EIS and stating how a copy may be obtained. The DEIS must also be filed with the EPA and is typically distributed to agencies, organizations and other interested parties. (The EPA publishes a separate NOA on receipt of the DEIS.) A minimum 45-day public comment period then ensues, and a public hearing is conducted to provide an opportunity for interested parties to provide oral comments on the DEIS. Verbal and written comments received are considered and the DEIS is revised as appropriate. NMFS is required to specifically address each substantive comment received and include copies of the comments in the final EIS (FEIS). Once the FEIS is completed, it is published and available for a minimum 30-day public comment period. Public comments received on the FEIS are collected and considered by the lead agency prior to making a final decision.

Following the completion and submission of the FEIS and the public comment period, a Record of Decision (ROD) is prepared by the lead agency. The ROD: (1) states what the decision was in regard to the proposed action; (2) identifies alternatives considered in reaching the decision; and,

(3) states whether all practicable means have been employed to avoid or minimize the environmental harm from the alternative selected and if not, why not.

4.2 EIS Public Scoping Process

The scoping process began with a review of existing documentation and reports of advisory body meetings held during the FMP preparation process. The process included opportunities for the public to comment on the proposed actions and their environmental concerns stemming from these actions. The following public meetings were held:

Public Scoping Hearing - Honolulu (Council meeting)	16 June 1999
Public Scoping Hearing - Honolulu (Plan Team meeting)	15 July 1999
Public Scoping Hearing - Guam	28 July 1999
Public Scoping Hearing - CNMI	29 July 1999
Public Scoping Hearing - Honolulu (Ecosystem and Habitat Advisory Panel (EHAP) meeting)	5 August 1999
Public Scoping Hearing - American Samoa	19 August 1999
Public Scoping Hearing - Kona, Hawaii	31 August 1999
Public Hearing - Honolulu (Plan Team and EHAP meeting)	17 September 1999
Public Scoping Hearing - Honolulu (SSC meeting)	12 October 1999
Public Scoping Hearing - Honolulu (Council meeting)	18 October 1999
Public Meeting - American Samoa	20 December 1999
Public Meeting - Guam	28 December 1999
Public Meeting - Kona, Hawaii	28 December 1999
Public Meeting - Commonwealth of the Northern Mariana Islands	29 December 1999
Public Meeting - Hilo, Hawaii	29 December 1999
Public Meeting - Kahului, Maui	4 January 2000
Public Meeting - Haleiwa, Oahu	5 January 2000
Public Meeting - Lihue, Kauai	6 January 2000
Public Meeting - Waianae, Oahu	10 January 2000
Public Meeting - Lanai City, Lanai	11 January 2000
Public Meeting - Molokai	12 January 2000
Public Meeting - Honolulu	13 January 2000
Public Meeting - Honolulu (Hawaii Plan Team and Advisory Panel meeting)	26-28 January 2000
Public Meeting - Honolulu (Council meeting)	28 Feb - Mar 2 2000
Public Meeting - Honolulu (Plan Team meeting)	25 April 2000
Public Meeting - Honolulu (Joint Plan Team and Advisory Panel meeting)	26 April 2000
Public Meeting - Honolulu (SSC meeting)	16 - 18 May 2000
Public Meeting - Maui (Council meeting)	14 - 16 June 2000
Public Meeting - Honolulu (Council meeting)	10 - 12 July
Public Meeting - Honolulu (SSC meeting)	12 October 2000
Public Meeting - Honolulu (Council meeting)	1 December 2000

Public Scoping Hearing - Agana, Guam	16 January 2001
Public Scoping Hearing - Saipan, CNMI	17 January 2001
Public Scoping Hearing - Kahului, Maui	19 January 2001
Public Scoping Hearing - Kaunakakai, Molokai	22 January 2001
Public Scoping Hearing - Kona, Hawaii	23 January 2001
Public Scoping Hearing - Hilo, Hawaii	24 January 2001
Public Scoping Hearing - Lihue, Kauai	25 January 2001
Public Scoping Hearing - Lanai City, Lanai	26 January 2001
Public Scoping Hearing - Honolulu, Oahu	29 January 2001
Public Meeting - Honolulu (SSC Meeting)	1 February 2001
Public Scoping Hearing - Fagatogo, American Samoa	5 February2001
Public Meeting - Honolulu (Council meeting)	15 February 2001
Public Meeting - Honolulu (Joint Coral Reef Ecosystem Plan Team and Ecosystem and Habitat Advisory Panel meeting)	8 March 2001
Public Meeting - Honolulu (Council meeting)	13 March 2001
Public Meeting - Honolulu (Coral Reef Ecosystem Plan Team meeting)	11 - 12 April 2001
Public Meeting - Honolulu (SSC meeting)	17 May 2001
Public Meeting - Honolulu (Council meeting)	21 June 2001

The scoping process concluded with a review of issues arising from public meetings and documentation review to determine which were potentially significant.

4.2.1 Issues Raised During Scoping and Addressed in the FMP and EIS

The comments made during scoping may be consolidated into several themes, which are presented here. Generally, the management implications stemming from these issues are addressed in the FMP, while the EIS analyzes impacts. All of the comments raised during scoping are listed in Chapter 9, along with responses addressing each comment.

1. Inter-jurisdictional boundaries and consistency in management: Many of the existing problems and threats to coral reef resources occur in territorial waters, but the CRE-FMP would regulate 3-200 nm from shore in most areas. Inconsistent management resulting from much stricter regulations in the EEZ compared to territorial waters could increase pressures on reefs under local jurisdiction. Jurisdiction is particularly troublesome in the CNMI, where both local and federal governments claim authority over the EEZ.

2. Diverse uses of and impacts on coral reef resources: The FMP can only regulate fisheries, but numerous other ecological, aesthetic, economic, and cultural benefits of coral reefs should be considered, as well as the impacts of non-fisheries uses.

3. Coral Reef Ecosystem, Bottomfish and Crustacean FMPs are interdependent: Species managed on the sustainable yield principle under other FMPs (i.e., Bottomfish and Seamount Groundfish; Crustaceans) are part of coral reef ecosystems but they are explicitly excluded from the CRE-FMP. The FMPs are interdependent, yet there is no

meaningful connection between the Coral Reef, Crustacean and Bottomfish Plan Teams. How will plan teams incorporate each other's information and how will differing positions be resolved?

4. The process of developing the FMP may stimulate the types of unregulated activities that it seeks to prevent: Leaving coral reef resources exposed for a year before the FMP is in place would violate the precautionary principal. (*Note: A moratorium alternative was examined, as a possible action separate from the FMP process and as a measure within the draft FMP.*)

5. Small-scale, sustainable domestic Fisheries in the U.S. Pacific Islands will be penalized for the destructive, illegal and non-sustainable harvesting practices employed by foreign and large-scale fisheries.

6. Designation of and jurisdiction over marine protected areas (MPAs): MPAs are considered essential for coral reef ecosystem management, but there is resistance to federal designation in many island areas. Fishermen in Hawaii have already been excluded from many areas. It is premature to designate MPAs in the CNMI because of conflicting jurisdictional claims. Closure of EEZ banks off American Samoa and Guam is viewed as penalizing domestic fishermen. Existing National Wildlife Refuges in the NWHI and some of the remote U.S. island possessions already function as *de facto* MPAs, which could be reinforced by the FMP without changing jurisdictional authority over the areas. The total area of MPAs should be a large enough percentage of the total area of EEZ reef to protect overall biodiversity and ecosystem structure and function.

7. Stony coral/live rock harvest restrictions: Some commentators see the need for an almost complete prohibition on take to conserve a non-renewable resource and to conform to national and international initiatives. Others describe scenarios in which harvest would not harm the resource (e.g., in areas to be filled or dredged, collection of broken pieces after typhoons, collection of fragments of faster-growing species). Wild stock will play an integral role in developing a coral and live rock aquaculture industry.

8. Exploratory fishing permit period and conditions: A one-year permit is insufficient to allow for mobilization of a new fishing enterprise. Permit conditions and reporting requirements should be more reasonable. One commentator proposed a cap on cumulative harvest under the permit system and cautioned that the cumulative effects of subsistence fishing (exempted from permits) could be substantial.

9. Performance standards for controlling fishing gear, and adding or removing gear types from a list of those allowed for use: According to one commentator, the problem with a prohibited gear list is that it cannot anticipate new kinds of gear. An allowed gear list, on the other hand, does not create incentives for innovative solutions. Another commentator suggested: (1) adding manned submersibles and remotely operated vehicles to allowed gear types, and (2) a case-by-case review of the use of intoxicating substances through the

permitting process because some may be demonstrated to be harmless (e.g., clove oil). Consider allowing more selective methods of gill netting in which fish are herded rather than gilled.

10. Impacts on threatened or endangered species degradation of wilderness resources, especially in the NWHI and PRIAs: The Hawaiian Islands National Wildlife Refuge provides critical habitat for a variety of protected species, including the Hawaiian monk seal, migratory seabirds, and sea turtles. It is also the largest tract of relatively undisturbed coral reef in the US. The cumulative effect of the No-action Alternative (1), or actions stemming from the FMP, might contribute to loss of critical habitat, increased interactions with fishing gear, marine debris, and undesirable changes in this ecosystem, including loss of rare species.

11. Degradation of water quality: Good water quality is crucial for coral reef habitats. The cumulative effect of the No Action alternative, or actions stemming from failure to implement the FMP, might contribute to increased sedimentation, turbidity, nutrient loading.

12. Displacement of traditional fisheries: Harvesting of coral reef resources is a traditional and valued part of Pacific Islanders' heritage. The cumulative effect of actions taken under the FMP might contribute to displacement of traditional fisheries.

13. Reduced ocean access: The FMP proposes designation of marine protected areas in the EEZ. The cumulative effect of this action may contribute to reduced fishing access for the general public.

14. Restrictions on harvesting underutilized marine resources: The FMP proposes to regulate fishing for coral reef resources in the EEZ. This action may restrict fishing for resources that are underutilized because they are below Optimum Yield.

15. Inequity for indigenous fishermen: Pacific Islanders are under-represented in commercial fisheries. The CRE-FMP proposes to limit fishing for coral reef resources in the EEZ and its cumulative effect may provide further disincentives to indigenous-owned fishing enterprises.

4.3 Screening Process to Identify Potentially Significant Issues

This section identifies the potentially significant issues from a full array of environmental impact categories. Issues are considered potentially significant if they arose during public scoping or if the comparison of FMP management alternatives predicted adverse effects for any category of the impacts considered. Table 4.1 summarizes the screening process. Any issue in the table that is definitely significant ("yes") or that "may be" significant due to implementation of the FMP is analyzed in Chapter 5 to define baseline criteria for significance and to assess the environmental consequences of the alternative control measures considered in the FMP. The screening reveals that the following topics are potentially significant issues:

Biological/Ecological Resources

1. Target fishery resources
2. Non-target fishery resources
3. Protected species and wilderness resources
4. Corals, live rock, essential fish habitat, reef ecosystems and biodiversity
5. Exotic species

Physical Resources

6. Coastal water quality

Social and Economic Factors

7. Cultural resources
8. Native cultures
9. Sustained participation by fishing communities
10. Fairness and equity to fishermen
11. Search for promising new medicines
12. Non-consumptive values and uses
13. Administration and enforcement of regulations

During development of the EIS it became evident that coastal water quality, which rated a "maybe" in the scoping process, was not a significant issue in federal waters. Almost all water quality problems derive from land-based sources. Coral reef resources managed under the FMP are in federal waters. Thus, they are generally more than three nautical miles from shore and away from inhabited areas, where coastal water quality is most severely degraded. In some remote areas federal waters do extend to the shoreline, and land-based sources of pollution are

minimal or non-existent in these areas. In addition, the scope of management measures that could be included in an FMP cannot directly address land-based pollution sources originating from non-fishing activities. Although water quality problems derived from land-based sources do not appear to be a problem for coral reef resources in federal waters, all waters are part of the ecosystem and impacts in one area can affect another. Therefore, there is a need to manage the coral reef resources as an entire ecosystem, and the EFH-related consultative process will allow NMFS and the Council to make recommendations on land-based actions that may affect EFH.

The introduction of exotic species is considered a significant issue. However, rather than being considered in a separate section in Chapter 5, impacts are considered under other biological/resource categories.

Table 4.1: Screening process to identify potentially significant issues.

General Topic	Potential Issue	Is Issue Significant Due to Implementation of FMP?	Is Issue Significant When Implementation of FMP is Considered With Cumulative Effects?
I. BIOLOGICAL/ECOLOGICAL RESOURCES			
Target resources	Will implementation of FMP affect the populations of target resources? Yes.	**Yes.** Coral reef resources already harvested in EEZ but not regulated under other FMPs would be managed to prevent overfishing. New and poorly understood resources not previously harvested would be managed with caution until sustainable yield can be assessed. Reservoirs of spawning biomass would be protected within no-take marine protected areas (MPAs).	**Yes.** Could add to (or reduce) spawning stocks of heavily fished species, provide "insurance" against (or increase risk of) recruitment failure. Could control (or not control) harvest of new, poorly understood resources at safe levels until sustainable yields are better known. Redirection of fishing effort to areas already heavily exploited could cause local overfishing.
Non-target resources	Will implementation of FMP affect the populations of non-target resources? Yes.	**Yes.** Coral reef resources already harvested incidentally in EEZ but not regulated under other FMPs would be managed to minimize bycatch. New and poorly understood resources not previously harvested would be managed with caution until level of bycatch can be assessed. Reservoirs of spawning biomass would be protected within no-take marine protected areas (MPAs).	**Yes.** Could add to (or reduce) spawning stocks of non-target species, provide "insurance" against (or increase risk of) recruitment failure, control (or not control) incidental harvest of new, poorly understood resources at safe levels until sustainable yields are better known.
Protected species and areas (e.g., wildlife refuges, wilderness resources)	Will implementation of FMP affect the populations of protected species or other wilderness resources? Yes, in NWHI, remote islands.	**Yes.** Could affect interactions with Hawaiian monk seal, green sea turtle populations, habitats. Controls proposed by FMP could extend protected areas, screen out potentially damaging fishing activities, reduce risk of vessel groundings, scrutinize potential impacts of non-fishing activities on EFH.	**Yes.** Could reduce (or add to) other pressures on Hawaiian monk seal, green turtle populations, habitats and other wilderness resources.

General Topic	Potential Issue	Is Issue Significant Due to Implementation of FMP?	Is Issue Significant When Implementation of FMP is Considered With Cumulative Effects?
Corals, live rock, essential fish habitat (EFH), reef ecosystem, biodiversity	Will implementation of FMP affect corals, EFH, reef ecosystems, biodiversity? Yes.	**Yes**. A major purpose of FMP is to protect corals, reef ecosystems, biodiversity and EFH from degradation. Controls proposed by FMP could extend protected areas, screen out potentially damaging fishing activities, reduce risk of vessel groundings, scrutinize potential impacts of non-fishing activities on EFH.	**Yes**. Could reduce (or add to) local human stressors on coral reefs, ecosystems, biodiversity, EFH. Little affect on global stressors, however.
Exotic species, disease	Will implementation of FMP affect introduction of any new/noxious species or diseases? Yes.	**Yes**. Controls proposed by FMP could extend protected areas, screen out potentially damaging fishing activities, reduce risk of vessel groundings, scrutinize potential impacts of non-fishing activities on EFH. Inter-agency and inter-regional management to avoid problem (e.g., through marine debris) could improve.	**Yes**. Could affect sources of marine debris from outside U.S. Pacific Islands.
II. PHYSICAL RESOURCES			
Air quality	Will implementation of FMP affect air quality. No.	No. No change from existing conditions.	No. No change from existing conditions.
Climate	Will implementation of FMP affect the climate. No.	No. No change from existing conditions.	No. No change from existing trends (globally, marine environment is becoming increasingly hostile to coral).
Geology, landscapes	Will implementation of FMP increase reef or coastal erosion or alter unique landscapes or oceanscapes? No.	No. No change from existing conditions.	No. No change from existing conditions.
Water quality	Will implementation of FMP affect coastal water quality? Maybe.	**Maybe**. Focus of regulation through FMP is the EEZ, not coastal waters. EFH consultation would encourage better scrutiny of potential impacts of non-fishing activities.	**Maybe**. EFH consultation could address sedimentation, nutrient loading impacts from non-fishing activities in inshore areas not directly regulated through FMP.
Flooding	Will implementation of FMP increase risk of flooding in coastal areas? No.	No. No change from existing conditions.	No. No change from existing conditions (globally, reef erosion may be reducing shore protection against storm waves).

General Topic	Potential Issue	Is Issue Significant Due to Implementation of FMP?	Is Issue Significant When Implementation of FMP is Considered With Cumulative Effects?
Groundwater	Will implementation of FMP affect groundwater quality? No.	No. No change from existing conditions.	No. No change from existing conditions.
Noise	Will implementation of FMP increase noise levels? No.	No. No change from existing conditions.	No. No change from existing conditions.
III. CULTURAL RESOURCES			
Archaeological features, historic places, National Landmarks	Will implementation of FMP affect archaeological/historic sites? No.	No. No change from existing conditions.	No. No change from existing conditions.
Native cultures	Will implementation of FMP affect native cultures? Yes.	**Yes**. No-take MPAs are proposed for some submerged lands for which the claims of indigenous people are not yet resolved. Gear controls proposed by FMP could displace traditional fishing methods.	**Yes**. New restrictions on indigenous people could add to a series of previous displacements.
IV. HAZARDS			
Navigation and vessel safety	Will implementation of FMP interfere with vessel navigation and safe anchorage? Maybe in no anchoring zones.	No. Maritime law allows vessel anchoring in emergencies, even in no-anchoring zones proposed by FMP.	No. Minimal change from existing conditions.
V. INFRASTRUCTURE			
Harbors	Will implementation of FMP create demand for new harbor facilities? No.	No. No change from existing conditions.	No. No change from existing conditions.
Underwater cables, construction	Will implementation of FMP interfere with existing or proposed underwater communication cables? No.	No. No change from existing conditions.	No. No change from existing conditions.

General Topic	Potential Issue	Is Issue Significant Due to Implementation of FMP?	Is Issue Significant When Implementation of FMP is Considered With Cumulative Effects?
VI. SOCIAL AND ECONOMIC FACTORS			
Land use	Will implementation of FMP affect present land use? No.	No. No change from existing conditions.	No. No change from existing conditions.
Sustained participation by fishing communities	Will implementation of FMP interfere with sustained participation by fishing communities? Yes.	**Yes**. Established fisheries could be displaced. MPAs that could totally or partially restrict access for fishing are proposed by FMP. Permits and other FMP controls could discourage harvesting of underutilized marine resources and new entry.	**Yes**. Could add new restrictions to previous closures in EEZ and nearshore areas. Permits and other FMP controls could add to existing restrictions on reef-related fisheries. Relocation to areas already heavily fished could cause a decline in catch rates.
Fairness and equity to fishermen (including environmental justice E.O. 12898)	Will implementation of FMP have disproportionate impacts on low-income or indigenous populations? Yes.	**Yes**. Technically difficult and costly permit application and reporting requirements place unreasonable burdens on indigenous and other small-scale, poorly financed participants.	**Yes**. New restrictions on indigenous and other small-scale participants could add to a series of previous displacements.
Search for promising medicines	Will implementation of FMP interfere with the search for promising medicines? Yes.	**Yes** No-take MPAs are proposed by FMP.	**Yes** Would add to no-take coral reef areas worldwide.
Non-consumptive marine recreation	Will implementation of FMP affect non-consumptive marine recreation? Yes.	**Yes**. Controls on live coral take and MPAs proposed by FMP could improve (or degrade) non-consumptive recreational diving and underwater scenic opportunities.	**Yes**. Fishing controls proposed by FMP could improve (or degrade) environmental quality for non-fishery uses.

4.4 Baseline Evaluation Criteria for Potential Impacts

Criteria for evaluating each of the 12 subject areas identified during scoping as possibly involving significant impacts are listed below in Table 4.2. The table also shows which section in Chapter 5 addresses the topic area. (During EIS development some of the topic areas were further subdivided, or in one case consolidated, and the section titles have been changed slightly to better reflect the nature of the analysis.)

Table 4.2: Evaluation criteria for potential impacts.

Topic Area	Potentially Significant If:	Analyzed in Section:
Biological/Ecological Resources		
1. Target resources	Overfishing.	5.2
2. Non-target resources	Large bycatch.	5.3
3. Protected species, wilderness resources	Loss of rare species, critical habitat; increased interactions with fishing gear, vessel operations, marine debris.	5.4, 5.5
4. Corals, live rock, essential fish habitat (EFH), reef ecosystem and biodiversity	Undesirable change in ecosystem structure or function, loss of rare species, live coral habitat, other EFH degradation.	5.6. 5.7
Cultural Resources		
5. Native cultures	Displacement of indigenous claims to submerged lands. Loss of existing/potential opportunities to collect coral reef resources for customary and traditional indigenous uses.	5.8
Social and Economic Factors		
6. Sustained participation by fishing communities	Displacement/relocation of established fisheries, with possible decline in catch rates. Fishing is restricted for resources that are not at or above sustainable yield.	5.9
7. Fairness and equity to fishermen	Unreasonable technical/cost burdens on indigenous and other small-scale, poorly financed fishermen for entry into fishery.	5.9
8. Search for promising new medicines	Loss of opportunity to make small collections for lab screening and future synthesis.	5.10
9. Non-consumptive uses of coral reefs	Loss of environmental quality.	5.11
10. Administration and enforcement of regulations	Multiple new and complex management responsibilities.	5.12

CHAPTER 5

ENVIRONMENTAL CONSEQUENCES

5.1 Introduction

Analysis of the environmental consequences of the proposed action and its alternatives is perhaps the most important part of an EIS. (For a summary of the alternatives see Tables 2.3a-d.) It must consider socioeconomic effects, to the degree that they are interrelated with environmental effects. In doing so, this chapter describes the projected direct, indirect and cumulative effects of the alternatives, and summarizes the planned mitigation measures. It also describes the conflicts between the effects of the alternatives and other plans and policies. The environment can be directly changed by the activities promoted by an alternative. These changes may trigger indirect effects on other components of the environment. Cumulative effects are the combined effects of past, present, and reasonably foreseeable future actions on the environment. Mitigation measures are activities planned to prevent, rectify or reduce projected adverse effects on the environment. Few of the effects can be measured in rigorous quantitative terms and many can only be described in qualitative terms.

Some elements of the EIS analysis parallel the MSFCMA requirement to include a fishery impact statement describing how the FMP will affect fishery participants and fishing communities (§303 (a)(9)). In addition, MSFCMA National Standard 8 requires that the management measures take into account the importance of fishing resources to fishing communities in order to provide for "sustained participation" by fishing communities, and "to the extent practicable, minimize adverse economic impacts on such communities." The economic and social impacts of the proposed actions and their alternatives are analyzed and discussed in the FMP Appendix A, which contains the Regulatory Impact Review (RIR) and Initial Regulatory Flexibility Analysis (IRFA). The RIR focuses on impacts to the net value of affected fisheries, as well as the non-fishery sectors that are dependent on coral reef ecosystems, including marine tourism, biodiversity, and other ecological services provided by coral reefs. The IRFA focuses on impacts to fishery participants as businesses, or as "small entities," as required by the Regulatory Flexibility Act. It focuses on the identification and minimization of increased burdens to small entities, such as commercial fishermen.

5.1.1 Consideration of the NWHI Coral Reef Ecosystem Reserve

The NWHI Coral Reef Ecosystem Reserve, established by President Clinton's Executive Orders 13178 (December 4, 2000) and 13196 (January 18, 2001), is likely to have effects cumulative with those of the CRE-FMP. Conservation measures included in the two NWHI Executive Orders (EOs) are described in FMP Section 9.2. The anticipated potential impacts of the NWHI

EOs to Hawaii fisheries could be substantially negative, depending on how aspects of the conservation measures are clarified and the outcome of President George W. Bush's Administration's review. If fully implemented, the Reserve could eliminate current and future sustainable, profitable, and environmentally sensitive commercial fishing in the NWHI, directly and through attrition. Estimated cumulative effects are discussed in Sections 5.2 through 5.12 of this EIS.

The Reserve is intended to be a temporary management regime until completion of the process to designate the NWHI as a National Marine Sanctuary. The Secretary of Commerce has stated (in a letter to the Council Chairman, June 21, 2001) that "while the sanctuary designation process and review of the NWHI EOs are underway, the Department will continue to use conservation and management measures under existing statutory authorities, including the Magnuson-Stevens Fishery Conservation and Management Act."

On January 19, 2001, the NOAA/NOS Office of National Marine Sanctuaries announced its intent to initiate the Sanctuary designation process for the Reserve pursuant to sections 303 and 304 of the National Marine Sanctuaries Act (16 U.S.C. 1433, 1434). During this process, NOAA will prepare an environmental impact statement and management plan, which will examine the management, boundary, and regulatory alternatives associated with sanctuary designation. As required, NOAA must also initiate public scoping meetings to solicit information and comments on the range and significance of issues related to sanctuary designation and management.

In designating the sanctuary, the December 4, 2000 Executive Order "directs the Secretary of Commerce to supplement or complement the existing Reserve, and ... in consultation with the Governor of the State of Hawaii, determine whether State submerged lands and waters should be included as part of the Sanctuary." How the Reserve will ultimately affect the CRE-FMP, and existing FMPs, depends on the outcome of the Administration's ongoing review of the EOs and clarification of the conservation measures that remain ambiguous. For example, the draft Reserve Operations Plan does not clarify how individual fishing caps will be determined, nor how straight-line boundaries will be drawn. Impacts of the EOs (as best estimated) would generally fit within the range of alternatives analyzed in the EIS, most closely approximating Alternative 4 "maximum additional protection to coral reef resources," where all EEZ waters 0-100 fm would be a no-take MPA. The likely cumulative effects of the NWHI CRE Reserve on specific components of the environment are preliminarily assessed below. Table 5.1 compares the main measures of the CRE-FMP (the Preferred Alternative) to the conservation measures of the EO, as best understood.

Table 5.1: Comparison between the management measures of the WPRFMC's CRE-FMP (preferred alternative) and the NWHI Coral Reef Ecosystem Reserve Executive Order.

Coral Reef Ecosystem FMP- In general, the FMP does not differentiate between commercial and recreational fishing (Alternative 3)	**EO establishing the NWHI Reserve- management measures differ for commercial vs. recreational fishers**
Effects on Existing NWHI Fisheries	
All fisheries: No-take marine protected areas (MPAs) around all NWHI and reefs from 0-10 fm and 0-50 fm around Laysan Island, French Frigate Shoals and the northern half of Midway Atoll. Limited fishing allowed under special permit for all waters designated as low-use MPAs (all federal waters 10-50 fathoms in NWHI; and 0-50 fathoms around Johnston, Palmyra and Wake Atoll, and the southern half of Midway Atoll). Vessel insurance to cover the cost of clean up and wreck removal is required when operating or transiting through MPAs; Nighttime spearfishing with scuba gear is prohibited. Fishing with poisons, explosives or intoxicating substances is prohibited.	**All fisheries:** Restricted within Reserve boundaries (50 miles around all NWHI) and Reserve Preservation Areas (RPAs). RPAs extend: (1) to a depth of 100 fathoms (fm) around Nihoa and Necker Islands, French Frigate Shoals, Gardner Pinnacles, Maro Reef, Laysan and Lisianski Islands, Pearl and Hermes Reef, and Kure Atoll, and (2) to a distance of 12 nautical miles (nm) around the first bank east of French Frigate Shoals, Southeast Brooks Bank, St. Rogatien Bank, the first bank west of St. Rogatien and east of Gardner Pinnacles, Raita Bank and Pioneer Bank. Limited commercial bottomfishing and commercial and recreational trolling for pelagics allowed in all, or portions of 10 of 15 RPAs. No new gear-types allowed.
Pelagic fisheries: Continue 50 mile closure to longline fishing gear. Pelagic fishing in low-use MPAs via special permits permitted.	**Pelagic fisheries:** Commercial and recreational trolling for pelagics permitted at previous levels for historical participants within Reserve waters outside of 25 fm (within RPAs) around Nihoa and Necker Islands, Gardner Pinnacles, Maro Reef, and Lisianski Island; outside 50 fm (within the RPAs) around Laysan Island; and within the entire RPAs around St. Rogatien Bank, the first bank west of St. Rogatien Bank and east of Gardner Pinnacles, Raita Bank, and Pioneer Bank. Longlining prohibited. Other commercial fishing for pelagics allowed only beyond RPA boundaries, but limited to an individual's take in the year preceding 12/04/00. Increase of recreational fishing effort beyond historical levels prohibited throughout the reserve.
Bottomfish fisheries: Continue closure for armorhead around Hancock Seamount. Bottomfish fishing in low-use MPAs permitted for NWHI bottomfish limited entry permit holders. Continue limited entry program. (Under the Bottomfish FMP, permits required to fish for Bottomfish Management Unit Species in NWHI).	**Bottomfish fisheries:** Commercial fishermen who held NWHI permits as of 12/04/00 will be allowed to fish at previous levels within Reserve waters, and outside of 25 fm (within RPAs) around Nihoa and Necker Islands, Gardner Pinnacles, Maro Reef, and Lisianski Island; outside 50 fm (within the RPAs) around Laysan Island; and within the entire RPAs around St. Rogatien Bank, and Pioneer Bank. Fishing allowed for 5 years at the first bank west of St. Rogatien Bank and east of Gardner Pinnacles and Raita Bank subject to continuation after review. Each permittee's annual aggregate level of take is capped at that permittee's individual average taken over the five years preceding 12/04/00.

Effects on Existing NWHI Fisheries	
Crustacean fisheries: Continue closure to 20 miles at Laysan Island, 10 fm elsewhere. Lobster fishing in low-use MPAs permitted for NWHI crustacean permit holders. Continue limited entry program with annual area specific harvest guidelines. (Under the Crustaceans FMP, permits required to fish for Crustacean management unit species in the NWHI).	**Crustacean fisheries:** No commercial fishing allowed within the RPA. Outside of RPAs, no commercial fishing is allowed because landings during the year preceding 12/04/00 were zero and the level of permitted annual aggregate take cannot exceed a permittees individual take in the year preceding 12/04/00. Recreational fishing (outside of RPAs) may continue at historical levels, which are also likely to be zero.
Precious coral fisheries: Continue closure of Refugia bed. Precious coral harvest in low-use MPAs permitted for NWHI precious coral permit holders. Continue general access program with annual bed and area harvest quotas. (Under Precious Corals FMP, permits required to fish for Precious Corals management unit species).	**Precious coral fisheries:** No commercial fishing within the RPAs. Outside of RPAs, no commercial fishery is allowed landings from the NWHI if the previous year's landings were zero. Recreational fishing (outside of PRAs) may continue at historical levels (likely to be zero).

Effects on New NWHI Fisheries	
Operators intending to target any coral reef ecosystem management unit species within low-use MPAs, and those intending to target "Potentially Harvested" management unit species anywhere in the NWHI EEZ must obtain Special CRE permits, which are issued on a case-by-case basis.	No new fisheries permitted.

Effects on Native Hawaiian Subsistence and Cultural Uses	
Allows an exemption for the harvest of live hard coral for cultural and ceremonial purposes under special permit in low-use MPAs (10-50 fm). Framework provision to designate a set percentage of low-use MPAs in NWHI for sole use by Native Hawaiians.	Non-commercial subsistence, cultural, and religious activities by Native Hawaiians may be permitted in areas determined by the Secretary (including RPAs) as long as it does not cause injury to the coral reef ecosystem and associated marine species. Areas may be revised with adequate public comment.

Effects on Gear Use and Insurance Requirements	
Nighttime spearfishing with scuba gear is prohibited. Fishing with poisons, explosives or intoxicating substances is prohibited. Only the following selective and non-destructive gear and methods are allowed: (1) hand collection; (2) hook and line, except longline; (3) rod and reel; (4) dip net; (5) scoop net; (6) slurp gun; (7) barrier nets for ornamental fish only; (8) use of spear without scuba; (9) use of spear with Scuba from 6:00 am to 6:00 pm only; (10) traps with owner identification only; (11) surround nets/seine nets attended at all times; (12) remotely operated vehicles; and (13) submersibles, manned or unmanned. Vessel removal and pollution clean up insurance required for all fishing vessels operating in or transiting through MPAs.	Fishery participants may not change gear types without Secretarial approval. No new insurance requirements.
Effects on Monitoring and Adaptive Management	
Existing fisheries will continue logbook reporting and Fishery Management Plan requirements with annual reports; NWHI CRE fisheries will report via special permits with annual report on the fishery. Establishes framework process to provide rapid implementation of new regulatory measures based on the best available scientific and commercial information.	Allows commercial bottomfishing and recreational trolling for pelagics to occur within portions of RPAs, as described above, unless otherwise determined by the Secretary with adequate public comment. The Secretary, after consultation with Interior and the State of Hawaii, public review and comment, and consideration of recommendations, may further restrict fishing activities as necessary to protect Reserve resources, or may authorize or require alternate gear types. The Secretary may conduct or authorize research or monitoring activities within any RPA that furthers the management principles of the EOs. A "Reserve Operations Plan" must be developed that provides for research, monitoring, and assessment of the Reseve, and use of vessel monitoring systems for any vessel entering or transiting the Reserve, if warranted.

Effects on Midway-based Fishing Operations	
No-take MPA 0-50 fm in northern half of Midway Atoll Refuge. Special permits required for all fishers operating in the low-use MPA located 0-50 fm in southern half of Midway Atoll Refuge.	No effect within the boundaries of the national wildlife refuge because the refuge is outside the Reserve.
Effects on New and Existing Fisheries around the Main Hawaiian Islands	
Special permits required for target of "Potentially Harvested" coral reef taxa in the EEZ.	No effect.

Effects on New and Existing Fisheries Around the PRIAs	
No-take MPAs out to 50 fm at Jarvis, Howland, Baker Islands, Kingman Reef, and Rose Atoll. Low-use MPAs out to 50 fm at Palmyra Atoll, and Johnston and Wake Islands. Recreational fishing under special permit permitted in low-use MPAs. Nighttime spearfishing with scuba gear is prohibited. Fishing with poisons, explosives or intoxicating substances is prohibited. Special permits required for target of "Potentially Harvested" coral reef taxa in the EEZ.	No effects.
Effects on New and Existing Fisheries Around American Samoa, Guam, and the CNMI	
Special permits required for target of "Potentially Harvested" coral reef taxa in the EEZ. Fishing with poisons, explosives or intoxicating substances is prohibited. Prohibits anchoring on Guam's Southern Bank by fishing vessels larger than 50 ft.	No effects.
Miscellaneous Effects	
Attempts to develop indices of ecosystem health as targets for management, as well as to encourage and promote improved surveillance and enforcement. The CRE-FMP also promotes participation, fairness, and equity in policy and management.	Prohibition throughout the Reserve on: oil, gas or mineral production; drilling into or otherwise altering the seabed; discharging or depositing any material into the Reserve except fish chum, biodegradable effluent, wash water, and cooling water; unauthorized removal or damage to Reserve resources.

Public Participation Process	
Detailed Environmental Impact Statement (EIS) prepared, published, and submitted to the Environmental Protection Agency.	No Environmental Assessment or Environmental Impact Statement to date.
48 Public Hearings and Meetings held throughout the region.	Seven Public Hearings held (six in Hawaii; one in Washington D.C.).
Published individual responses addressing public comments.	No individual responses to public comments published to date.

The potential for fishing and non-fishing activities to have environmental effects depends on how they are managed through one or more of the following control measures: creation of marine protected areas, institution of permit and reporting requirements, designation of allowable fishing gear, and other management measures.

Each of alternatives analyzed in this EIS contains these four control measures in varying degrees. These four alternatives are detailed in Section 2.3. Alternative 1 (No-action) would implement no new regulations. Alternative 2 (Minimal Additional Protection) would designate several low-use MPAs, require permits for some takes of Coral Reef Ecosystem Management Unit Species (CRE MUS, see FMP Section 1.6.2), limit takes of live rock and coral, and prohibit the use of non-selective gears to harvest CRE MUS throughout the EEZ. In addition to low-use MPAs in remote areas, Alternative 3 (Substantial Additional Protection - the Preferred Alternative) would designate several no-take MPAs, require all fishing vessels transiting MPAs to carry wreck cleanup and removal insurance, and prohibit the use of nighttime spearfishing for CRE MUS with scuba and/or hookah gear in the EEZs of the NWHI and the PRIAs. Finally, Alternative 4 (Maximum Additional Protection) would also establish no-take MPAs out to 100 fathoms around all of the region's islands and atolls. These alternatives are summarized in Table 2.3.

Sections 5.2-5.12 analyze the consequences of the four alternatives on the subject areas that were identified during scoping, as discussed in Chapter 4. Each of these subject areas are components of the human environment. By section number, these components are: 5.2-target stocks; 5.3-non-target stocks; 5.4-protected species; 5.5-national wildlife refuge resources; 5.6-coral reef habitat (live rock, coral, essential fish habitat, etc.); 5.7-ecosystem biodiversity, structure and function; 5.8-native cultures; 5.9-existing fisheries and communities; 5.10-bioprospecting and other new fisheries; 5.11-non-consumptive values and uses; 5.12-administration and enforcement of regulations.

5.2 Environmental Consequences for Target Stocks (Management Unit Species)

To date, Alternative 1 (No-action) has prevented overfishing for currently-harvested coral reef taxa in the EEZ, but it may not adequately protect coral reef resources from new harvest pressures. Council FMPs can only close federal or EEZ waters; they cannot regulate the state or territorial areas immediately surrounding most inhabited areas. Because of this jurisdictional

constraint, Alternatives 2 through 4 could redirect some fishing effort for currently-harvested resources away from no-take zones to fully exploited sub-populations in state waters. Nevertheless, all these alternatives would reduce the risk of overfishing for coral reef resources in EEZ waters.

5.2.1 Direct Effects on Target Stocks

Overfishing

Individual sub-populations of larger stocks of reef species may increase, decrease or cease to exist locally without adversely affecting an overall population. The condition of an overall population of a particular species is linked to the variability among sub-populations: the ratio of sources and sinks, their degrees of recruitment connection, and the proportion of the sub-populations with high variability in reproductive capacity.

Coral reefs in remote areas of the EEZ are not in danger of being overfished by existing fisheries for currently-harvested resources (Green 1997). Therefore, none of the alternatives to designate MPAs in remote areas of the EEZ are expected to have any effect on overfishing that is substantially different from that of Alternative 1 (No-action). However, MPAs may provide a reservoir of unexploited spawning biomass as "insurance" against recruitment failure in nearby sub-populations, so the broader designation of MPAs in Alternative 4—which would include EEZ waters around the main inhabited islands of American Samoa, Guam, the Northern Mariana Islands and Hawaii, in addition to remote reefs—would likely have a greater beneficial impact on target stocks in comparison to the No-action alternative. This is because some stocks in nearshore reef areas under island government jurisdiction have been locally overfished (Green 1997) and adjacent MPAs could be beneficial in restocking these areas.

The largest existing reef-related fisheries are hook-and-line bottomfishing in the EEZ around American Samoa, Guam, the Northern Mariana Islands, the MHI, and the NWHI, and lobster trapping around some of the NWHI. These fisheries are, and will continue to be, managed and closely monitored under separate state and federal fishery management plans in order to prevent overfishing. Therefore, none of the alternatives is likely to have significant direct effects on these stocks. Bottomfish and lobster fishing effort in the EEZ around the NWHI is controlled by limited entry permits and other measures, including boat size limits for bottomfishing vessels and annual harvest guidelines for lobster trapping. American Samoa, Guam, and CNMI EEZ fisheries for bottomfish and lobsters are currently quite small (less than $0.2M).[1]

New fisheries, such as bioprospecting, could target potentially-harvested coral reef taxa for which sustainable yields have not yet been determined. The detailed permit controls (i.e., special permits) in remote coral reef areas required under Alternatives 2-4 would be beneficial because

[1]A summary of landings and value of the region's coral reef resources is included in the description of the fishery section of the FMP. Chapter 4 of the CRE-FMP specifies MSY, OY, and overfishing, and domestic harvesting/processing capacity, as required by the MSFCMA.

proposals to take potentially-harvested resources would be carefully scrutinized before permits would be approved. The highly discretionary nature of special permit review and approval would allow specific activities to be disapproved if they are likely to bring about ecosystem or targeted stock overfishing. Issuance of permits and associated landings could be closely monitored to maintain harvests at safe levels while new resource information is acquired to estimate sustainable yields. Permit holders in other FMP-managed fisheries will continue to provide information on currently harvested resources; thus additional permit requirements for these managed fisheries will not further the objective of preventing overfishing.

The gear controls common to Alternatives 2-4 allow only selective methods of fishing and would more effectively prevent overfishing of both Currently Harvested and Potentially Harvested Coral Reef Taxa in comparison to Alternative 1 (No-action). Restrictions on the use of spear fishing with scuba under Alternatives 3 and 4 would also limit harvest rates. Most of the spawning adults of the more valuable food fish species are fully exploited in shallow waters near the major inhabited islands, and the deep portion of the spawning biomass should be conserved to prevent recruitment overfishing. Scuba-assisted fishing has the potential to harvest reproductive adults throughout their entire depth range. Because many of these species are especially vulnerable at night, prohibiting scuba-assisted fishing at night would provide a significant benefit to the deep-water portion of the spawning stocks, compared to Alternative 1 (No-action). The third alternative's prohibition of this gear at night in the NWHI and PRIA EEZs would provide substantial refuge for target stocks, while the fourth alternative's prohibition throughout the EEZ at all times would protect a wider area. However, the additional prohibition on its use during the day is not expected to make a significant difference because it is the nighttime vulnerability of these species that is of highest concern.

Measures under Alternatives 2 and 3, which would limit the commercial harvest of live rock and coral, would relieve pressure on species that are slow growing and have low turnover rates, while the fourth alternative's complete prohibition on all commercial take of live rock and coral would provide even greater protection to these species. Due to a lack of an FMP for these resources, their current EEZ harvest levels are unknown but believed to be low.

5.2.2 Indirect Effects on Target Stocks

Redirection of fishing effort

The designation of no-take MPAs in Alternatives 2-4 could displace existing fishing and redirect this effort to areas where the same stocks may be fully exploited, thereby increasing the risk of localized overfishing. The deeper seaward boundaries and broader designation of no-take MPAs under Alternative 4 could lead to the greatest redirection of fishing effort, while the inclusion of low-use MPAs (which allow limited fishing) in Alternatives 2 and 3 provide a lesser likelihood of significant redistribution of fishing effort and resultant indirect effects on target stocks.

The detailed special permit requirement in Alternatives 2-4 also has the potential to redirect effort if it proves too difficult to obtain permits for desirable resources. Given their ongoing

regulation under other FMPs, the exemption for harvest of those MUS by other FMP permit holders would be expected to safely reduce the probability that these operations would move to new areas.

Alternatives prohibiting in the EEZ popular but non-selective fishing gear regularly used to harvest CRE MUS in nearshore coral reef fisheries are much more likely to redirect fishing effort to fully exploited nearshore stocks as restrictions increase in scope from Alternative 1 (No-action) to Alternative 4. An objective of the FMP is to collaborate with other agencies and share in decision-making and monitoring to ensure redirection of fishing effort does not impact adjacent fishery resources in state waters.

Alternatives 3 and 4 will restrict any such new fishing effort to nearshore areas where scuba fishing is permitted by some island governments. If this gear is prohibited only in remote areas, where there is currently very little such fishing (Alternative 3- the Preferred Alternative), there would be no effort to redirect, so the impact would be similar to that of Alternative 1 (No-action). It is likely that Alternative 4 would have the greatest potential to redirect fishing effort into nearshore areas because it prohibits this gear at all times. In contrast, Alternative 1 (No-action) would allow this currently increasing effort to expand into the EEZ.

Recruitment

To be useful to fisheries and to promote the conservation of coral reef resources on a broad scale, MPAs should serve as sources of reproductive output to replenish larger surrounding areas. It has been suggested that linking populations among MPAs over a broad area is necessary to assure restocking. Recruitment to populations of coral reef organisms depends largely on the pathways of larval dispersal and "downstream" links. One must ask, are the connections sufficient to actually restock distant sub-populations or only enough to maintain a homogenous genetic stock? Existing information is insufficient to quantify the potential impacts of the various MPA schemes proposed in each alternative on the recruitment of target resources. However, if larger MPAs result in more recruitment, then the successively larger areas designated as MPAs in Alternatives 2-4, respectively, should result in corresponding increases in recruitment of CRE MUS, compared to Alternative 1 (No-action).

5.2.3 Cumulative Effects on Target Stocks

Cumulative effects on target stocks could occur if natural events, such as hurricanes and winter storms or increases or decreases in the nutrient flux into the coral reef system, are coupled with fishing pressures in the EEZ. A series of winter storms or an increase in sea surface temperature due to an El Niño event may cause coral reef mortality. Living coral reef is believed to support a higher level of biomass than dead reef. The amount of nutrients flowing into the coral reef ecosystem is difficult to quantify, but is directly proportional to the amount of biomass the reef will support. Any of these events will likely cause stress to stocks. When these occur in conjunction with fishing, stocks could become further depleted.

Alternative 1 (No-action) does not take into account the synergistic effects of natural stressors with fishing pressure. No mechanism would be in place to diminish fishing pressure under a naturally stressed ecosystem. The creation of low-use MPAs under Alternative 2 would allow better monitoring of fishing activity and let managers react to a changing environment. The Preferred Alternative institutes some no-take MPAs; these areas would be free from fishing pressure and could preserve some healthier stocks during periods when the reef is less productive. Alternative 4, with 100% of coral reefs throughout the region designated no-take MPAs, removes all fishing pressure so that natural population variations would occur. Both Alternatives 3 and 4 will accommodate the study of natural fluctuations in coral reef ecosystem populations, which could help managers to better understand the cumulative effects of fishing pressure and natural stressors.

Because this FMP can only regulate fishing activities in the EEZ, none of the alternatives would prevent overfishing of currently-harvested or potentially-harvested coral reef resources in nearshore areas regulated by island governments. Localized overfishing of high-value species is known to be occurring in the most accessible reef areas near island population centers (Green 1997).

Cyclical oceanographic events—which affect productivity over extensive areas and may account for large fluctuations in population abundance—are perhaps the most important factor in the population dynamics of many coral reef species and ecosystems in the NWHI, and likely elsewhere in the Western Pacific Region. In a study of recent climatic and oceanographic events and their effect on productivity in the NWHI, Polovina *et al.* (1994) found that 30-50% declines in the abundance of a number of species representing various trophic levels, from the early 1980s to the present, could be explained by a shift in oceanographic conditions. In contrast, oceanographic conditions during the late 1970s and early 1980s moved nutrient-rich deep ocean water into the euphotic zone, resulting in higher survival of reef fish, crustaceans, monk seals and birds. Specific management measures to address such environmental changes are not directly incorporated in any alternative. But the CRE-FMP (the Preferred Alternative) includes a non-regulatory framework procedure for timely and rapid adjustments based on feedback from the monitoring of fisheries and resource conditions. (Note that Alternatives 2-4 also include the monitoring component.) In addition, the requirement for special permits under Alternatives 2-4 would easily allow managers to change allowed harvest levels for most CRE MUS.

The conservation measures contained in the NWHI EOs would likely reduce all fishing activities in the NWHI with the exception of fishing based on Midway Atoll NWR, which is not part of the NWHI Reserve. The NWHI EOs caps commercial and recreational fishing at levels of effort and take of the year preceding December 4, 2000. Under the Code of Federal Register §660.12, the fishing begins on January 1, and ends on December 31. (The "year preceding December 4, 2000" as described in the EO is ultimately undefined). For commercial bottomfish permit holders, the level of effort and take will be each permitee's individual average taken over the past five years. Additionally, the NWHI EOs will allow only those fisheries that were permitted in the year preceding December 4, 2000 to continue. Before the date of the order there was no permitted NWHI coral reef fishery in operation; therefore, no such fishery would be allowed in the NWHI.

Further, no NWHI commercial crustacean or precious coral permits were active in the year preceding the initial executive order, resulting in a harvest cap of zero for those fisheries. As a result, the NWHI EOs are likely to preclude these fisheries from operating in the NWHI, which would alleviate all commercial fishing pressures on those target stocks.

Of the existing FMP fisheries permitted to operate in the NWHI, only the bottomfish fishery would be allowed to continue, with specific depth restrictions in federal waters in 10 of the 15 RPAs. It is expected that these depth restrictions would reduce the amount of suitable bottomfish habitat currently available to the fishery by nearly 60%, thus allowing these areas to be free from fishing pressure. As a result, bottomfishing effort will be shifted into more confined locations. However, should the fishery maintain a level of effort and take equal to the aggregate average taken over the past five years, it is expected that fishing pressures on target stocks in certain productive areas will increase, potentially resulting in localized depletions similar to that of the MHI.

Overall, the effects on bottomfish target stocks as a result of the NWHI EOs would be similar to that of the Preferred Alternative, with much reduced fishing pressure. For all other target stocks, the implementation of the NWHI EOs would be similar to Alternative 4 with primary effects due to natural variations.

5.2.4 Consistency with Other Plans and Policies for Target Stocks

Alternatives likely to cause substantial displacement of existing bottomfish and lobster fishing activities in the EEZ would prevent sustainable use and optimum yield of those resources, which are the main objectives of the FMPs for Bottomfish and Crustaceans.

5.2.5 Mitigation Measures for Effects on Target Stocks

If environmental fluctuations or other natural or human factors change target resource conditions so that there is a greater risk of overfishing, timely preventive action can be taken under the framework adjustment procedures included in the already-implemented bottomfish, crustaceans, and precious corals FMPs, and in the CRE-FMP (the Preferred Alternative). Future adjustments could include such actions as changes in MPA boundaries, in the number of special permits or their conditions of use, in the fishing gear that is allowed or not allowed, or designation of new MPAs.

5.3 Environmental Consequences for Non-Target Resources

Alternative 1 (No-action) adequately minimizes bycatch in fisheries for currently harvested coral reef resources in the EEZ, but it does not consider the potential for indirect effects on non-target resources through food web relationships. Alternatives 2, 3 (the Preferred Alternative), and 4 could redirect some fishing effort from no-take zones to areas where non-target resources are more fully exploited, but they would address the potential food web effects of fishing through scientific review of applications to fish potentially harvested resources.

5.3.1 Direct Effects on Non-Target Resources

Bycatch

Most of the fishing methods presently used to harvest coral reef resources around the U.S. Pacific Islands are relatively selective, and bycatch (i.e., discards) is negligible because almost all of the species taken can be eaten or sold. The principal exceptions are fish species that are considered to pose a high risk for ciguatera poisoning. The largest existing reef-related fisheries are hook-and-line bottomfishing in the EEZ around American Samoa, Guam, the CNMI, the MHI and the NWHI, and lobster trapping off some of the NWHI. These fisheries are already managed and closely monitored under separate FMPs to minimize bycatch, so none of the alternatives are likely to have direct effects significantly different from those of the No-action alternative. Bottomfish and lobster fishing effort in the EEZ around the NWHI is controlled by limited entry permits and other measures, including boat size limits for bottomfishing vessels and annual harvest guidelines for lobster trapping. Indiscriminate gears—including bottom trawls, dredges and bottom-set nets—are already prohibited by these FMPs. Lobster traps must have escape vents, which minimize bycatch. Bottomfishing vessels are often equipped with electronic navigational devices to relocate fishing areas, and sonar devices to target productive habitat and fish aggregations. This gear is relatively selective, with the ability to successfully target particular species groups, depending on the skill of the vessel captain. Experienced vessel crew have the ability to catch the desired species with little non-target catch. It is, however, impossible to completely avoid non-target species with most hook-and-line fishing methods.

The greatest potential for large unintended catch or bycatch would come from live rock collection or potential new fisheries that harvest a broader spectrum of resources than existing fisheries. Alternatives 3 and 4, which designate no-take zones in remote reef areas of the EEZ, provide a larger reservoir of unexploited spawning biomass than Alternatives 1 (No-action) and 2. These reservoirs act as "insurance" against recruitment failure in nearby sub-populations of non-target resources but the potential for actual restocking of other areas through recruitment cannot be evaluated with available scientific information. Broader designation of MPAs around the main inhabited islands of American Samoa, Guam, the CNMI and Hawaii, in addition to those around remote reefs, may have less ambiguous recruitment benefits than the No-action alternative or designating MPAs only in remote areas. Alternatives 3 and 4, which zone a larger part of MPAs as no take zones, would enlarge the reservoir of unexploited spawning biomass more than Alternatives 1 and 2, but the potential for actual restocking of other areas through recruitment cannot be evaluated with available scientific information.

Alternatives 3 and 4, which require a special permit and detailed reporting requirements to take potentially-harvested coral reef resources in some areas of the EEZ, would keep harvesting at low levels relative to natural environmental disturbance and mortality levels. More data could then be collected to estimate biological reference points and determine sustainable yields for species about which little is known. Alternative 1 (No-action) does not provide such safeguards against high levels of bycatch in new fisheries characterized by broad spectrum resource harvesting—such as bioprospecting.

Alternatives that prohibit approval of permits for commercial collection of live rock and stony coral would reduce the incidental take of other organisms, which is unavoidable when habitat is removed. Under the No-action alternative, removal of live rock and stony corals is regulated by island governments, and only in state waters.

Alternatives 2-4, which would only allow selective fishing gear in the EEZ or in parts of the EEZ, are expected to keep bycatch at lower levels than the No-action alternative. If selectivity is not a criterion in allowing gear, the impact would differ little from that of the No-action alternative. Scuba-assisted fishing is generally highly selective and has no bycatch, so none of the alternatives that control it would result in any more bycatch, compared to Alternatives 1 and 2, which do not control that practice.

5.3.2 Indirect Effects on Non-Target Resources

Food Web Effects

Coral reef ecosystems are comprised of multi-species resources that share a long co-evolutionary history. Removal of some species may cause undesirable changes in the abundance of other species through predator-prey relationships. Food web effects are poorly understood for coral reef ecosystems. Alternatives 3 and 4, which designate no-take MPAs, can compensate for this lack of understanding by holistically conserving the ecosystem. Existing levels of coral reef resources fishing in the EEZ are relatively low, however. Whether alternatives to designate MPAs in remote reef areas only would have any detectable effects different from those of Alternative 1 (No-action) is difficult to assess against the background of high natural variability in coral reef ecosystems. Alternative 4, which designates MPAs in reef areas adjacent to major inhabited island groups where fishing is heavy, is more likely to have detectable effects that differ from the No-action alternative. The removal of prey or alteration of prey assemblages by existing bottomfish and lobster fishing activities in the NWHI appears to be minimal URS Corp. in prep.), especially in comparison to the high levels of prey consumed by large jacks (Sudekum *et al.* 1991).

New fisheries, such as bioprospecting, could target potentially harvested coral reef resources whose role in the food web is poorly understood. Alternatives 2-4, which require a special permit and detailed reporting requirements in order to take potentially-harvested coral reef resources in some areas of the EEZ, would allow proposals to be carefully scrutinized before permits are approved. This could keep harvesting at low levels, relative to levels and frequency of natural environmental disturbance and mortality, while data are collected to assess possible food web effects. The highly discretionary nature of the special permit review process would allow specific activities to be disapproved if there is a risk of adverse food web effects. The No-action alternative does not provide such safeguards in new fisheries, such as bioprospecting, which may be characterized by broad spectrum resource harvesting.

5.3.3 Cumulative Effects on Non-Target Resources

Only fishing activities in the EEZ would be managed by the CRE-FMP (the Preferred Alternative). None of the alternatives would prevent high fishing mortality of non-target coral reef resources that are currently-harvested or potentially-harvested in nearshore areas regulated by island governments. The most accessible reef areas near island population centers are heavily fished (Green 1997).

Allowances for cyclical oceanographic events that affect productivity, discussed elsewhere in this chapter and in Section 3.2.1, are not directly incorporated in any alternative, but the CRE-FMP includes a framework procedure for timely and rapid regulatory adjustments based on feedback from monitoring of changing fisheries and resource conditions.

As the NWHI EOs prevent fishing for coral reef resources (previously unpermitted), impacts on non-target resources by reef-directed fisheries would be negligible. Incidental catch is rare in most Pacific Island reef fisheries because almost everything that is harvested is utilized in some way. Under the EO provisions, the crustacean and precious corals fisheries harvest levels would be capped to zero. Similarly, the bottomfish fishery would also be restricted from operating in a significant portion of the historical bottomfishing grounds. These restrictions would concurrently reduce associated incidental take of CRE MUS by these fisheries.

5.3.4 Consistency with Other Plans and Policies for Non-Target Resources

The Preferred Alternative (3) may cause some existing bottomfish and lobster vessels to be displaced from certain fishing areas, however, Alternative 4, would likely cause substantial displacement of existing bottomfish and lobster fishing activities in the EEZ. This would reduce the data that are collected about incidental catches in these fisheries under the reporting requirements of the FMPs for Bottomfish and Crustaceans. A special permit and reporting requirement, part of Alternatives 2-4 and applying to all coral reef fishing activities in the EEZ around Palmyra, Johnston and Wake Atolls and off the southern half of Midway Atoll is consistent with special permits required by the USFWS for entry and use of National Wildlife Refuge (NWR) resources associated with those islands.

5.3.5 Mitigation Measures for Effects on Non-Target Resources

The current management regime (the No-action alternative) under the FMP for Crustaceans includes mandatory trap escape vents, which reduce incidental catch of non-target resources.

If environmental fluctuations or other natural or human factors change non-target resource conditions so that fishing mortality presents a higher risk to the system, timely preventive action can be taken under the framework adjustment procedures included in the established FMPs for bottomfish, crustaceans and precious corals and in the CRE-FMP. Future adjustments could include such actions as changes in MPA boundaries, in the number of special permits or their conditions of use, in the fishing gear that is allowed or not allowed, or designation of new MPAs.

5.4 Environmental Consequences for Protected Species and Non-Endangered Marine Mammals

Alternative 1 (the No-action alternative) provides some protection to listed species present in the action area. Alternative 2 provides some additional protection by establishing low-use MPAs to a depth of 50 fm around all NWHI. The Preferred Alternative (3) reinforces existing protected species zones established under other FMPs and provides a higher level of protection by enlarging no-take zones off the two islands that are most important for breeding by the endangered Hawaiian monk seal in the NWHI. French Frigate Shoals, which provides habitat for the largest colony of monk seals and where prey availability may be a factor limiting population recovery, is one of the areas where no-take zones would extend to a depth of 50 fm offshore under the Preferred Alternative. The second largest monk seal colony occurs at Laysan Island, where the no-take zone would also be enlarged under the Preferred Alternative, compared to the No-action alternative. Alternative 4 would provide the most protection to protected species and non-endangered marine mammals by creating a no-take MPA throughout the region's EEZ in all areas shallower than 100 fm.

5.4.1 Direct Effects on Protected Species and Non-Endangered Marine Mammals

Direct interactions of Hawaiian monk seals with existing fisheries in the NWHI are rare (URS Corp. in prep). and a low level of risk would remain under all alternatives, including the No-action alternative. However, there have been three documented cases of monk seals hooked at Kure Atoll by recreational fishermen (Henderson 1998), and it is clear that the sport fishery at Midway Atoll has the potential to interact with monk seals. Alternatives 2 and 3, which require detailed permit control and reporting of existing fishing in low-use MPAs, including recreational and subsistence activities at Midway, would provide more information about interactions than provisions in the No-action alternative would. Alternative 4 would prevent direct interactions with protected species and non-endangered marine mammals by creating a no-take MPA throughout the region's EEZ in all areas shallower than 100 fm.

Direct interactions between Hawaiian monk seals and fishermen targeting bottomfish have occurred both in the NWHI and the MHI under the No-action alternative. However, accidental hookings of monk seals or other marine mammals have been reported or observed only rarely in these fisheries (Nitta 1999). In 1982, a monk seal was photographed at French Frigate Shoals with a circle hook in its mouth. This type of hook is used in numerous fisheries, including the bottomfish fishery. The seal was later seen alive without the hook (Nitta 1999). In 1989, the hook from a slide-bait rig was observed in the mouth of a female monk seal near Kauai (Nitta 1999; K. Kawamoto, pers. comm. 2000, NMFS-HL). This type of fishing gear is typically used during shoreline fishing, and is not employed in the NWHI bottomfish fishery. The hook was removed from the seal with no apparent serious after-effects (Nitta and Henderson 1993). State of Hawaii observers deployed on commercial bottomfish fishing vessels in 1981 and 1982 recorded no interactions with monk seals or other marine mammals (Nitta 1999). The NWHI bottomfish fishery was monitored by NMFS observers from October 1990 to December 1993 with about 13% vessel coverage (Nitta 1999). No Hawaiian monk seals were observed hooked or entangled in fishing gear.

In 1990, there were allegations that some fishermen were intentionally killing or injuring monk seals in order to stop them from stealing fish and bait from hooks (NMFS 1991). At that time a number of dead monk seals were observed by NMFS researchers with head injuries that did not appear to have been inflicted by sharks or other natural predators. However, there was no evidence that the fatalities were caused by bottomfish fishermen. The only documented case of an illegal killing of a Hawaiian monk seal occurred when a resident of Kauai killed an adult female in 1989 (NMFS 1996). Since 1990, no additional monk seals have been sighted with injuries suspected of being intentionally inflicted by humans (G. Antonelis, pers. comm. 2000, NMFS-HL).

The NMFS observer program for the NWHI bottomfish fishery conducted from October 1990 to December 1993 reported no interactions between sea turtles and the bottomfish fishery (Nitta 1999). Continued bottomfish fishing in the NWHI is expected to have little effect on sea turtles in the region under all alternatives (URS Corp. in prep.). The observer program also reported a moderate level of interactions between seabirds and the bottomfish fishery, characterized by attempted bait theft only when trolling for pelagic MUS. Although there is a possibility of accidental hooking, circle hooks used in the bottomfish fishery do not lend easily to snagging. No seabird injuries or mortalities were reported while fishermen were fishing for bottomfish. One interaction involving a Laysan albatross occurred while a bottomfish fishing vessel was trolling for pelagic species. The bird became hooked, but was subsequently released alive. While continued bottomfish fishing may affect a limited number of individual seabirds, it is expected to have no effect on seabird distribution, survival, or population structure. The NWHI lobster fishery does not use gear that is likely to cause any interactions with seabirds and none have been reported or are expected under any of the alternatives (URS Corp. in prep.).

Direct interactions of Hawaiian monk seals with the NWHI lobster fishery are rare. In 1986, a monk seal was entangled and drowned in the trap bridle and main lines of a string of lobster traps in the vicinity of Necker Island (Nitta and Henderson 1993). This is the only reported mortality of a monk seal associated with the lobster fishery. The low level of risk of such direct interactions would be reduced (in comparison to the No-action alternative) under alternatives that extend no-take zones off French Frigate Shoals, which provides habitat for the largest colony of monk seals in the NWHI.

There have been no reported interactions by NWHI fisheries with species of whales listed as endangered under the Endangered Species Act, but there is always a low level risk of behaviorial disturbance or vessel collision under any of the alternatives. Several species of marine mammals that are protected under the Marine Mammal Protection Act, but are not listed as threatened or endangered, occur in the areas where bottomfish fisheries operate. The NMFS observer program for the NWHI bottomfish fishery conducted from October 1990 to December 1993 reported interactions between bottlenose dolphins and the bottomfish fishery (Nitta 1999). No dolphins were observed hooked or entangled in fishing gear. Interactions were characterized by removal of fish catch from bottomfish fishing lines. Dolphins interacting with fishing operations typically stayed with vessels as long as fish were being retrieved. Analysis of observer reports determined a dolphin interaction rate of one event per 37.7 hours of fishing; however, this rate of interaction

is grossly overestimated as many bait stealing events were assumed to be taken by a monk seal and not directly observed. This estimated level of interaction between dolphins and the bottomfish fishery would continue under all alternatives. There have been no reported interactions of the NWHI lobster fishery with whales or dolphins and this is expected to continue for all alternatives (URS Corp. in prep.).

5.4.2 Indirect Effects on Protected Species

Interactions are characterized by removal of fish catch from bottomfish fishing lines. Some seals showed no fear of vessels and exhibited an apparent familiarity with certain vessels. In those areas heavily targeted by bottomfish fishing vessels, conditioning of monk seals to associate vessels with easy meals may have occurred. By analyzing observer reports, a monk seal interaction rate of one event per 67.4 hours of fishing was calculated; however, this interaction rate is grossly overestimated as observers assumed monk seals were stealing fish from the gear and did not actually observe the action. In some interactions monk seals were observed consuming discarded bottomfish, which could contain high levels of ciguatoxin or other biotoxins (Nitta and Henderson 1993; Nitta 1999). In particular, *kahala* are often discarded during bottomfish fishing operations because large specimens have a reputation for carrying worms and ciguatoxin and, consequently, are not accepted for sale in the Honolulu fish auction. However, two studies in the NWHI found that *kahala* tested positive for ciguatoxin much less frequently than shallow-water species, such as wrasses, that are known to be significant monk seal prey items (Goodman-Lowe 1998; Ito *et al.* 1983; Kimura *et al.* 1984).

Poisoning by ciguatoxin or related toxins was suspected as the primary cause of death of at least 50 monk seals at Laysan Island in 1978, and may have been a contributing factor to the high mortality of juvenile seals translocated to Midway Atoll in 1992 and 1993 (NMFS 1997). However, evidence proving that marine toxins caused or contributed to these monk seal deaths is lacking (T. Work, pers. comm.). Moreover, there is no evidence that monk seals are susceptible to ciguatoxin poisoning. Given that frequently highly ciguatoxic fish, such as moray eels and wrasses, make up a substantial portion of the diet of the Hawaiian monk seal suggests that the seals are resistant to ciguatoxin.

Alternatives 3 and 4 would enlarge no-take zones around the NWHI, providing additional buffer zones, but it is highly debatable whether this action would reduce food competition with monk seals any more than the No-action alternative. The removal of prey or alteration of prey assemblages by existing bottomfish and lobster fishing activities in the NWHI appear to be minimal (URS Corp. in prep.), especially in comparison to the high levels of prey consumed by large jacks (Sudekum *et al.* 1993). According to research on the diet of monk seals, the commonly caught species in the bottomfish fishery are a small fraction of the total number of monk seal prey items. The NWHI lobster fishery has the potential of interacting with the Hawaiian monk seal indirectly by reducing prey availability. According to NMFS, however, there are insufficient data at this time to support statements that the fishery affects any important source of prey for any species of mammal, including the monk seal (URS Corp. in prep.). The potential for indirect interaction with seabirds due to competition for prey is negligible, because

seabirds do not prey on bottomfish. In those areas heavily targeted by bottomfish fishing vessels, conditioning of dolphins to associate vessels with easy meals may be occurring. Such a food subsidy may be a positive direct impact, although consumption of fish with high concentrations of ciguatoxin could be a negative direct impact if these marine mammals are susceptible to the toxin.

The accidental grounding of fishing boats can also adversely affect coral reefs and other types of bottom habitat used by Hawaiian monk seals and sea turtles. The impact of a vessel striking the bottom can physically destroy coral colonies in the immediate area, and the possible subsequent break-up of the vessel and release of fuel and oil can result in pollution of habitat and mortality of marine life. A grounding can also lead to the introduction of alien species, such as rodents or insects, that can have an adverse impact on terrestrial native fauna and flora in the area. Fishing vessel groundings in the NWHI are relatively rare events. Only two fishing boats have run aground in the area during the past 15 years—one was a swordfish longline vessel at Pearl and Hermes Reef, and the other a lobster boat at Kure Atoll. In both cases there was localized mortality of corals crushed under the hull, but no reported effects on surrounding areas.

None of the alternatives are expected to have any indirect effects on protected seabirds or on whales and dolphins different from those of the No-action alternative. Enlargement of the no-take zone off French Frigate Shoals, with conditions for vessel passage, would provide a higher level of protection for green turtle critical nesting habitat than the No-action alternative.

5.4.3 Cumulative Effects on Protected Species

None of the alternatives is likely to add significantly to cumulative effects of reef-related (non-pelagic) fisheries on species of sea turtles or seabirds listed under the ESA. Nor would any alternative change cumulative effects on non-endangered species of whales and dolphins.

The overall status of the endangered Hawaiian monk seal may be grave. Contributing to the species' decline in the NWHI over the past four decades have been changes in oceanographic productivity, shark predation, attacks by aggressive adult male monk seals on females and immature seals of both sexes, entanglement in derelict fishing gear originating in the North Pacific, marine toxins from past DOD activities, and human disturbance. Research and recovery activities are additional sources of human disturbance to the species (see Section 3.2.4). At each colony, differing combinations of these factors likely have contributed to local trends in abundance, with the relative importance of individual factors changing over time. A systematic assessment of the relative importance of various threats to the survival of the Hawaiian monk seal has not yet been conducted. However, the available information suggests that fisheries conducted in the NWHI under established FMPs, or that could be conducted under the CRE-FMP, account for a very small proportion of the potential impacts to the Hawaiian monk seal. To date, no information suggests that current direct or indirect effects of bottomfish and lobster fishing activities (e.g., change in prey availability) would inhibit the recovery of the Hawaiian monk seal (URS Corp. in prep.). This applies both to fisheries managed under other FMPs and expected levels of new fishing activities that could occur under the CRE-FMP.

Allowances for cyclical oceanographic events that affect productivity, discussed elsewhere in this chapter and in Section 3.2.1, are not directly incorporated in any alternative, but the CRE-FMP includes a framework procedure for timely and rapid regulatory adjustments based on feedback from monitoring of changing fisheries and resource conditions.

Cumulative effects of the NWHI CRE Reserve on protected species and non-endangered mammals could result in an increased risk, due to increased tourism, educational, research, and indigenous activities promoted in the Reserve. Increased visitation, and additional boats and infrastructure planned for the area, may ultimately have a negative impact on protected species. The draft NWHI Reserve Operations Plan identifies a budget and plans to construct warehouses on French Frigate Shoals (one of the most important NWHI areas for endangered Hawaiian monk seals and threatened green turtles) and Midway Atoll (which is not part of the Reserve) for boats and related field supplies. Frequent field trips would promote the Reserve and support goals for research, development of educational materials, and cultural studies. The logistics of these field activities could potentially increase the degree and frequency of disturbance and compound the environmental impacts to protected species.

Furthermore, studies by Antonelis and Ragen (1997) concluded that Hawaiian monk seals are extremely sensitive to human disturbances. Therefore, increased field research in monk seal habitat and management activities on monk seals could also have a negative impact on seal survival (J. Henderson unpubl. info.).

The conservation and management measures of the NWHI EOs focusing on commercial and recreational fishing are similar to Alternatives 3 and 4 of the CRE-FMP, and will likely reduce all fishing activity with the exception of fishing occurring at Midway Atoll NWR. The cumulative effects of the NWHI Reserve would be negligible because commercial fishery-related interactions with protected species are already rare. However, as mentioned earlier, other non-fishing activities may potentially impact protected species in the NWHI, depending on the areas and the degree to which they are allowed to occur.

5.4.4 Consistency with Other Plans and Policies for Protected Species

The CRE-FMP is consistent with other plans and policies for recovery and conservation of the Hawaiian monk seals, including the Hawaiian Monk Seal Recovery Team (HMSRT), the Marine Mammal Research Program, and the Marine Mammal Commission. The Preferred Alternative (3), applying the precautionary principle, proposes a no-take MPA in waters surrounding French Frigate Shoals to provide increased protection to the largest breeding colony of Hawaiian monk seals. For further discussion on monk seal recovery efforts see Section 3.2.4.

The CRE-FMP is consistent with the recovery efforts for sea turtles, marine mammals, and seabirds, and the proposed action under the preferred alternative is not expected to adversely affect any endangered or threatened species.

5.4.5 Mitigation Measures for Effects on Protected Species

The FMP for bottomfish and Seamount Groundfish contains management measures intended to monitor and mitigate interactions between the fishery and Hawaiian monk seals. The NMFS RA has the authority to place federal observers on board bottomfish vessels to record interactions with monk seals or other protected species, if this action is deemed necessary. In addition, before the NMFS RA issues a Mau Zone or Ho`omalu Zone limited access permit to fish for bottomfish, the primary operator and relief operator named on the application must have completed a protected species workshop conducted by NMFS. The HMSRT has suggested that direct interactions between monk seals and existing fisheries in the NWHI managed by other FMPs can best be mitigated by continuing to educate fishermen through briefing materials and workshops.

The FMP for crustaceans contains management measures intended to mitigate and monitor interactions between the NWHI fishery and Hawaiian monk seals. The maximum size restriction for lobster trap openings helps eliminate the potential for monk seal entrapments. No fishing zones in the NWHI (0-10 fm around all islands and 20 mile radius around Laysan) mitigate direct and indirect interactions between monk seals and the lobster fishery. The current management regime (the No-action alternative) also includes lobster harvest guidelines and mandatory trap escape vents, which reduce impacts on monk seal prey distribution and abundance. The NMFS RA is authorized to place an observer aboard a permitted vessel to determine if any interactions occur. The RA also has the authority to close the fishery if a report is received indicating a mortality of a monk seal due to the fishery. At present, vessels participating in the NWHI lobster fishery are not obligated to carry NMFS scientific data collectors. Since 1997, however, most vessel owners have allowed data collectors on board their boats during the fishing season. Not only do they gather catch and effort data but they record bycatch and any fishery interactions with protected species.

Prohibitions in both FMPs on the use of nets, explosives, and chemicals reduce the potential for incidental harm to monk seals and help protect their habitat. By reducing fishing effort in the NWHI, the limited access programs for FMP-managed bottomfish and lobster fisheries lower the potential for direct interactions, as well as the risk of vessel groundings and other accidents which could result in monk seal mortality and habitat degradation. The current "retain-all" policy of lobster fishery management reduces the potential for direct impacts from monk seals approaching lobster fishing vessels and feeding on discarded lobster.

As a result of recent litigation and its effects on fisheries locally and elsewhere, individual fishermen are more conscious of the seriousness of protected species interactions to the continuation of their livelihoods. Fishermen are now more inclined to implement methods to minimize such interactions. For example, NWHI bottomfish fishermen developed and agreed to use voluntary mitigation measures when or if they encounter monk seals during fishing operations. These recommendations were reviewed and approved by the Council and its advisory bodies.

It is possible that colonies of gold coral at sub-photic depths near French Frigate Shoals (FFS) may provide foraging habitat for the endangered Hawaiian monk seal, and the future harvest of live gold coral could have an adverse effect on the monk seal population at FFS by reducing the availability of prey species (URS Corp. in prep.). This potential impact has been addressed through a regulatory adjustment to the Precious Corals FMP that would suspend the harvest of gold coral throughout the EEZ around the NWHI while additional research is conducted on the relationship between monk seal foraging behavior and gold coral.

If environmental fluctuations or other natural or human factors change resource conditions so that fishing presents a higher risk, timely preventive action can be taken under the framework adjustment procedures included in the established FMPs for bottomfish, crustaceans, and precious corals and in the CRE-FMP. Future adjustments could include such actions as changes in MPA boundaries, the number of special permits or their conditions of use, the fishing gear that is permitted or prohibited, and also the designation of new MPAs.

5.5 Environmental Consequences for National Wildlife Refuge Resources

Alternative 1 (the No-action alternative) conserves National Wildlife Refuge (NWR) resources. Alternative 2 provides some additional protection to these resources by creating a low-use MPA around the NWHI to a depth of 50 fm. The Preferred Alternative (3) reinforces the no-take status of NWR resources and provides a higher level of protection by enlarging no-take zones off two islands in the Hawaiian Islands NWR and off all NWR islands in the Pacific remote island areas. Alternative 4 would provide the most protection to NWR resources by creating a no-take MPA throughout the region's EEZ in all areas shallower than 100 fm.

5.5.1 Direct Effects on NWR Resources

The accidental grounding of fishing boats can have an adverse effect on coral reefs by physically destroying coral colonies in the immediate area of impact and possible break-up of the vessel and release of fuel and oil causing additional habitat degradation and mortality of reef life. A vessel grounding can lead to the introduction of alien species, such as rodents or insects, which can have an adverse impact on terrestrial native fauna and flora on remote islands. Fishing vessel groundings in the NWHI are relatively rare events. Only two fishing boats have run aground during the past 15 years. In both cases there was localized mortality of corals crushed under the hulls, but no reported effects on surrounding reef areas (URS Corp. in prep.). Grounding of a foreign fishing vessel at Rose Atoll in 1983, however, caused more widespread damage (Green 1997).

Designation of extensive no-take zones, and permit and vessel operational controls in MPAs would reinforce existing protection of shallow reef resources off NWR islands and, in comparison to the No-action alternative, would extend no-take zones farther offshore in the EEZ around particularly sensitive NWR in the NWHI and PRIAs. This would also minimize the

potential for the introduction of invasive species into those sensitive environments by restricting access to all coral reef habitat areas within National Wildlife Refuges.

5.5.2 Indirect Effects on NWR Resources

Existing bottomfish and lobster fishing activities managed under other FMPs would be displaced from particularly sensitive reef areas in the NWHI under Alternatives 3 and 4. These fisheries are already regulated to limit bycatch, to prohibit destructive and non-selective gears, and to conserve EFH for the target stocks. The indirect effects of displacement on NWR resources are uncertain but they would, nevertheless, be reduced in particularly sensitive areas of the NWHI from the levels under the No-action alternative.

5.5.3 Cumulative Effects on NWR Resources

Alternatives 2, 3, and 4 reinforce the protected status of shallow reef resources adjacent to National Wildlife Refuge islands in the Western Pacific Region. Some of the activities that can degrade resources, however, are not controllable through unilateral management. One of the most serious problems in the NWHI is the accumulation of marine debris, largely derelict gear lost from North Pacific fisheries. Inter-regional and international management will be necessary to find solutions to this problem.

Allowances for cyclical oceanographic events that affect productivity, discussed elsewhere in this chapter and in Section 3.2.1, are not directly incorporated in any alternative, but the CRE-FMP includes a framework procedure for timely and rapid regulatory adjustments based on feedback from monitoring of changing fisheries and resource conditions.

In the NWHI the USFWS (Department of Interior) administers the Hawaiian Islands National Wildlife Refuge, which asserts boundaries to 10 fm around the islands and atolls from Nihoa to Pearl and Hermes, and to 20 fm around Necker. It also administers the Midway Atoll NWR, which is not included as part of the NWHI CRE Reserve. These refuges encompasses waters under the jurisdiction of the State of Hawaii, the Department of Commerce, and the Department of the Interior.

The Reserve and Refuge are similar in purpose. The draft NWHI Reserve Operations Plan includes an Action Plan for the cleanup and prevention of marine debris in the Reserve. Numerous agencies are already involved in such work and the bulk of the problem relative to habitat impacts is in shallow nearshore state waters, which are not part of the Reserve. Marine debris impacts on protected species are well documented. However, impacts to coral reefs and benthic habitat from the marine debris removal have not been assessed.

The no-take MPAs in the CRE-FMP mostly parallel the Hawaiian Island NWR boundaries in the EEZ. However, the CRE-FMP is stricter than the USFWS and the NWHI EOs in terms of the no-take areas designated for Midway Atoll NWR. The CRE-FMP establishes no take MPA for the northern half of Midway Atoll from 0-50 fathoms.

The cumulative effects of the NWHI CRE Reserve on NWR resources would be expected to be low since the EO states that nothing in the order shall enlarge or diminish the jurisdiction or authority of the DOI in managing its Refuge. The NWHI EOs would considerably reduce commercial and recreational fishing activities throughout the Reserve. However, if ecotourism, restoration, research and other non-fishing activities are allowed to increase in adjacent areas under the NWHI CRE Reserve, the effects of those activities may carry over and potentially impact NWR resources.

5.5.4 Consistency with Other Plans and Policies for NWR Resources

Designation of no-take zones adjacent to NWR islands would reinforce the protected status and limited access policies for refuge resources. A special permit and reporting requirement for all coral reef fishing activities in the EEZ around Palmyra, Johnston, and Wake Atolls, and off the southern half of Midway Atoll is consistent with special permits required by the USFWS for entry into National Wildlife Refuges and use of refuge resources associated with those islands.

5.5.5 Mitigation Measures for Effects on NWR Resources

By reducing fishing effort in the NWHI, the limited access programs for FMP-managed bottomfish and lobster fisheries lower the potential for vessel groundings or other accidents that could result in habitat degradation.

If environmental fluctuations or other natural or human factors change coral reef resource conditions so that fishing presents a higher risk, timely preventive action can be taken under the framework adjustment procedures included in the established FMPs for bottomfish, crustaceans, and precious corals, and in the CRE-FMP. Future adjustments could include such actions as changing MPA boundaries or designating new MPAs, changing the number of special permits or their conditions of use, or revising the list of permitted and prohibited fishing gear.

5.6 Environmental Consequences for Live Rock, Corals, Essential Fish Habitat and Environmental Quality

Alternative 1 (the No-action alternative) adequately manages live rock and stony coral harvest in nearshore reefs under island government jurisdiction, but not in the EEZ. However, it does not prevent or mitigate ongoing degradation of reef habitats under island government management. Alternative 2 would prohibit take of live rock or live coral in low-use MPAs, except for incidental take by other FMP permit holders. Under a permit system it would also allow take by indigenous people for traditional or ceremonial use, use by aquaculture operations as seed stock, for science and management purposes, and for bioprospecting. The Preferred Alternative (3) would extend conservation measures for live rock, coral and essential fish habitat into the EEZ and would extend no-take zones to a depth of 50 fm off two islands in the NWHI and off most of the PRIAs. Alternative 4 would prohibit take of live rock and coral from all of the region's EEZ. Implementation of Alternatives 2, 3, and 4 would require consultations with NMFS and the Council for federal activities that have the potential for adverse effects on EFH.

5.6.1 Direct Effects on Coral Reef Habitat

Permit measures prohibiting commercial collection of live rock and stony coral would conserve non-renewable reef habitat on a broader scale than the No-action alternative (1). Control of fishing gear types, allowing only non-destructive methods, would also provide a higher level of habitat conservation in more areas of the EEZ than would the No-action alternative.

The accidental grounding of fishing boats can have an adverse effect on coral reefs by physically destroying coral colonies in the immediate area of impact and possible break-up of the vessel and release of fuel and oil, causing additional habitat degradation and mortality of reef life. Fishing vessel groundings in the NWHI are relatively rare events. Only two fishing boats have run aground during the past 15 years. In both cases there was localized mortality of corals crushed under the hulls but no reported effects on surrounding reef areas (URS Corp. in prep.). Grounding of a foreign fishing vessel at Rose Atoll in 1983 caused more widespread damage (Green 1997).

Designation of extensive no-take zones and restrictions on how vessels operate in these zones would reinforce the existing protection of shallow reef habitat adjacent to the NWR in the NWHI and PRIAs and extend it to broader areas of the EEZ than under the No-action alternative (1) . Alternatives 3 (the Preferred Alternative) and 4 are particularly beneficial because they add protection to French Frigate Shoals, the southern-most atoll in the NWHI and the largest coral reef area in the Hawaiian Islands. It has one of the highest diversities of stony coral species in the Hawaiian Archipelago (Grigg 1983).

Anchor damage can occur on coral reefs and other types of benthic habitat from vessels attempting to maintain position over productive fishing areas. The dropping of handline weights on coral substrate and line entanglements during normal hook-and-line fishing operations could theoretically affect benthic habitat. These impacts have not yet been assessed for bottomfish fishing activities in the NWHI, but it is likely that they are minimal. Most bottomfish fishing in the NWHI occurs at depths (100-400m) deeper than the part of the photic zone where coral reefs and reef building organisms are normally found (50-100m). When bottomfish fishing vessels fish in shallower waters for species such as *uku* they generally drift or slowly troll, rather than anchoring (URS Corp. in prep.). In addition, given the large perturbations in coral reef habitat in the NWHI that result from the action of winter storms and associated storm surge and swell (Grigg 1983), the impact of fishing activities on this habitat is likely to be relatively small. Direct effects on reef habitat by bottomfishing vessels are minimal under the No-action alternative but they would, nevertheless, be reduced in no-take MPAs around some of the NWHI, under alternatives that would displace fishing effort.

NMFS observer logs from the 1999 NWHI lobster fishery and follow-up interviews with observers reveal that both pieces of live coral and entire coral heads were caught in some lobster traps and ground line and landed onboard lobster vessels. One observer noted that "small broken pieces of coral were frequently (as many as one piece per five traps) wedged in the holes of the traps. Numerous softball-sized and a few basketball-sized whole coral heads came up stuck to

the mainline." Only a part of the damaged coral reaches the vessel to be seen by observers. Some of the damaged coral that remains on the bottom may continue growing, but others may be covered in sand or swept off the banks. The damage may vary from bank to bank. Trapping at atolls where lobster habitat is limited and coral density high may result in more coral damage than at islands with large, flat algal or sand bank areas. The observed bycatch of coral apparently came from habitats that would not usually be fished. These were areas where permit holders had been encouraged to trap experimentally during the 1999 season in an attempt to prevent fishing effort from concentrating solely on lobster populations off Necker Island. The long-term impact of lobster trapping on coral reef habitat is difficult to estimate because it is in the interest of the permit holders to avoid rugged coral bottoms and to set gear in flat areas where lobster catches have been historically higher. Nevertheless, the Preferred Alternative (3) is likely to reduce impacts in sensitive areas from levels in the EEZ around the NWHI and PRIAs experienced under the No-action alternative (1).

5.6.2 Indirect Effects on Coral Reef Habitat

Existing bottomfish and lobster fishing activities managed under other FMPs would be displaced from particularly sensitive reef areas in the NWHI under Alternatives 3 and 4. These fisheries are already regulated to prohibit destructive gears and to conserve EFH for the target stocks. Their indirect effects on coral reef habitat are uncertain but they would, nevertheless, be reduced under Alternatives 3 and 4 from the levels under the the No-action alternative.

5.6.3 Cumulative Effects on Coral Reef Habitat

Only fishing activities in the EEZ are managed by FMPs, which are monitored for possible adverse effects on EFH and management is adjusted as necessary. The majority of reefs affected by the management measures in the CRE-FMP are in remote areas that are far removed from terrestrial activities and impacts. None of the alternatives considered by the CRE-FMP would restore or prevent new degradation of EFH in nearshore reef areas managed by island governments. Nor does any alternative mitigate or prevent impacts on nearshore reef habitats that results from coastal construction, watershed management, shoreline erosion, or water pollution. The EFH consultation procedure required after implementation of the CRE-FMP will help to mitigate the future potential for adverse effects resulting from proposed federal activities, but it will not address non-federal activities or the condition of nearshore fishery stocks.

Considering the large perturbations in the NWHI and other coral reef habitats that result from large storms and associated wave action, the impact of fishing gear allowed under FMPs for bottomfish, crustaceans and precious corals and the CRE-FMP would not be significant. Researchers have observed that periodic storms in the NWHI reduce live coral cover to 10% in some areas. Coral cover eventually returns to 50% or more in areas where the disturbance cycle is infrequent (R. Grigg, comm. at June 14th, 2000 Council meeting).

Some of the activities that can degrade EFH are not controllable through unilateral management. The accumulation of marine debris, largely derelict gear lost from North Pacific fisheries, is one

of the most serious problems in the NWHI. Inter-regional and international management will be necessary to find solutions to this problem.

In 1998, global coral bleaching and die-off was unprecedented in geographic extent, depth and severity. Several studies have related bleaching to the combination of increased ultraviolet radiation and ocean warming, phenomena that may be exacerbated by human activities. Projected long-term climatic changes are likely to expose stony corals to an increasingly hostile environment and could possibly lead to another episode of mass extinctions. Stony corals damaged by acute, local stresses (e.g., hurricanes, starfish predation) have often been able to recover, as long as surrounding reefs remained healthy. Renewal of reef building following chronic, widespread stresses acting synergistically is likely to be much slower. Human uses of reefs have never been higher and there is growing concern about human impacts that could add to cumulative stresses on coral reefs in the Western Pacific Region. Allowances for such outside influences are not directly incorporated in any alternative, but the CRE-FMP includes a framework procedure for timely and rapid regulatory adjustments based on feedback from monitoring of changing fisheries and resource conditions.

The conservation measures outlined in the NWHI EOs would prohibit anchoring on any living or dead corals or altering the seabed in any way, and would also prohibit removal of living or non-living marine resources in the NWHI. However, the NWHI EOs provide for exemptions to these restrictions and promotes several resource dependent activities, such as increased restoration and monitoring programs, potential tourism, recreational and commercial activities, and education and research opportunities.

The potential impacts from NWHI CRE Reserve activities on coral reef and fish habitat have not been assessed, but they could be significant. Following over two decades of federally-managed commercial fisheries, the NWHI is still considered nearly pristine, based on extensive multi-agency surveys over the past year (e.g., NOW-RAMP 2000 Expedition). The NWHI EOs appear to promote a shift from commercial fishing to indigenous uses and tourism, both of which have little history in the NWHI. Increased visitation, and additional boats and infrastructure planned for the area, may ultimately have a negative impact on habitat (e.g., vessel groundings, anchor damage). In contrast, the CRE-FMP Preferred Alternative (3) requires all fishing vessels operating or transiting in the NWHI low-use MPA (10-50 fathoms) to have vessel insurance to cover the cost of vessel removal and clean-up; the NWHI EOs have no such comparable provision. The draft Reserve Operations Plan identifies a budget and plans to construct warehouses for boats and related field supplies on French Frigate Shoals—one of the most important NWHI areas for endangered Hawaiian monk seals—and Midway Atoll, which is not part of the Reserve. Frequent field trips would promote the Reserve and support goals for research, and development of education materials and cultural studies. The logistics of these field activities could potentially increase the degree and frequency of disturbance and compound the environmental impacts to coral reef habitats. The cumulative effects of the NWHI CRE Reserve will reduce commercial fishing activity. However, this reduction in commercial fishing activity would not significantly reduce impacts on live rock, coral reefs, and fish habitat because commercial fishing impacts on coral reefs and fish habitat are already minimal. Potential

cumulative impacts to coral reef and fish habitat may occur from other non-fishing activities identified by the NWHI EO. However, these impacts are contingent on the location of and the degree to which these activities are allowed to occur in the NWHI CRE Reserve.

5.6.4 Consistency with Other Plans and Policies for Coral Reef Habitat

The Preferred Alternative would address the MSFCMA requirement to avoid significant adverse effects on EFH more comprehensively than the No-action alternative, under which EFH is more narrowly designated for other FMP-managed fisheries. The 10-year target established by the U.S. Coral Reef Task Force to designate 20% of reefs off U.S. coasts as no-take zones will be easily met if the State of Hawaii takes consistent action for nearshore reefs adjacent to MPAs designated in the adjacent EEZ. The Preferred Alternative is also consistent with Presidential directives aimed at protecting coral reefs in the U.S. and specifically in the NWHI.

5.6.5 Mitigation Measures for Effects on Coral Reef Habitat

The current management regime (the No-action alternative) under the FMPs for bottomfish and crustaceans include prohibitions on the use of nets, explosives, and chemicals, which reduce the potential degradation of coral reef habitat.

If environmental fluctuations or other natural or human factors change habitat conditions (e.g., hurricanes, coral bleaching episodes) so that fishing mortality presents a higher risk to the ecosystem, timely preventive action can be taken under the framework adjustment procedures included in the established FMPs for bottomfish, crustaceans, and precious corals, and also in the CRE-FMP. Future amendments could include such changing MPA boundaries or designating new MPAs, changing the number of special permits or their conditions of use, or revising the list of permitted and prohibited fishing gear.

None of the alternatives would directly mitigate adverse effects on coral reef habitats and environmental quality in nearshore areas under island government jurisdiction. However, designation of EFH and implementation of the CRE-FMP would mandate EFH consultations by NMFS and the Council for any proposed federal activity that has the potential for significant adverse effects.

5.7 Environmental Consequences for Reef Ecosystem Biodiversity, Structure and Function

Alternative 1 (the No-action alternative) does not adequately conserve reef ecosystem biodiversity, structure or function. Alternative 2 would provide some additional protection over the No-action alternative by creating low-use MPAs. However, this level of protection is not considered adequate to provide the desired long-term conservation of CRE biological resources. The Preferred Alternative (3) would immediately designate no-take zones and add others through amendments that will easily meet the 20% protected reef resources target that the U.S. Coral

Reef Task Force has set for the year 2010. Another way in which the Preferred Alternative provides a higher level of ecosystem conservation is through a procedure that coordinates the plan teams who monitor different FMPs. This would also allow joint analysis and evaluation of possible adverse effects of any fishery on coral reef ecosystems. If environmental fluctuations or other natural or human factors change resource conditions so that fishing presents a higher risk, timely preventive action can be taken under the framework adjustment procedures included in the Council's already implemented FMPs and in the CRE-FMP (the Preferred Alternative). This would allow the kinds of adjustments mentioned in other sections, dealing with MPAs, permits, and permissible fishing gear.

5.7.1 Direct Effects on Reef Ecosystems

Alternatives 3 and 4, which designate no-take MPAs for reefs in remote areas of the EEZ would have a more positive impact than the No-action alternative. They would conserve a large reservoir of spawning biomass and genetic material for diverse coral reef resources, including endemic and rare species. Restrictions on vessel operation in MPAs would reduce the potential for vessel grounding, another beneficial effect. The No-action alternative (1) does not lower this risk to the same extent. Broader designation of no-take areas in Alternatives 3 and 4 could provide further benefits over those of Alternatives 1 and 2, while increasing the diversity of biotypes included in MPAs. Unlike the No-action alternative, the highly discretionary nature of the special permit process included in the Preferred Alternative (3) would allow limited harvesting, which is not likely to have adverse effects. Ongoing monitoring could then provide the new resource data needed for adaptive management of fishing.

As discussed in Section 5.6.1, alternatives that enlarge the no-take area off French Frigate Shoals provide significantly more benefit than the No-action alternative because of the high coral diversity there. Moreover, the expansive shallows enclosed by the barrier reef at FFS provides habitat for certain Indo-Pacific fish species that are rare or absent from other areas of the Hawaiian Islands (Hobson 1980). Added protection for Laysan Island also results in greater benefits, in comparison to the No-action alternative (1), because it represents a reef ecosystem type characteristic of the middle of the NWHI, and because there has been little previous human activity and disturbance of reefs there.

5.7.2 Indirect Effects on Reef Ecosystems

Restrictions on vessel operation in MPAs and the highly discretionary nature of the permit process would allow careful scrutiny of the potential for new fishing activities to introduce invasive alien marine species throughout the EEZ before harvesting is permitted. These measures would prevent loss of biodiversity better than current measures in the No-action alternative.

5.7.3 Cumulative Effects on Reef Ecosystems

Because the coral reef ecosystem is composed of multiple species with a long co-evolutionary history, removal of certain species can result in loss of biodiversity. These losses can also result in undesirable changes to ecosystem structure or function, such as a predominance of less valuable generalist species. Possible secondary effects of fishing may be overlooked in conventional management of specific target stocks. Alternatives that would designate large no-take MPAs—such as Alternatives 3 and 4—and allow for highly discretionary special permit review in adjacent low-use MPAs—as in the Preferred Alternative—would guard against cumulative effects on reef ecosystem biodiversity, structure and function, while also guarding against overfishing of potentially-harvested species. In addition, the Preferred Alternative includes a consultation procedure among plan teams for different FMPs to monitor possible ecosystem effects of all reef-related fisheries in the EEZ and adjust management as needed.

Only fishing activities in the EEZ would be managed by the CRE-FMP. None of the alternatives would prevent adverse effects on reef ecosystem biodiversity, structure, or function in the nearshore areas regulated by island governments. Nor does any alternative mitigate or prevent impacts on nearshore reef ecosystems resulting from coastal construction, watershed management, shoreline erosion, or water pollution. The EFH consultation procedure required after implementation of the CRE-FMP (the Preferred Alternative) will help to mitigate adverse effects resulting from proposed federal activities, but it will not address non-federal activities or the condition of nearshore ecosystems.

Allowances for cyclical oceanographic events that affect productivity, discussed elsewhere in this chapter and in Section 3.2.1, are not directly incorporated in any alternative, but the CRE-FMP includes a framework procedure for timely and rapid regulatory adjustments based on feedback from monitoring of changing fisheries and resource conditions.

A major effect of the CRE Reserve is to reduce commercial fishing, but NWHI reef ecosystems remain in excellent condition despite years of fishing effort. Following over two decades of federally managed commercial fisheries, the NWHI is still considered nearly pristine, based on extensive multi-agency surveys over the past year (NOW-RAMP 2000). Severe winter storms, large waves, and broad-scale shifts in oceanic productivity exert significantly greater impacts on these attributes.

Activities identified by the NWHI EOs may have the potential to impact coral reef ecosystem structure and function depending on the location and the extent to which these activities are allowed to occur. The NWHI EOs promote a shift from commercial fishing to indigenous uses and tourism. Increased visitation, additional boats, and infrastructure planned for the area may ultimately have a negative impact on habitat, due to vessel groundings or anchor damage, for example. The draft NWHI Reserve Operations Plan includes a budget and plans to construct warehouses on French Frigate Shoals and Midway Atoll for boats and related field supplies. Frequent field trips would promote the CRE Reserve and support goals for research, development of education materials, and cultural studies. The logistics of these field activities

could potentially increase the degree and frequency of disturbance and compound ecosystem impacts.

5.7.4 Consistency with Other Plans and Policies for Coral Reef Ecosystems

The Preferred Alternative (3) is consistent with the 10-year target of the U.S. Coral Reef Task Force to designate 20% of reefs off U.S. coasts as no-take marine protected areas. It also adheres to ecosystem management principles and policies recommended to Congress by the national Ecosystems Principles Advisory Panel (1999). The Preferred Alternative is also consistent with Presidential directives aimed at protecting U.S. coral reefs and specifically those in the NWHI. No-action would be inconsistent with these policies.

5.7.5 Mitigation Measures for Effects on Reef Ecosystems

The CRE-FMP (the Preferred Alternative) includes a coordination procedure for the plan teams monitoring different Council FMPs. This would allow joint analysis and evaluation of possible adverse effects of any fishery on coral reef ecosystems. As discussed elsewhere, if natural or human conditions change, framework measures, allowed under the Council's already implemented FMPs and also under the CRE-FMP, would allow rapid and effective managerial response. As mentioned, management measures—including MPA design and extent, the permit regime, and regulation of fishing gear—could be changed by amendment.

None of the alternatives would directly mitigate adverse effects on coral reef habitats and environmental quality in nearshore areas under island government jurisdiction. However, designation of EFH and implementation of the CRE-FMP would mandate EFH consultations by NMFS and the Council for any proposed federal activity that has the potential for significant adverse effects.

5.8 Environmental Consequences for Native Cultures

Under Executive Order 12898, dated February 11, 1994, federal agencies are required to address the potential for disproportionately high and adverse environmental effects of their actions on minority and low-income populations. Agencies are required to ensure that their programs and activities that affect human health or the environment do not directly or indirectly use criteria, methods, or practices that discriminate on the basis of race, color, or national origin. NEPA documents are specifically required to analyze effects of federal actions on minority and low-income populations and, whenever feasible, to develop mitigation measures to address significant and adverse effects on such communities. In addition, the Executive Order requires provision of opportunities for community input in the NEPA process. It states that the public, including minority and low-income communities, should have adequate access to public information relating to human health or environmental planning, regulation, and enforcement.

In designating no-take zones, the Preferred Alternative does not address Native Hawaiian concerns about their claims to the NWHI, but it would provide for preferential access to

indigenous zones in MPAs immediately and in the future. It would also increase indigenous participation in the coral reef management process for the EEZ around the NWHI and elsewhere. Therefore, the Preferred Alternative has less negative effects on native cultures than the No-action alternative. Alternative 4 would prohibit all fishing activities in waters shallower than 100 fm and would decrease indigenous participation in coral reef fisheries conducted in the EEZ around the NWHI and elsewhere. Therefore, Alternative 4 has greater negative effects on native cultures than Alternatives 1-3.

5.8.1 Direct Effects on Native Cultures

Any alternative that designates no-take zones in the EEZ around the NWHI (including the existing protections included in the the No-action alternative) is potentially in conflict with the lingering sovereign claim by native Hawaiians. In 1993, Congress passed the Apology Bill, which states that "...the indigenous Hawaiian people never directly relinquished their claims to their inherent sovereignty as a people over their national lands to the United States, either through their monarchy or through a plebiscite or referendum." Murakami and Freitas (1987) argue that the legal claims of Native Hawaiians to the fishery in the MHI and NWHI have never been extinguished by the U.S. government, either by condemning the fisheries granted to Hawaiian commoners and their successors and paying compensation for taking of their fishing grounds, or by exercising its public trust duties to protect the aboriginal claims to the resources of the EEZ and determining the extent of participation by Hawaiians in the revenue from resource use and in resource conservation.

Broader designation of the no-take zones in the NWHI included in Alternatives 3 and 4 would adversely affect Native Hawaiians who are owners, captains of, or deckhands on fishing vessels operating in that region, depriving them of a means of livelihood. In view of the historic and cultural importance of fishing to Native Hawaiians, this deprivation of the right to make a living at *koa* (Kahaulelio 1902, pp. 22, 24), which they have been accustomed to frequent in the NWHI, is an especially onerous penalty. The United States annexation of Hawaii exacerbates this loss of access because any U.S. citizen now has free access to these fishery resources (Kosaki 1954). This increases fishing pressure on resources customarily used by Native Hawaiians and weakens the cultural norms that controlled the proper conduct of fishing.

An alternative to reserve sub-zones of MPAs for indigenous use would be more beneficial than the No-action alternative because it would compensate for the hardship to native cultures resulting from previous closures of fishing grounds, without considering the claims of indigenous Pacific Island populations.

5.8.2 Indirect Effects on Native Cultures

For centuries, native cultures in the U.S. Pacific Islands relied on seafood as their principle source of protein. However, the availability of many traditional seafoods has been significantly diminished as a result of environmental degradation of nearshore reef areas under the jurisdiction of island governments. Localized overfishing is blamed for some of the adverse impacts. But

coastal construction, industrial discharges, and poor watershed management have damaged coral reef habitat on a massive scale near population centers. Shomura (1987) notes that between 1900 and 1986, commercial landings of coastal fish species in Hawaii declined by 80%. The drastic changes in diet that resulted from loss of access to marine fishery resources have contributed to the poor health of Native Hawaiians. Of all the racial groups living in Hawaii, Native Hawaiians are the group with the highest proportion of multiple risk factors leading to illness, disability, and premature death (Look and Braun 1995). None of the alternatives would mitigate this situation, although reservation of MPA sub-zones for indigenous use would be more beneficial than the No-action alternative.

5.8.3 Cumulative Effects on Native Cultures

Samoa, Hawaii, and the Mariana Islands were originally settled by seafaring peoples. The lack of terrestrial resources in most areas led to great dependence on fishing for food security. This dependence shaped the social organization, cultural values, and spiritual beliefs of the indigenous populations. Repeated contact with Europeans and North Americans eroded the stability of the social structures and subsistence economies created by indigenous people.

With the exception of American Samoa, and small enclaves in Guam, Hawaii, and the CNMI, the descendants of the islands' original inhabitants are dispersed as part of cosmopolitan populations. Island societies have become pluralistic, and many aspects of their economies and cultures have evolved in modern times. Nonetheless, the people descended from the original indigenous inhabitants have a particularly deep traditional, historical, and contemporary involvement with coral reef resources. Fishing not only provides food; it also cultivates intimacy and harmony with the ocean. This reinforces their sense of kinship with nature, and their relationships with places that perpetuate cultural identities and beliefs. Increasing restrictions on customary and traditional uses of marine resources are jeopardizing cultural continuity in many areas of the U.S. Pacific.

The cumulative effects of the NWHI EOs on Native Hawaiian cultures is expected to be minimal. The NWHI CRE Reserve allows Native Hawaiian non-commercial subsistence, cultural, or religious uses to continue in both the Reserve and Reserve Preservation Areas, although the specifics on the location of these activities remain to be determined. This allowance minimizes cumulative effects on native cultures. In addition, the Secretary of Commerce may also revise the areas where these activities may continue after public review and comment.

The Preferred Alternative (3) requires a special permit for the take of live rock and live coral for traditional and ceremonial uses. In comparison, the NWHI EOs do not include any such permitting provision for cultural studies and indigenous uses of NWHI marine resources. Additionally, the preferred alternative in the CRE-FMP does not allow any fishing in its no-take MPAs; it is therefore more restrictive than the NWHI Reserve in this regard.

5.8.4 Consistency with Other Plans and Policies for Native Cultures

The Preferred Alternative (3) is consistent with the Apology Bill in which Congress expressed its commitment to acknowledge the ramifications of the overthrow of the Kingdom of Hawaii. In order to provide a proper foundation for reconciliation between the U.S. and the Native Hawaiian people, a series of reconciliation hearings—attended by federal representatives, Native Hawaiians, and the general public—were conducted in Hawaii in December 1999. In July 2000, Hawaii's congressional delegation introduced a bill that clarifies U.S. policy on its relationship with Native Hawaiians. It also provides a process for the reorganization of a Native Hawaiian government, and the recognition by the U.S. of a Native Hawaiian government.

5.8.5 Mitigation Measures for Effects on Native Cultures

Some of the alternatives could partially mitigate the cumulative effects resulting in this hardship by designating sub-zones in MPAs; this would give indigenous populations preferential access to, and use of, resources.

In addition, the MSFCMA provides for the establishment of a western Pacific community development program for any fishery under Council authority. This provision was added to the Act to address concerns that communities consisting of descendants of indigenous peoples in the Council's area of authority have not adequately shared in the benefits from the area's fisheries. The Council and the Secretary of Commerce have discretion to develop and approve indigenous demonstration programs for eligible communities. Currently, the Council, in consultation with NMFS, is developing criteria for community eligibility. In 1999, the Council developed and the Secretary of Commerce approved an allocation of approximately one-fifth of the target number of Mau Zone bottomfish permits to a community development program.

5.9 Environmental Consequences for Existing Fisheries and Communities

Alternative 1 (the No-action alternative) would continue the present effects. Alternative 2 would have very little impact on existing fisheries and communities. The Preferred Alternative (3) would increase adverse impacts on existing fisheries and communities by displacing existing bottomfish and lobster fishing effort around some NWHI where the seaward boundary of no-take zones would extend to a depth of 50 fm. Alternative 4 would further increase adverse impacts on existing fisheries and communities by displacing existing bottomfish and lobster fishing effort around some NWHI where the seaward boundary of no-take zones would extend to a depth of 100 fm. Occasional bottomfishing activities off Kingman Reef may also be adversely affected by no-take designations. Permit and reporting requirements would be imposed on participants in existing recreational and subsistence fisheries at Midway, Johnston and Wake Atolls, and on developing recreational fishing at Palmyra as well. For these reasons, the Preferred Alternative has greater negative impacts than Alternatives 1 and 2, while Alternative 4 would have the greatest impact of all the alternatives.

5.9.1 Direct Effects on Existing Fisheries and Communities

Designation of no-take zones in the NWHI could result in some negative impacts on Hawaii communities by causing a loss of earning potential, investment value, and lifestyle for some bottomfish and lobster fisheries participants. Relatively few persons would be negatively impacted and the State's economy would be relatively unaffected. But this does not lessen the economic hardship that reduced earnings or loss of jobs would create for some fishermen and their families. Pooley and Kawamoto (1990) show that the net revenue of a bottomfish fishing vessel operating in the NWHI is most sensitive to the crew share percentage and to changes in total fixed costs. If closure of some NWHI bottomfishing grounds causes a reduction in net revenues, captain/owners may compensate by decreasing the pay of deckhands or laying them off. Suitable employment opportunities outside of fishing may be limited for affected deckhands.

Alternatives 3 and 4, which designate no-take zones in the EEZ, are likely to displace existing fisheries to a varying extent. If no-take zones are limited in depth and are confined to remote areas of coral reefs, such as in the Preferred Alternative, the most significant displacement would be in the NWHI bottomfish fishery, with far fewer effects on the NWHI lobster fishery. Permit holders in these fisheries would lose access to a few familiar fishing grounds, but the area closures are likely to have less adverse impact than closure of more productive areas of the NWHI. Data provided by the Council demonstrates that no-take zones with a boundary of 50 fm in the NWHI have accounted for about 10% of recent bottomfishing effort in the NWHI bottomfish fishery. Applied to recent (1994-1998) landings data (WPRFMC 1999b), this percentage represents about 36,000 lbs. of bottomfish with an ex-vessel value of $115,000. The same areas have recently accounted for about 1.2% of the total lobster harvest in the NWHI fishery. Applied to recent (1996-1999) landings data (URS Corp. in prep.), this percentage represents about 3,100 lbs. of spiny and slipper lobsters with an ex-vessel value of $16,000. It is likely that the displaced participants could recover this loss in revenue by moving to other fishing grounds. Recreational fishing activities for tourists could continue at Midway but with the exception of Palmyra Atoll, future development of other PRIAs as sportfishing destinations would be deterred.

Broader designation of no-take zones in Alternative 4, with seaward boundaries extending to the 100 fm isobath throughout the EEZ, would virtually eliminate existing bottomfish and crustacean fisheries in the NWHI, small recreational fisheries at Midway, Johnston, and Wake Atolls, and the developing recreational fishery at Palmyra. Immediate closure of the NWHI bottomfish fishery would impose an economic hardship on fishery participants. This alternative would immediately prohibit bottomfish fishing in the EEZ surrounding the NWHI. It is estimated that up to 45 fishermen would be displaced by this action, based on the current number of vessels (17) eligible to fish in the area under the limited access programs for the Mau and Ho'omalu Zones. This assumes that each Mau Zone vessel and Ho'omalu Zone vessel has a crew of two and three, respectively, and one-fourth of the vessels are not owner-operated. Based on recent landings data (1994-1998), about 360,000 lbs. of bottomfish with an ex-vessel value of about $1,152,000 would no longer be harvested from the NWHI fishery (WPRFMC 1999b).

The termination of the NWHI bottomfish fishery would force displaced fishermen to relocate their fishing activities to bottomfish grounds that are still open, shift to different fisheries, or tie up their vessels. Closure of the NWHI fishery is likely to have less of an impact on Mau Zone permit holders than Ho`omalu Zone permit holders, because most of the former tend to own smaller boats and currently use MHI bottomfish fishing grounds and/or participate in other fisheries (e.g., handlining or trolling for pelagic species). In contrast, Ho`omalu Zone vessels require larger catches to be profitable and have few, if any, viable alternative fisheries. For the owners of these vessels, closure of the fishery would represent a sunk cost of $150,000 to $250,000 per vessel. Broader designations of no-take zones in the NWHI would also displace 13 permit holders in the NWHI lobster fishery, which annually harvests 211,000-330,000 lbs. of lobsters with an ex-vessel value of $1,043,000 to $1,896,000 (URS Corp. in prep.). No such losses would be incurred under the No-action alternative.

Under Alternatives 2-4, fisheries for currently-harvested resources in low-use zones of MPAs and for potentially-harvested resources anywhere in the EEZ would face inefficiencies and higher costs as a result of special permit technical prerequisites and compliance costs. Such costs would not be incurred under the No-action alternative. The difficulty and high cost of compliance with special permit requirements is likely to favor applicants who are well financed to research and express scientific information over small-scale, low-income fishermen. Measures that allow some types of fishing methods but not others (including Alternatives 3 and 4, which control scuba-assisted spear fishing) have disproportionate effects on fishermen who use one type of gear but not others. These impacts are not incurred with the No-action alternative.

5.9.2 Indirect Effects on Existing Fisheries and Communities

Displaced fishermen who relocate to grounds that remain open may be forced to travel farther than previously, thereby making fishing more costly. In addition, competition for the remaining open fishing locations would increase and catch rates might fall, generating less revenue for the same fishing effort. Enterprises with high operating costs would be the first to feel the cost-revenue squeeze (Samples and Sproul 1988).

Transfer of effort from the NWHI to the MHI could indirectly create economic hardship in the form of reduced profitability for fishermen already engaged in the MHI fishery. Bottomfish fishing grounds in the MHI are fully utilized with few, if any, unexploited areas. Recently implemented state regulations that close certain bottomfish fishing grounds have further increased competition for fishing locations around the MHI. If NWHI fishermen were to shift their effort to the MHI, catch per unit effort and individual harvest for both displaced and resident fishermen would likely decline substantially, due to the intensified fishing pressure on bottomfish resources. Lower individual catches would mean a decrease in the incomes of part-time and full-time commercial fishermen and a reduction in the non-market value of the fishing experience to a number of recreational fishermen and charter fishing patrons. Total harvest in the MHI fishery would probably remain at current levels regardless of increased participation from displaced NWHI fishermen because nearly all MHI fishing grounds are fully utilized.

Those displaced fishermen who elect to target other species are likely to recover some part of the revenue previously generated from bottomfish fishing in the NWHI, particularly if they pursue more widely distributed species like tuna. Many Mau Zone vessels are already outfitted to participate in fisheries on other stocks, but some boat owners may not be capable of shifting into other fisheries without significant additional capital outlays. Conversion to charter fishing may be a feasible option for some vessel owners. However, the charter fishing fleets in most of Hawaii's ports are already over-capitalized (Hamilton 1998).

Given that opportunities for displaced fishermen to recover their lost harvest and income would be limited and the fishery is already characterized by limited profitability, it is likely that some displaced fishermen would be forced to sell out or retire. It is uncertain how active the Hawaii or nationwide market is for the types of vessels, gear, and other investment capital used in the NWHI bottomfish fishery, but it is possible that the Hawaii market for these assets could quickly be flooded. Closing the NWHI bottomfish fishery would probably depress the immediate resale market for bottomfish fishing equipment and vessels. It would also diminish the long-term investment value of the vessels owned by displaced fishermen who opt to continue fishing. This could create an economic hardship for fishermen that rely on money earned from selling their fishing assets to supplement their retirement funds (URS Corp. in prep.).

It is possible that closure of the NWHI fishing grounds could help rebuild stocks in the MHI and sustain or increase harvests, thereby mitigating the revenue reductions from fishing restrictions. However, the ability of closed areas to increase yields has not been demonstrated for bottomfish fisheries in Hawaii. It should also be noted that, even if a closed area and resulting fishery closure increases fish populations and fishery productivity, it may be several years before this effect to be realized. This is due to the high age of first reproduction for most bottomfish species. Given this time lag, it is unlikely that the potential economic benefits of an area closure would accrue to the current generation of bottomfish fishermen. Moreover, if fishing effort is allowed to increase in the MHI, any economic gains from a closed area will be dissipated over the long-run (URS Corp. in prep.).

Over the longer run, operations with higher fixed costs could be disadvantaged by the reduced margin of each fishing trip. Such effects could cause some fishermen to exit the NWHI fishery. For those enterprises that weather these negative effects, the long-term outlook could be brightened by a gradual increase in catch rates in response to initial effort reduction. It is possible that no-take zones could restock nearby fishing grounds and increase future harvest potential, thereby mitigating loss of revenue. However, the ability of closed areas to increase equilibrium yields has not been demonstrated for bottomfish fisheries in Hawaii (URS Corp. in prep.).

5.9.3 Cumulative Effects on Existing Fisheries and Communities

Many of the families that depend on fishing and the seafood industry in the U.S. Pacific Islands are probably already economically, socially, and psychologically stressed because of declining catch rates, increasing competition, or unstable markets. The imposition of ever more restrictive

state and federal regulations and uncertainty due to pending litigation also contributes to this stress. In just two years, a limited access program was established for the Mau Zone of the NWHI bottomfish fishery, the State of Hawaii closed some areas around the MHI to bottomfishing, and NMFS issued an emergency regulation that stopped the NWHI lobster season from opening in 2000. In addition, during this period litigation over the possible impacts to sea turtles from the Hawaii-based pelagic longline fishery led a federal judge to issue an injunction. This required NMFS to implement area closures, gear and effort restrictions, and increased observer coverage for the pelagic fishery. Undoubtedly, many fishermen in Hawaii have the sense that government regulations are "boxing them in" and reducing their ability to maintain their characteristic highly flexible fishing strategy. This flexibility is important to the economic success of many smaller and medium-sized fishing vessels because of natural variations in the availability of various types of fish. Closure of some NWHI fishing grounds would further confine fishermen and could jeopardize the long-term economic viability of their fishing operations.

In addition to potential economic losses associated with the cumulative effects of various fishery closures, there would be a loss of lifestyle, assuming that displaced fishermen cannot find an equally satisfactory alternative way of life. Some Hawaii fishermen feel a sense of continuity with previous generations of fishermen and want to perpetuate the fishing life style. A 1993 survey of participants in the NWHI bottomfish fishery found that half of the respondents who fish in the Ho'omalu Zone were motivated to fish by a long-term family tradition (Hamilton 1994). This sense of continuity is also reflected in the importance placed on the process of learning about fishing from "old timers" and transmitting that knowledge to the next generation. Hawaii's commercial fishing industry dates back nearly 200 years, and closing some fishing grounds in the NWHI would probably also negatively impact those who value the continued existence of Hawaii's maritime tradition and culture.

Just as Hawaii's fishing tradition is an integral part of the islands' heritage and character, the image of Hawaii has become linked with the consumption of some types of locally-caught seafood. The availability of seafood is also important to Hawaii's tourist industry, the mainstay of the state economy. Japanese tourists visiting Hawaii often want to enjoy the traditional foods and symbols of Japan while they vacation in Hawaii, including various types of high quality fresh fish (Peterson 1973). Hawaii tourists from the U.S. mainland and other areas where fish is not an integral part of the customary diet typically want to eat seafood because it is part of the unique experience of a Hawaii vacation. Consuming fish that is actually caught in the waters around Hawaii further enhances that experience (URS Corp., in prep.).

The impacts of the NWHI CRE Reserve on existing fisheries and communities could be considerable. Before the NWHI CRE Reserve was established, there were no existing permitted coral reef fisheries in operation. Therefore, no such fishery would be allowed in the NWHI under the conservation measures of the NWHI EOs.

NWHI bottomfish landings could be significantly reduced, depending on how areas closed to bottomfishing within the Reserve Preservation Areas are converted from fathoms to longitude-

latitude straight lines. In addition, the annual landings permitted by individual permit holders may also be reduced depending on how fishing quotas are calculated. The NWHI bottomfish fishery is a mixed fishery with vessels entering and exiting the fishery as result of opportunities in other fisheries, such as pelagic handline and trolling. It has an ex-vessel value of more than $1 million per year and provides 44% of all commercial bottomfish landed in the state. The fishery's 17 non-transferrable limited entry permits could be eliminated as they are nullified through attrition, due to the assimilation of existing annual trip and landing requirements with the allocation of individual fishing quotas as determined by the December 4, 2000 NWHI EO. The allocation of individual fishing quotas are to be determined by the NWHI CRE Reserve Council.

Apart from simply closing areas to fishing, the CRE Reserve will constrain fishing operations in adjacent open areas. Due to the high bathymetric relief of NWHI reefs and banks, the lack of accurate soundings for those reefs and banks, and current bottomfish fishing techniques, the conversion of straight-line boundary closures based on 25 or 50 fathom contours will likely have the effect of a 100-fathom contour closure. In order to successfully target bottomfish, a vessel must be able to operate on either side of the preferred target depth because the vessel may be in shallow waters while the actual lines are in much deeper waters.

The bottomfish fishery also targets *uku*, a bottomfish associated with the shallow-water species complex. During certain years, large quantities of *uku* are caught by bottomfishing and trolling in waters ranging between 15-30 fathoms. Between 1995 and 1998, *uku* contributed 18%, 20%, 11% and 17% of the total NWHI bottomfish landings respectively (WPRFMC 1999b). The NWHI Reserve's restriction of bottomfishing in waters shallower than 25 fm could considerably reduce this component of future bottomfish landings in the EEZ.

Immediate impacts of the NWHI CRE Reserve would include a redistribution of fishing effort to the remaining open bank areas, possibly leading to localized depletion. Displaced fishing vessels could also add to fishing pressure on MHI resources, some of which are believed to be depleted due to fishing pressure from more than 2,500 registered commercial and recreational bottomfish vessels.

Bottomfish species are culturally important to Hawaii residents and economically valuable to the state's visitor industry, which depends on Hawaii's regional cuisine featuring these locally-caught fish as a visitor attraction and marketing tool. Red fish are in demand locally, especially for year-end holidays. Foreign imports may increase to maintain the availability of bottomfish for local markets, which could potentially eliminate small family-owned fishing businesses and fishery support businesses dependent on the fishery.

The NWHI lobster fishery includes 15 limited entry permits and has an ex-vessel value of approximately $1 million or more per year and is the only commercial lobster fishery in the state. The NWHI CRE Reserve would have significant impacts on the NWHI lobster fishery. Caps on commercial fishing catch-and-effort at levels of the year preceding December 4, 2000, and prohibiting fishing in waters shallower than 100 fm could permanently close the NWHI limited entry lobster fishery. Reserve Preservation Areas to 100 fathoms (similar to Alternative 4) would

close all productive lobster grounds, because fishing generally takes place in 10-40 fm. The small-business permit holders are expected to incur a substantial economic loss.

The management provisions of the Crustaceans FMP and the annual harvest guidelines allow removal of only 13 percent of the total lobster population. Depending on the interpretation of the year preceding December 4, 2000, the NWHI EO may cap this fishery's harvest level at zero. As a result, the long-term effect of NWHI EO closure on the target species would be mainly a function of cyclical climate and oceanographic conditions that affect the recruitment dynamics of lobster.

With respect to precious corals, the Council has recommended adoption of a precious corals mega-reserve, which sets aside an area over 250 miles long to a depth of 750 fm—including Necker through French Frigate Shoals—where harvesting of pink, red, and gold precious coral would be banned. Harvest of gold precious coral, will also be banned throughout the entire NWHI.

The provision of the NWHI EOs to cap commercial fishing at levels of catch and effort of the year preceding December 4, 2000, could close two-thirds of the deep-water precious coral grounds (175 to 750 fm) surrounding the NWHI EEZ and likely eliminate the potential for domestic harvest in the area. The precious corals fishery is potentially worth $1 million in landed value and an additional $25 million in revenue for associated jewelry businesses (R. Grigg, pers. comm.).

Capping recreational fishing to that taken in the levels of catch and effort of the year preceding December 4, 2000 may preclude any future recreational fishing in the NWHI. There is no current permit or reporting requirement by the state or the federal government for recreational fishing in Hawaii, or in the area encompassed by the NWHI CRE Reserve. Therefore, it is unclear how the recreational fishing level in the NWHI will be determined. Under the rules promulgated under the Crustaceans FMP and the Bottomfish FMP, fishing for, retaining of, or taking of any crustacean or bottomfish management unit species in the NWHI EEZ without a limited access permit issued by PIAO is prohibited. Therefore, recreational take of bottomfish and crustaceans is also expected to be capped at zero.

5.9.4 Consistency with Other Plans and Policies for Existing Fisheries and Communities

The Preferred Alternative (3) is consistent with the requirement of the MSFCMA to define affected fishing communities and to minimize, wherever practicable, adverse economic impacts on these communities.

5.9.5 Mitigation Measures for Effects on Existing Fisheries and Communities

Displacement of existing bottomfish and lobster fishing activity from no-take zones in the NWHI, which would be created under Alternatives 3 and 4, cannot be mitigated by transferring

effort to other fisheries in Hawaii because those fisheries are becoming increasing restricted by state and federal regulations.

5.10 Environmental Consequences for Bioprospecting and Other New Fisheries

Alternative 1 (the No-action alternative) does not recognize bioprospecting as an emerging fishery. Alternative 2 would impose greater inefficiencies and higher costs than the No-action alternative to comply with restrictions on vessel operation in MPAs and other permit conditions. Alternatives 3 (the Preferred Alternative) and 4 would manage bioprospecting through permitting and reporting.

5.10.1 Direct Effects on Bioprospecting

Bioprospecting activities would not be prohibited by any of the alternatives. Even in no-take zones, bioprospecting may be conducted as "scientific research," if a permit is approved by the NMFS RA after consultation with the Council. Restrictions on vessel operation in MPAs and imposing permit and reporting requirements could create inefficiencies and add to the cost of bioprospecting. Such enterprises are generally well financed, however. Even if novel techniques are employed to collect samples for laboratory screening, unevaluated collection methods using gear not currently on the allowable gear list could be approved after evaluation of the potential for adverse effects. The effects of Alternatives 2, 3, and 4, therefore, differ little from those of the No-action alternative.

5.10.2 Indirect Effects on Bioprospecting

Alternatives 3 and 4, which broadly designate no-take zones, conserve a large reservoir of diverse genetic material of potential interest to bioprospecting operations seeking small samples of diverse organisms to screen for bioactive properties. Biodiversity may be reduced as a result of fishing activities under Alternatives 1 (No-action) and 2.

5.10.3 Cumulative Effects on Bioprospecting and Other New Fisheries

Due to the high profile of bioprospecting enterprises, advocate groups have been active in controlling this industry and protecting the rights of indigenous populations throughout the world. It has become common practice for the industry to write detailed contracts with local and indigenous groups, which strictly regulate harvest, negotiate up-front royalties for successful products, train local people to join the industry, and offer assistance in environmental protection.

The NWHI Reserve will preclude future opportunities for bioprospecting and other commercial coral reef fisheries, as none existed in the year preceding the EO. In addition, the designation of nearly all of the coral reef habitat to 100 fm as Reserve Preservation Areas would preclude future sustainable harvesting of coral reef ecosystem resources in the NWHI, with the exception of bottomfish. As a result, the potential economic gains lost to Hawaii could be significant. As an example, due to the uncertainties of the outcome of the NWHI EO and the reduction of other Hawaii based commercial fisheries due to litigation, the commercial fishing industry has not

reserved a single lease in the State of Hawaii's new $13 million dollar commercial fishing facility. Should the NWHI EO be fully implemented, it is unlikely that the commercial fishing facility will be leased by Hawaii's commercial fishing industry or its investors.
The NWHI Reserve provision to cap recreational fishing to previous year levels may preclude any future recreational fishing, an activity believed to have considerable future economic value to the State of Hawaii as a new or expanded fishery in the NWHI. State and federal governments do not have any permit or reporting requirements for recreational fishing in Hawaii. Thus, it is unclear how the year 2000 recreational fishing level in the NWHI will be determined, but it is expected that it will be capped at zero.

5.10.4 Consistency with Other Plans and Policies

The Convention on Biological Diversity, drafted at the Rio Earth Summit, recommends strong measures of protection against harmful bioprospecting, which the Council, under the Coral Reef Ecosystem FMP management regime, will be able to ensure.

5.10.5 Mitigation Measures for Effects on Bioprospecting

If environmental fluctuations or other natural or human factors change resource conditions so that harvesting presents a higher risk, timely preventive action can be taken under the framework adjustment procedures included in the established FMPs for bottomfish, crustaceans, and precious corals and in Alternatives 2, 3 (the Preferred Alternative), and 4. Changes in MPA boundaries and designations, the number of special permits or their conditions of use, or allowable fishing gears and methods could be implemented through amendments to the CRE-FMP (the Preferred Alternative), or under Alternative 2.

5.11 Environmental Consequences for Non-Consumptive Values and Uses

Alternatives 3 and 4 may provide greater opportunities for research than Alternatives 1 (No-action) and 2 because they better conserve coral reef organisms. However, opportunities for marine recreation by the general public may be somewhat limited in the new no-take zones designated under Alternatives 3 (the Preferred Alternative) and 4 because some of these zones are located in remote areas of the EEZ that are relatively inaccessible and, in some cases, off limits to the general public. On the other hand, the increased protection provided to the coral reef ecosystem in Alternatives 3 and 4 would help maintain coral reef habitats in their natural state and allow the development of ecotourism. None of the alternatives would restore or prevent new degradation of reef habitat and environmental quality in nearshore reef areas managed by island governments.

5.11.1 Direct Effects on Non-Consumptive Values and Uses

Alternatives 3 and 4, which designate no-take zones in remote areas of the EEZ, would conserve a large reservoir of relatively undisturbed coral reef resources and habitats with high non-consumptive values. However, these areas are relatively inaccessible and are generally off limits

to the public, except at Midway atoll, so there would be little change in impact from the No-action alternative. Under Alternatives 3 and 4, the opportunities for research of undisturbed coral reef baseline conditions would increase significantly above the level provided under Alternatives 1 (the No-action alternative), or Alternative 2. Broader designation of no-take zones under Alternatives 3 and 4 could emphasize underwater viewing and other non-consumptive activities in more accessible areas of the EEZ, but deeper boundaries would be well below safe scuba diving depths. The resulting benefits for non-consumptive values and uses would be greater under Alternatives 3 and 4 than those provided by Alternatives 1 and 2.

5.11.2 Indirect Effects on Non-Consumptive Values and Uses

None of the alternatives would directly mitigate adverse effects on coral reef habitats and environmental quality in nearshore areas under island government jurisdiction. However, designation of EFH and implementation of the CRE-FMP would mandate EFH consultations by NMFS and the Council for any proposed federal activity that has the potential for significant adverse effects. The consultation procedure produces greater benefits than the No-action alternative.

5.11.3 Cumulative Effects on Non-Consumptive Values and Uses

Alternatives that would affect reefs only in remote and inaccessible areas of the EEZ would contribute less to cumulative effects than Alternative 4, which affects reefs throughout the EEZ. Only fishing activities in the EEZ are managed by FMPs, which monitor for possible adverse effects on EFH and adjust management as necessary. The majority of reefs affected by management measures in the CRE-FMP are in remote areas far removed from terrestrial activities and impacts. Because of their inaccessibility, access for non-consumptive recreation is restricted. The no-take zones designated under Alternatives 3 and 4 would benefit research by allowing researchers to compare undisturbed baseline conditions with coral reefs that are heavily exploited.

Several factors already mentioned in this chapter also have cumulative effects on non-consumptive values. First, none of the alternatives apply in nearshore areas managed by state governments. These are the areas most affected by terrestrial and coastal activity. However, the CRE-FMP (the Preferred Alternative) would implement a consultation procedure for federal activities affecting EFH. This would help mitigate some impacts to fish stocks in nearshore areas.

Second, storms can reduce coral cover by as much of 10% in some parts of the NWHI (R. Grigg, comm. at June 14, 2000 Council meeting). (If storms are infrequent, coral cover can eventually increase to near normal levels.) Considering these large perturbations, the impact of fishing gear allowed under the Bottomfish, Crustaceans, and Precious Corals FMPs, and also those allowed under the Preferred Alternative (CRE-FMP) would not significantly affect non-consumptive values.

Third, allowances for cyclical oceanographic events that affect productivity (also see Section 3.2.1,) are not directly incorporated in any alternative, but the Preferred Alternative (the CRE-FMP) includes a framework procedure for timely and rapid regulatory adjustments based on feedback from monitoring of changing fisheries and resource conditions.
Finally, the stated management principles of the NWHI CRE Reserve—which include enhancing public awareness, and understanding and appreciation of the Reserve—appear to promote a shift from commercial fishing to tourism and indigenous uses. In support of these principles, the NWHI Reserve Operations Plan prioritizes the identification of potential tourism, recreational, and commercial activities in the Reserve. These activities could cause more damage to the reef habitat and protected species than commercial fishing. Possible impacts include diver damage to live corals and hooking of monk seals by recreational fishing activities. An associated increase in visitors, boats, and infrastructure could have negative impacts on habitats, resulting from vessel grounding and anchor damage, for example. The NWHI CRE Reserve has a considerable budget and plans to construct warehouses on French Frigate Shoals (one of the most important NWHI areas for endangered Hawaiian monk seals and the main nesting areas for the green sea turtle) and Midway Atoll (which is not part of the Reserve) for boats and related field supplies. On the other hand, frequent field trips would promote the NWHI CRE Reserve and support goals for research, and development of education materials and cultural studies, however, the logistics of these field activities would increase the degree and frequency of disturbance and compound the environmental impacts.

5.11.4 Consistency with Other Plans and Policies for Non-Consumptive Values and Uses

The Preferred Alternative is consistent with the 10-year target of the U.S. Coral Reef Task Force to designate 20% of reefs in U.S. waters as no-take MPAs.

5.11.5 Mitigation Measures for Effects on Non-Consumptive Values and Uses

As discussed elsewhere in this chapter, coordination of the Council's different FMP plan teams—a measure in the Preferred Alternative—would allow rapid identification of fishery-related impacts to coral reefs. The framework procedures that are part of all of the Council's FMPs, and the CRE-FMP as well, would allow rapid adjustment in response to changes in the fishery or environmental conditions. Management measures can also be adjusted through amendments to the FMPs.

5.12 Environmental Consequences for Administration and Enforcement of Regulations

Alternative 1 (the No-action alternative) would not add new responsibilities or costs to existing administration and enforcement burdens. Low-level surveillance of remote coral reef areas of the EEZ would continue. Therefore, it would be difficult to prosecute violators of island government regulations who claim that the illegal activity occurred in the adjacent EEZ. Alternatives 2, 3,

and 4 would significantly increase responsibilities and costs, but with positive conservation benefits for coral reef ecosystems.

5.12.1 Direct Effects on Administration and Enforcement

Implementation of Alternatives 2 and 3 would be technically complex because of their special permit regime, which covers fishing in low-use MPAs and catching potentially-harvested coral reef resources. The cost of administration and enforcement under these alternatives would be much greater than costs under Alternative 1 (the No-action alternative) because each permit is customized to the proposed activity. Scientists and Council members would have to evaluate all applications before special permits are approved. A large number of applications could overwhelm and delay permit review and administration. Additional responsibilities and costs for permitting would not be incurred under Alternative 1 (the No-action alternative).

The enforcement of MPA boundaries would be simpler if the boundaries were delineated by grids or centroids rather than depth limits, and if there were no-take zones rather than different zones for a range of uses. Live rock harvest controls have similar enforcement issues. A prohibition on possession is simpler to enforce than a prohibition on commercial collection or exemptions for aquaculture brood stock and indigenous use. No new responsibilities or additional costs would be incurred under Alternative 1 (the No-action alternative).

At-sea enforcement of MPA zoning is likely to require additional air and sea patrols. Additional patrols would cost as much as $100,000 per air patrol and $250,000 per surface patrol (WPRFMC 1999a). No additional costs would be incurred under Alternative 1 (the No-action alternative).

5.12.2 Indirect Effects on Administration and Enforcement

If substantial fishing activity is displaced from the NWHI as a result of broad designation of no-take MPAs under Alternatives 3 (the Preferred Alternative) and 4, administrative and enforcement costs associated with permitting, data collection, and observer coverage in the limited entry programs for FMP-managed bottomfish and lobster fisheries could be reduced below present levels (i.e., the No-action alternative). Broad designations of no-take zones in the NWHI that displace existing fishing activities would remove any incentive for fishermen to self-monitor domestic fishing activity, and such designations would also eliminate opportunities for fishermen to report illegal foreign and domestic fishing activity that may occur in the EEZ. These are both negative enforcement impacts of Alternatives 3 and 4 compared to Alternatives 1 (the No-action alternative) and 2.

EFH designations in the Preferred Alternative would be implemented through consultations by NMFS and the Council with federal agencies proposing or conducting activities with the potential for adverse impacts on EFH. Such consultations may help avoid or mitigate some of the adverse effects that are currently occurring in nearshore reef areas under Alternative 1 (the No-action alternative).

5.12.3 Cumulative Effects on Administration and Enforcement

The complexity of Alternatives 2, 3, and 4 would add significantly to cumulative responsibilities and costs of fishery administration, surveillance, and enforcement for fisheries managed by FMPs. Separate jurisdictions and competing missions could hinder implementation of alternatives designating MPAs. It is likely that the process of developing inter-agency, inter-governmental and public-private relationships needed for ecosystem-scale management of coral reefs would be time consuming and costly.

The provisions of the EO for the NWHI CRE Reserve most closely parallel Alternative 4. The complex system of prohibitions and restrictions as defined in the NWHI EOs will be an even greater enforcement burden that Alternatives 3 or 4 of the FMP. Monitoring the additional restrictions, individual fishing caps on levels of catch and effort, closed RPA boundaries, and various exemptions would be expected to further increase the burden for administration and enforcement of regulations. At present enforcement agencies are unable to develop and implement an enforcement plan for the NWHI CRE Reserve, due to ambiguity of some of the conservation measures. Existing resources of enforcement agencies are already strained.

5.12.4 Consistency with Other Plans and Policies for Administration and Enforcement

Permit Alternatives 2-4 (including the Preferred Alternative), which exempt permit holders operating under established FMPs for bottomfish, crustaceans, and precious corals, avoid a duplication of administrative and enforcement costs stemming from their implementation.

In most areas of the NWHI where MPAs would be designated, the State of Hawaii could take action to extend no-take zones from the shoreline to 3 nm offshore. The implementation of alternatives to designate MPAs within 3 nm of shore would require an unprecedented level of cooperation among agencies and levels of government that have different jurisdictions and missions.

5.12.5 Mitigation of Effects on Administration and Enforcement

High enforcement costs could be moderated through use of VMS. MPA boundaries based on depth will be extremely difficult to enforce unless VMS is required for all fishing vessels. NMFS and the USCG already operate a Honolulu-based VMS to monitor compliance in the pelagic longline and NWHI lobster fisheries. Additional costs would be incurred if the existing VMS was expanded to accommodate the additional vessel and area coverage associated with MPA designations.

The Preferred Alternative (3) includes a framework procedure for adaptive management. This could be useful in streamlining the permit process, possibly by moving away from burdensome prerequisites and conditions toward performance standards that create positive incentives for innovation to minimize potential adverse fishery impacts. Such an approach would reduce the regulatory burden on fishermen, managers and law enforcement personnel.

Fishery Management Plans for other western Pacific fisheries have often served as a catalyst for better coordinated fishery management across jurisdictional borders. An example is the deep-slope bottomfish fishery in Hawaii. A limited access program for the EEZ around the NWHI was implemented under the Bottomfish and Seamount Groundfish FMP, but no regulations were imposed on bottomfishing activity in the EEZ adjacent to the MHI because the latter area has been traditionally managed by the State of Hawaii. After monitoring of the overall fishery documented localized overfishing of two deepwater snapper populations in the MHI, the State developed and implemented an ambitious plan for area closures to rebuild local bottomfish populations around the MHI.

Data collection is a necessary part of the adaptive management procedure included in the CRE-FMP. Some of the associated costs may be reduced by involvement of the fishing industry and other parties, such as university researchers and volunteers, but the costs will still exceed those of the No-action alternative. The Council has established an education and public outreach program for all FMP-managed fisheries. The program is being expanded to raise public awareness of coral reef ecosystems and to improve compliance with regulations controlling the harvest of coral reef resources.

5.13 Summary of Impacts

5.13.1 Environmental Effects of the Alternatives

The four alternatives respond to resource issues and concerns differently, and as such, have different environmental effects. The impacts of each alternative on the environmental components likely to be affected by management activities are summarized for comparative purposes in Table 5.2.

Table 5.2: Summary and comparison of effects of alternatives.

Target Stocks	
Alternative 1 (No-action):	All species currently harvested under established FMPs are above overfishing threshold. Changing conditions and environmental fluctuations are closely monitored and management is adapted as necessary. Does not prevent overfishing of potentially-harvested resources or of nearshore stocks managed by island governments.
Alternative 2 (Minimal Additional Protection):	All species currently harvested under established FMPs are above overfishing threshold. Changing conditions and environmental fluctuations are closely monitored and management is adapted as necessary. Does not prevent overfishing of potentially-harvested resources or of nearshore stocks managed by island governments.
Alternative 3 **Preferred Alternative (Substantial Additional Protection):**	Depending on zoning plan, some NWHI bottomfishing effort may be redirected from no-take areas to fully exploited stocks elsewhere. Spawning populations in MPAs might restock other areas connected through recruitment. Does not prevent overfishing of potentially-harvested resources or of nearshore stocks managed by island governments.
Alternative 4 (Maximum Protection):	All bottomfishing and lobster trapping effort in the EEZ would be prohibited. Spawning populations in MPAs could restock other areas connected through recruitment. Does not prevent overfishing of potentially-harvested resources or of nearshore stocks managed by island governments.

Non-target Resources	
Alternative 1 (No-action):	Bycatch currently harvested is reported under established FMPs. Food web effects are unknown but overshadowed in NWHI by high level of predation by jacks. Changing conditions and environmental fluctuations are closely monitored and management is adapted as necessary. Fails to prevent overfishing of potentially-harvested resources or of nearshore stocks managed by island governments.
Alternative 2 (Minimal Additional Protection):	Bycatch currently harvested is reported under established FMPs. Food web effects are unknown but overshadowed in NWHI by high level of predation by jacks. Changing conditions and environmental fluctuations are closely monitored and management is adapted as necessary. Fails to prevent overfishing of potentially-harvested resources or of nearshore stocks managed by island governments.
Alternative 3 **Preferred Alternative (Substantial Additional Protection):**	Small reduction in fishing mortality may occur in some areas but impact may not be detectable against natural population fluctuations. Spawning populations in MPAs could restock other areas connected through recruitment. Does not prevent overfishing of potentially-harvested resources or of nearshore stocks managed by island governments.
Alternative 4 (Maximum Protection):	Elimination of fishing mortality would occur in areas shallower than 100 fm. Spawning populations in MPAs could restock other areas connected through recruitment. Does not prevent overfishing of potentially-harvested resources or of nearshore stocks managed by island governments.

Live Rock, Coral, Essential Fish Habitat (EFH), and Environmental Quality	
Alternative 1 (No-action):	Destructive gears are prohibited in existing FMP-managed fisheries. Effects on EFH are closely monitored and management is adapted as necessary. Low potential for damage to EFH or coral from existing fishing or anchoring methods. Island governments regulate live rock and stony coral collection in nearshore reef areas. Fails to prevent large-scale removal of live rock/stony coral in EEZ. Continues present level of risk of vessel grounding. Does not mitigate marine debris impacts caused by derelict fishing gear drifting into region from North Pacific fisheries. Fails to restore or prevent new degradation of nearshore reef habitat managed by island governments. Does not mitigate or prevent impacts from coastal construction, watershed management, shoreline erosion or water pollution.
Alternative 2 (Minimal Additional Protection):	Destructive gears are prohibited in existing FMP-managed fisheries. Effects on EFH are closely monitored and management is adapted as necessary. Low potential for damage to EFH or coral from existing fishing or anchoring methods. Island governments regulate live rock and stony coral collection in nearshore reef areas. Fails to prevent large-scale removal of live rock/stony coral in EEZ. Continues present level of risk of vessel grounding. Does not mitigate marine debris impacts caused by derelict fishing gear drifting into region from North Pacific fisheries. EFH consultation may help mitigate or prevent impacts from coastal construction, watershed management, shoreline erosion or water pollution.
Alternative 3 **Preferred Alternative (Substantial Additional Protection):**	Positive impact – MPAs would encompass large tracts of relatively undisturbed reef habitat in remote areas. Potential for vessel groundings or anchoring to degrade reef habitat is reduced in some areas. Fails to restore or prevent new degradation of nearshore reef habitat managed by island governments. EFH consultation may help mitigate or prevent impacts from coastal construction, watershed management, shoreline erosion or water pollution. Does not mitigate marine debris impacts caused by derelict fishing gear drifting into region from North Pacific fisheries.

Live Rock, Coral, Essential Fish Habitat (EFH), and Environmental Quality	
Alternative 4 (Maximum Protection):	Positive impact – MPAs would encompass large tracts of reef habitat around remote and main inhabited islands. Potential for vessel groundings or anchoring to degrade reef habitat is reduced in some areas. Fails to restore or prevent new degradation of nearshore reef habitat managed by island governments. EFH consultation may help mitigate or prevent impacts from coastal construction, watershed management, shoreline erosion or water pollution. Does not mitigate marine debris impacts caused by derelict fishing gear drifting into region from North Pacific fisheries.

National Wildlife Refuge Resources	
Alternative 1 (No-action):	Shallow reefs adjacent to National Wildlife Refuge islands would continue to function as *de facto* MPAs. Continues present level of risk of vessel grounding. Does not mitigate marine debris impacts caused by derelict fishing gear drifting into region from North Pacific fisheries.
Alternative 2 (Minimal Additional Protection):	Provides some additional protection to these resources by creating a low-use MPA around the NWHI to a depth of 50 fm.
Alternative 3 **Preferred Alternative (Substantial Additional Protection):**	Reinforces the no-take status of NWR resources and provides a higher level of protection by enlarging no-take zones off two islands in the Hawaiian Islands NWR and off all NWR islands in the Pacific remote island areas. Does not mitigate marine debris impacts caused by derelict fishing gear drifting into region from North Pacific fisheries.
Alternative 4 (Maximum Protection):	Provides the most protection to National Wildlife Refuge resources by creating a no-take MPA throughout the region's EEZ in all areas shallower than 100 fm. Does not mitigate marine debris impacts caused by derelict fishing gear drifting into region from North Pacific fisheries.

Protected Species – Hawaiian Monk Seal	
Alternative 1 (No-action):	Risk of direct impact from gear in FMP-managed fisheries and indirectly from food competition in NWHI is low but remains unchanged. Fails to mitigate marine debris impacts caused by derelict fishing gear drifting into region from North Pacific fisheries.
Alternative 2 (Minimal Additional Protection):	Risk of direct impact from gear in existing FMP-managed fisheries and indirectly from food competition in NWHI is reduced by establishing low-use MPAs to a depth of 50 fm around all NWHI.
Alternative 3 **Preferred Alternative (Substantial Additional Protection):**	Provides a higher level of protection by enlarging no-take zones off the two islands that are most important for breeding by the endangered Hawaiian monk seal in NWHI. Potential direct impacts near breeding areas and indirect food competition in NWHI would be reduced. Depending on zoning plan, potential for vessel groundings to degrade critical habitat is reduced in some areas. Fails to mitigate marine debris impacts caused by derelict fishing gear drifting into region from North Pacific fisheries.
Alternative 4 (Maximum Protection):	Provides the highest level of protection by enlarging no-take zones off the two islands that are most important for breeding by the endangered Hawaiian monk seal in NWHI. Potential direct impacts near breeding areas and indirect food competition in NWHI would be greatly reduced. Depending on zoning plan, potential for vessel groundings to degrade critical habitat is reduced in some areas. Fails to mitigate marine debris impacts caused by derelict fishing gear drifting into region from North Pacific fisheries.

Protected Species – Sea Turtles	
Alternative 1 (No-action):	No change in impact. Fails to mitigate large take of green turtles in main Hawaiian Islands' shoreline fishery or degradation of nesting habitat in American Samoa. Fails to mitigate marine debris impacts caused by derelict fishing gear drifting into region from North Pacific fisheries.
Alternative 2 (Minimal Additional Protection):	Risk of direct impact from gear in existing FMP-managed fisheries in the NWHI is reduced by establishing low-use MPAs to a depth of 50 fm around all NWHI. Depending on zoning plan, potential for vessel groundings to degrade nesting habitat is reduced. Fails to mitigate large take of green turtles in main Hawaiian Islands' shoreline fishery or degradation of nesting habitat in American Samoa. Fails to mitigate marine debris impacts caused by derelict fishing gear drifting into region from North Pacific fisheries.
Alternative 3 **Preferred Alternative (Substantial Additional Protection):**	Provides a higher level of protection from gear interactions by enlarging no-take zones. Depending on zoning plan, potential for vessel groundings to degrade nesting habitat is reduced. Fails to mitigate large take of green turtles in main Hawaiian Islands' shoreline fishery or degradation of nesting habitat in American Samoa. Fails to mitigate marine debris impacts caused by derelict fishing gear drifting into region from North Pacific fisheries.
Alternative 4 (Maximum Protection):	Provides the highest level of protection from gear interactions by enlarging no-take zones. Depending on zoning plan, potential for vessel groundings to degrade nesting habitat is reduced in some areas. Fails to mitigate large take of green turtles in main Hawaiian Islands' shoreline fishery or degradation of nesting habitat in American Samoa. Fails to mitigate marine debris impacts caused by derelict fishing gear drifting into region from North Pacific fisheries.

Protected Species – Seabirds	
Alternative 1 (No-action):	Low risk of hooking in NWHI and PRIA continues at same level. Fails to mitigate marine debris impacts caused by derelict fishing gear drifting into region from North Pacific fisheries.
Alternative 2 (Minimal Additional Protection):	Low risk of hooking in NWHI and PRIA continues at same level. Fails to mitigate marine debris impacts caused by derelict fishing gear drifting into region from North Pacific fisheries.
Alternative 3 Preferred Alternative (Substantial Additional Protection):	Low risk of hooking in NWHI and PRIA continues at same level. Fails to mitigate marine debris impacts caused by derelict fishing gear drifting into region from North Pacific fisheries.
Alternative 4 (Maximum Protection):	Low risk of hooking in NWHI and PRIA continues at same level. Fails to mitigate marine debris impacts caused by derelict fishing gear drifting into region from North Pacific fisheries.

Protected Species – Non-endangered Marine Mammals	
Alternative 1 (No-action):	Low impact but dolphin interaction rate in hook-and-line fisheries would continue at same level.
Alternative 2 (Minimal Additional Protection):	Low impact but dolphin interaction rate in hook-and-line fisheries would continue at same level.
Alternative 3 Preferred Alternative (Substantial Additional Protection):	Low impact but dolphin interaction rate in hook-and-line fisheries would be reduced in no-take MPAs.
Alternative 4 (Maximum Protection):	Low impact but dolphin interaction rate in hook-and-line fisheries would be reduced in no-take MPAs.

Reef Ecosystem Biodiversity, Structure, and Function	
Alternative 1 (No-action):	Fails to prevent loss of biodiversity, undesirable changes in species dominance or introduction of invasive exotic species.
Alternative 2 (Minimal Additional Protection):	Slight positive impact--low-use MPAs would encompass areas of relatively undisturbed remote reef habitat. Fails to prevent the introduction of invasive alien species on derelict gear drifting into the region from the North Pacific. Fails to prevent loss of biodiversity or undesirable changes in species dominance in nearshore coral reef ecosystems managed by island governments.
Alternative 3 Preferred Alternative (Substantial Additional Protection):	Strong positive impact – low-use and no-take MPAs would encompass large tracts of relatively undisturbed remote reef habitat. A large reservoir of unexploited genetic material would be conserved. Fails to prevent the introduction of invasive alien species on derelict gear drifting into the region from the North Pacific. Fails to prevent loss of biodiversity or undesirable changes in species dominance in nearshore coral reef ecosystems managed by island governments.
Alternative 4 (Maximum Protection):	Strongest positive impact – No-take MPAs would encompass large tracts of relatively undisturbed remote reef habitat. A large reservoir of unexploited genetic material would be conserved. Fails to prevent the introduction of invasive alien species on derelict gear drifting into the region from the North Pacific. Fails to prevent loss of biodiversity or undesirable changes in species dominance in nearshore coral reef ecosystems managed by island governments.

Existing Fisheries and Communities	
Alternative 1 (No-action):	Continue present effects
Alternative 2 (Minimal Additional Protection):	Very little impact on existing fisheries and fishing communities.
Alternative 3 Preferred Alternative (Substantial Additional Protection):	No-take and low-use MPAs would increase adverse impacts on existing fisheries and fishing communities by displacing existing bottomfish and lobster fishing effort around some NWHI where the seaward boundary of no-take zones would extend to a depth of 50 fm. Existing NWHI fisheries would be displaced in some areas and fishing costs would be increased.
Alternative 4 (Maximum Protection):	No-take MPAs would greatly increase adverse impacts on existing fisheries and fishing communities by displacing existing bottomfish and lobster fishing effort around some NWHI where the seaward boundary of no-take zones would extend to a depth of 100 fm. Existing NWHI bottomfish and crustacean fisheries would be closed.

Bioprospecting and Other New Fisheries	
Alternative 1 (No-action):	No impact.
Alternative 2 (Minimal Additional Protection):	Very little impact.
Alternative 3 Preferred Alternative (Substantial Additional Protection):	New fisheries would be prohibited in some areas within the EEZ.
Alternative 4 (Maximum Protection):	New fisheries would be prohibited throughout the EEZ

Native Cultures and Environmental Justice	
Alternative 1 (No-action):	Fails to prevent decline of customary and traditional uses in nearshore areas closed to traditional fishing by island governments. Green turtles cannot be harvested for customary and traditional uses.
Alternative 2 (Minimal Additional Protection):	Fails to prevent decline of customary and traditional uses in nearshore areas closed to traditional fishing by island governments. Green turtles cannot be harvested for customary and traditional uses.
Alternative 3 **Preferred Alternative (Substantial Additional Protection):**	Would provide preferential access to indigenous zones in low-use MPAs designated immediately and in the future in the EEZ around U.S. Pacific islands. Would also increase indigenous participation in the coral reef management process for the EEZ around the NWHI and elsewhere. Therefore, less negative effects on native cultures than Alternative 1 (No-action). Financial institutions may view MPAs as creating too much risk and cost for new indigenous fishing enterprises. Green turtles cannot be harvested for customary and traditional uses.
Alternative 4 (Maximum Protection):	Would prohibit all fishing activities in waters shallower than 100 fm and would decrease indigenous participation in coral reef fisheries conducted in the EEZ throughout the Region. No-use MPAs close to main inhabited islands and in waters shallower than 100 fm would displace most customary and traditional coral reef fisheries. Therefore, has greater negative effects on native cultures than Alternatives 1, 2, or 3. Financial institutions are likely to view MPAs as creating too much risk and cost for new indigenous fishing enterprises. Green turtles cannot be harvested for customary and traditional uses.

Non-consumptive Values and Uses	
Alternative 1 (No-action):	No change in impacts. Island governments regulate live rock and stony coral collection in nearshore reef areas. Fails to prevent large-scale removal of live rock/stony coral in EEZ. Fails to restore or prevent new degradation of environmental quality in nearshore reef areas managed by island governments. Does not mitigate or prevent impacts from coastal construction, watershed management, shoreline erosion or water pollution.
Alternative 2 (Minimal Additional Protection):	Some positive impacts--low-use MPAs would encompass large tracts of relatively undisturbed reef habitat with high environmental quality. Fails to restore or prevent new degradation of environmental quality in nearshore reef areas managed by island governments. Does not mitigate or prevent impacts from coastal construction, watershed management, shoreline erosion or water pollution.
Alternative 3 **Preferred Alternative (Substantial Additional Protection):**	Strong positive impact – No-take and low-use MPAs would encompass large tracts of relatively undisturbed reef habitat with high environmental quality. Some areas may be accessible in the future for ocean recreation. Would provide undisturbed sites for surveying baseline characteristics of coral reefs. Fails to restore or prevent new degradation of environmental quality in nearshore reef areas managed by island governments. Does not mitigate or prevent impacts from coastal construction, watershed management, shoreline erosion or water pollution.
Alternative 4 (Maximum Protection):	Strongest positive impact – No-take MPAs would encompass large tracts of relatively undisturbed reef habitat with high environmental quality. Some areas may be accessible in the future for ocean recreation. Would provide undisturbed sites for surveying baseline characteristics of coral reefs. Fails to restore or prevent new degradation of environmental quality in nearshore reef areas managed by island governments. Does not mitigate or prevent impacts from coastal construction, watershed management, shoreline erosion or water pollution.

Administration and Enforcement of Regulations	
Alternative 1 (No-action):	No added responsibilities or costs. Continued low level of surveillance of remote reefs and difficulties in preventing violations of island government regulations.
Alternative 2 (Minimal Additional Protection):	Definition of seaward boundaries following 50 fm isobath complicates enforcement more than grid or circle definitions.
Alternative 3 Preferred Alternative (Substantial Additional Protection):	Definition of seaward boundaries following 50 fm isobath complicates enforcement more than grid or circle definitions.
Alternative 4 (Maximum Protection):	Definition of seaward boundaries following 100 fm isobath complicates enforcement more than grid or circle definitions.

5.13.2 Resource Tradeoffs

Short-Term Uses Versus Long-Term Productivity

Short-term uses generally determine the present quality of life for the public. In coral reef ecosystems, short-term uses include fishing and ocean recreation. The quality of life for future generations depends on continued productivity of coral reef resources, and for Pacific Island populations, the perpetuation of communities and cultures that are dependent on fishing and seafood. Long-term productivity refers to the capability of the ecosystem to provide resources on a sustainable basis. Management activities proposed by the CRE-FMP (the Preferred Alternative) could reduce the natural productivity of some coral reef areas in order to acquire new information and improve understanding and management of resources. The extent to which long-term productivity will be affected is not known because monitoring of these effects has only recently begun. However, it is known that coral reef management practices have the potential to reduce natural productivity if certain operating guidelines are not followed.

Control measures in all alternatives were specifically designed to meet the management standards of the MSFCMA and to prevent unacceptable degradation of coral reef resources. Monitoring will determine whether the control measures are effective and are being correctly applied. Alternatives 2-4 emphasize marine protected areas, gear restrictions to prevent destructive and non-selective fishing methods, and detailed permit control over new activities taking potentially-harvested resources about which little is known. These alternatives are less likely, therefore, to adversely affect long-term productivity than the No-action alternative. The framework procedure in the CRE-FMP allows managers to make rapid and timely regulatory adjustments in response to changing fisheries, resource conditions, and environmental fluctuations.

Unavoidable Adverse Effects

Implementation of any alternative may result in some adverse environmental effects that cannot be avoided. Control measures in all alternatives are intended to keep the extent and duration of these effects within acceptable levels but adverse effects cannot be completely eliminated. The following adverse environmental consequences would be associated with some of the alternatives:

- Displacement of some existing fishing effort from within no-take MPAs to areas outside such MPAs, and possible redirection of this effort to fully exploited coral reef resources elsewhere.

- Increased costs to fishermen who have to travel farther to fish in open areas, and have to comply with special permit, reporting, and insurance requirements for fishing vessel passage through MPAs.

- Increased governmental responsibilities and costs for administration, monitoring, and enforcement of proposed new federal regulations.

- Continuing degradation of essential fish habitat and adverse effects on coral reef resources in non-EEZ areas, and by non-fishing activities that cannot be directly managed under present MSFCMA authority.

Irreversible Resource Commitments

Irreversible commitments of resources are actions that disturb either a non-renewable resource—such as endangered species or cultural resources—or a renewable resource to the point that it can only be renewed over 100 years or more. (It may take slow-growing reef-building coral species this long to recover, for example). Measures to protect resources that could be irreversibly affected by other resource uses were incorporated into the Preferred Alternative. A summary of the major irreversible commitments of resources, and how they would be prevented, follows.

- Large-scale harvesting of live rock and stony corals directly removes major framework-building organisms that form coral reef habitat. Activities that damage reef habitat also cause irreversible losses because reef-building is very slow, often requiring eons to form a consolidated structure. Prohibitions on destructive fishing methods and on commercial collection of live rock and stony corals in Alternatives 3 and 4 are intended to prevent such irreversible losses.

- Loss of biodiversity and undesirable changes in ecosystem structure or function induced by human activities may also constitute irreversible resource commitments. For example, extinction of an endangered species, such as the Hawaiian monk seal, would constitute an irreversible loss. Even management activities undertaken to promote the recovery of endangered species can result in irreversible commitments of other resources. For example, management measures may deny indigenous island populations, who are dependent on fishing for cultural perpetuation, the opportunity to fish.

- Opportunities for research on undisturbed coral reef ecosystems to establish baselines are irreversibly lost once resources are harvested. Alternatives 1 and 2, which do not establish no-take zones, would have the most irreversible commitment of coral reef resources to uses other than baseline research, whereas Alternatives 3 and 4, which establish large no-take zones, would have the least impact.

- The use of fossil fuels for vessel operation and government surveillance and enforcement activities is an irreversible resource commitment. Alternatives with more activities and higher levels of surveillance and enforcement would cause higher consumption of fossil fuels.

Irretrievable Resource Commitments

An irretrievable commitment is the loss of opportunities for production or use of a renewable resource for a period of time. Almost all coral reef resource extraction activities produce varying degrees of irretrievable resource commitments. These commitments parallel the environmental

impacts for each resource summarized earlier in this section. The difference between resource levels under a given alternative and potentially higher levels that could be otherwise produced also represents an irretrievable commitment of resources. The difference in output levels is the opportunity cost, or lost production.

The major tradeoffs among resource output levels that may cause irretrievable commitments are: (1) between utilization of coral reef resources at sustainable levels and complete conservation through "no take;" (2) between multi-resource and single resource management activities; (3) between preventive management and mitigation after damage has occurred; (4) between management activities now or later; and, (5) between economic effects on potential new fisheries and effects on existing fisheries. These tradeoffs require commitments that are irretrievable because opportunities are foregone. The commitments are not irreversible, however, because they could be reversed by changing management direction. To allow for changes in management direction, the Preferred Alternative (3) includes an adaptive procedure. Rapid and timely regulatory adjustments can be made, based on changing fisheries, resource conditions, or environmental fluctuations.

5.14 Environmental Justice

Under Executive Order 12898, dated February 11, 1994, federal agencies are required to address the potential for disproportionately high and adverse environmental effects of their actions on minority and low-income populations. Agencies are required to ensure that their programs and activities that affect human health or the environment do not directly or indirectly use criteria, methods, or practices that discriminate on the basis of race, color, or national origin. NEPA documents are specifically required to analyze effects of federal actions on minority and low-income populations and, whenever feasible, to develop mitigation measures to address significant and adverse effects on such communities. In addition, the Executive Order requires provision of opportunities for community input in the NEPA process. It states that the public, including minority and low-income communities, should have adequate access to public information relating to human health or environmental planning, regulation, and enforcement. (See section 5.8.)

5.15 Significant Cumulative Effects

This section summarizes the cumulative impacts identified earlier in this chapter, in Sections 5.2-5.12. Cumulative effects occur when effects of coral reef management activities combine with effects of other activities to produce a greater net effect than either would if considered separately. Cumulative effects will occur as a result of implementing any alternative. Actions taken under Alternatives 3 and 4 are expected to moderate the cumulative effects of fishery activities. In contrast, measures in Alternatives 1 and 2 could increase cumulative effects. In all alternatives, management standards in the MSFCMA—to prevent overfishing and prevent adverse effects on essential fish habitat—will be met for those resources already being harvested by fisheries managed under the Council's already implemented FMPs. The cumulative effects on coral reef resources vary by alternative, but they depend largely on four factors:

1. The extent to which separate management activities in the EEZ can be integrated to avoid significant adverse effects on potentially-harvested resources and non-target coral reef resources, including protected species, and ecosystem structure and function.

2. The extent to which island governments in the U.S. Pacific implement management standards for state waters to avoid significant adverse effects on currently-harvested, potentially-harvested, and non-target coral reef resources.

3. The extent to which non-fishing activities in the EEZ and in state waters can be managed according to standards that prevent further adverse effects on coral reef habitat.

4. The extent to which adverse effects of fishing and non-fishing activities outside the Western Pacific Region (e.g., marine debris, introduction of invasive alien marine species) can be mitigated through inter-regional and international management.

Four factors contributing to cumulative impacts are considered: natural events, restrictions on fishing, marine debris, and the NWHI CRE Reserve Executive Orders.

In considering the cumulative impacts of the alternatives in this EIS, it is important to remember that the majority of reefs affected by the management measures in the CRE-FMP are in remote areas that are far removed from terrestrial activities and impacts. Thus, none of the alternatives would prevent overfishing of currently-harvested or potentially-harvested coral reef resources in nearshore areas regulated by island governments, nor would they prevent new degradation of EFH in these areas. (However, the EFH consultation procedure that would be implemented by the CRE-FMP will help to mitigate the future potential for adverse effects resulting from proposed federal activities.)

5.14.1 Natural Events

Natural events, such as hurricanes and winter storms or increases or decreases in the nutrient flux into the coral reef system, coupled with fishing pressure and other activities, can cumulatively impact coral reef resources. Storms can also significantly reduce coral cover. At a larger scale, cyclical oceanographic events affect productivity over extensive areas and may account for large fluctuations in population abundance. (El Niño is one example of such a cyclical event.) Coral bleaching is another natural event that can be exacerbated by human activity. Long-term environmental change could expose stony corals to an increasingly hostile environment and possibly lead to extinctions, although healthy corals in areas under less stress may contribute to recovery.

As discussed in the first part of this chapter, this variety of natural events could have a cumulative impact on target and non-target stocks in FMP-managed fisheries, protected species, National Wildlife Refuge Resources, coral reef habitats (including essential fish habitat), and coral reef ecosystems. Degradation of the coral reef ecosystem would also diminish the non-consumptive value of these resources. Alternatives with more extensive and restrictive MPAs

would generally reduce the cumulative impacts stemming from the combination of natural events and human activity. The Preferred Alternative's (CRE-FMP) framework procedure would also allow timely and rapid regulatory adjustments in response to these changes.

5.15.2 Restrictions on Fishing

Current levels of fishing under the Council's already-implemented FMPs appear sustainable. In addition, they have not had a significant impact on protected species, and other marine mammals, associated with the coral reef ecosystem. In particular, bottomfish and lobster fishing do not appear to have any direct or indirect effects that would inhibit the recovery of the Hawaiian monk seal.

Restrictions on fishing could have cumulative impacts on fishing communities and native cultures. Declining catch rates, increasing competition, and unstable markets have already affected fishermen in the region. Measures, such as those considered in the more restrictive alternatives, could reduce their ability to maintain the highly flexible fishing strategy that is important to the economic success of many smaller and medium-sized fishing vessels. Closing some NWHI fishing grounds would further could affect the viability of this strategy. The availability of seafood is important to Hawaii's tourist industry. Any reduction in the availability of locally-caught fish will impact the visitor experience to Hawaii. Not only would this result in some economic loss, resulting changes in lifestyle represent a social cost, assuming that displaced fishermen cannot find an equally satisfactory alternative way of life. Social costs extend to the sense of continuity that might be lost if fishing traditions cease. Pacific Islanders have an important connection with fishing; it cultivates their intimacy and harmony with the ocean. This reinforces their sense of kinship with nature, and their relationships with places that perpetuate cultural identities and beliefs. Increasing restrictions on customary and traditional uses of marine resources are jeopardizing cultural continuity in many areas of the U.S. Pacific.

Management measures in Alternatives 2, 3, and 4 , which restrict fishing, would add significantly to cumulative responsibilities and costs of fishery administration, surveillance, and enforcement. Separate jurisdictions and competing missions could hinder implementation of alternatives designating MPAs. It is likely that the process of developing inter-agency, inter-governmental and public-private relationships needed for ecosystem-scale management of coral reefs would be time consuming and costly.

5.15.3 The NWHI Coral Reef Ecosystem Reserve

The NWHI CRE Reserve, as implemented by Executive Orders, is expected to have cumulative effects in two areas. First, it is expected to reduce or eliminate commercial and recreational fishing in the NWHI. Second, it could increase other activities, with concomitant impacts.

The conservation measures contained in the NWHI EOs would likely reduce all fishing activities in the NWHI, as it caps commercial and recreational fishing to the level of effort and take to the year preceding December 4, 2000. The definition of the year preceding the December 4, 2000

remains undefined however, according to the Code of Federal Register §660. 13, the fishing year for Western Pacific FMP fisheries begins January 1 and ends on December 31. Of the Council's implemented FMP fisheries permitted to operate in the NWHI, only the bottomfish fishery would likely be allowed to continue, but with specific depth restrictions in federal waters in 10 of the 15 Reserve Protection Areas. (The crustacean and precious corals fisheries harvest levels would be capped to zero.) As a result, the NWHI EOs are likely to alleviate much commercial fishing pressure. However, if fishing effort and take remains at levels seen over the past five years, fishing pressure outside the Reserve Preservation Areas could increase, potentially resulting in localized depletions similar to that of the MHI. Cumulative impacts on target species could be significant, but the NWHI EOs are unlikely to have a significant impact on non-target resources. (Fishing based on Midway Atoll NWR is not expected to be affected because it is not part of the NWHI CRE Reserve.)

Apart from simply closing areas to fishing, the Reserve will constrain fishing operations in adjacent open areas. In order to successfully target bottomfish, a vessel must be able to operate on either side of the preferred target depth because the vessel may be in shallow waters while the actual lines are in much deeper waters. The NWHI CRE Reserve's restriction of bottomfishing in waters shallower than 25 fm could also considerably reduce future *uku* landings in the EEZ.

As noted, two other FMP-managed fisheries could be eliminated, even though FMP management provisions promote sustainable harvest. For example, the annual harvest guidelines under Crustaceans FMP allow removal of only 13% of the total lobster population. Closing fishing areas in the NWHI lobster fishery would affect 15 limited entry permits and a fishery with an ex-vessel value of $1 million or more per year. It is the only commercial lobster fishery in the state. Although the precious corals fishery is not yet active in the NWHI, closures could potentially eliminate $1 million in landed value and an additional $25 million in revenue for associated jewelry businesses (R. Grigg, pers. comm.). Interpretation of the NWHI EOs also suggests that recreational take of bottomfish and crustaceans will be capped at zero.

As with the precious corals fishery, the NWHI Reserve will preclude future opportunities for bioprospecting and other commercial coral reef fisheries, as none existed in the year preceding the EO. In addition, the designation of nearly all of the coral reef habitat to 100 fm as Reserve Preservation Areas would preclude future sustainable harvesting of coral reef ecosystem resources in the NWHI, with the exception of bottomfish. As a result, the potential economic gains lost to Hawaii could be significant.

The reduction and elimination of fisheries, resulting from the NWHI CRE Reserve, would have cumulative impacts on economic and social components similar to—although more severe—than those outlined above for fishing restrictions. Unlike the Preferred Alternative (3), the CRE Reserve EOs do not have any provisions for the take of live rock and live coral for cultural and ceremonial purposes. This would be a cumulative impact on native cultures.

Increased visitation, and additional boats and infrastructure planned for the NWHI CRE Reserve, may ultimately have cumulative impacts on protected species, National Wildlife Refuge

resources, coral reef habitat (including EFH), the coral reef ecosystem, and non-consumptive values. However, the cumulative effects of the NWHI CRE Reserve on NWR resources would be expected to be low because it would not impinge on DOI authority over Refuge management. Warehouses may be constructed on French Frigate Shoals (one of the most important NWHI areas for endangered Hawaiian monk seals and primary nesting ground for green sea turtles) and Midway Atoll (which is not part of the Reserve but part of the ecosystem) for boats and related field supplies. The logistics of these field activities could potentially increase the degree and frequency of disturbance and compound environmental impacts on coral reef components. Because Hawaiian monk seals are extremely sensitive to human disturbances, increased field research and management activities on monk seals and in monk seal habitat, related to Reserve operations, could reduce seal survival rates. On the other hand, frequent field trips would promote the Reserve and support goals for research, development of educational materials, and cultural studies.

The conservation measures outlined in the NWHI EOs would prohibit anchoring on any living or dead corals, altering the seabed in any way, and would also prohibit removal of living or non-living marine resources in the NWHI. However, the NWHI EOs provide for exemptions to these restrictions and promotes several resource-dependant activities.

The complex system of prohibitions and restrictions as defined in the NWHI EOs will be an even greater enforcement burden that Alternatives 3 (the Preferred Alternative) or 4 of the FMP.

5.15.4 Marine Debris

One of the most serious problems in the NWHI is the accumulation of marine debris, largely derelict gear lost from North Pacific fisheries. This debris has a cumulative impact on National Wildlife Reserve resources and coral reef habitats. Inter-regional and international management will be necessary to find solutions to this problem.

CHAPTER 6

LIST OF PREPARERS

Contractors:

Paul Bartram, Marine Biologist
Christopher Dahl, EIS Specialist
Tom Graham, Fisheries Economist
Wayne Haight, Fishery Biologist
Karen Thomas, GIS Consultant

Council Staff:

Kathy Cousins, Protected Species/NEPA Coordinator
Paul Dalzell, Pelagics Coordinator
Charles Kaaiai, Indigenous Coordinator
Kevin Kelly, Adaptive Management Coordinator
Lucinda Knapman, Education Coordinator
Jarad Makaiau, Habitat Coordinator
Mark Mitsuyasu, Program Officer
Robert Schroeder, Senior Scientist

North Pacific Council Staff:

Gail Bendixen, Fisheries Analyst
David Witherell, NEPA Plan Coordinator

National Marine Fisheries Service:

Marcia Hamilton, Fishery Program Specialist
Alvin Katekaru, Resource Management Specialist
Steve Leathery, Fisheries Biologist

CHAPTER 7

LIST OF AGENCIES AND PERSONS CONSULTED AND RECIPIENTS

Federal Agencies

Members of the U.S. Coral Reef Task Force:

Governor	Commonwealth of the Northern Mariana Islands
Governor	Commonwealth of Puerto Rico
Governor	State of Florida
Governor	State of Hawaii
Governor	Territory of American Samoa
Governor	Territory of Guam
Governor	U.S. Virgin Islands
Secretary	U.S. Department of Commerce
Secretary	U.S. Department of Interior
Secretary	U.S. Department of State
Secretary	U.S. Department of Department of Defense
Secretary	U.S. Department of Agriculture
Attorney General	U.S. Department of Justice
Secretary	U.S. Department of Transportation
Director	Council for Environmental Quality, White House
Administrator	National Aeronautics and Space Administration
Director	National Science Foundation
Administrator	U.S. Agency for International Development
Administrator	U.S. Environmental Protection Agency, (Hdqrts. and Region IX)

Other:

Administrators	National Marine Fisheries Service Regional Offices
Directors	National Marine Fisheries Service (NFMS) Science Centers
Administrator	National Oceanic and Atmospheric Administration
Deputy Assistant Secretary	National Oceanic and Atmospheric Administration
Director	NMFS Honolulu Laboratory
Chief	NMFS Office of Law Enforcement, Long Beach & Hawaii
Administrator	NMFS Pacific Islands Area Office
Director	Office of Policy & Strategic Planning, NOAA
Executive Director	Science Advisory Board, NOAA
General Counsel	Southwest Region, NOAA
Director	U.S. Army Corps of Engineers

Admiral	U.S. Coast Guard (Hdqrts., 14th District & Public Affairs)
Administrator	U.S. Fish and Wildlife Service
Chairman	Marine and Fisheries Advisory Council

U.S. Congressional Delegation:

Representative	Commonwealth of the Northern Mariana Islands
Senators	State of Hawaii
Representatives	State of Hawaii
Representative	Territory of Guam
Representative	Territory of American Samoa

International Organizations

Director	Inter-American Tropical Tuna Commission
Director General	International Center for Living Aquatic Resource Management
Director	International Marine Life Alliance
Executive Director	Marine Aquarium Council
Director	Palau Coral Reef Center
Director General	Secretariate of the Pacific Community
Director	South Pacific Regional Environment Programme
Director General	Food & Agricultural Organizations/Fisheries

State/Territory/Commonwealth Agencies/Organizations

Director	American Samoa Coastal Management Program
Director	American Samoa Department of Marine and Wildlife Resources
Director	American Samoa Department of Planning
Director	American Samoa Environmental Protection Agency
Director	CNMI Coastal Resources Management
Director	CNMI Department of Planning
Director	CNMI Division of Fish & Wildlife
Director	CNMI Division of Environmental Quality
Director	Division of Aquatic Resources, DLNR
Director	Division of Conservation & Resource Enforcement, DLNR
Director	Guam Bureau of Planning
Director	Guam Coastal Management Program
Director	Guam Division of Aquatic and Wildlife Resources

Director	Guam Environmental Protection Agency
Director	Hawaii Coastal Zone Management Program
Director	Hawaii Department of Health
Director	Hawaii Department of Land and Natural Resources
Director	Hawaii Office of Environmental Quality Control
Manager	Living Marine Resources, U.S. Coast Guard, Hawaii
Board of Trustees	Office of Hawaiian Affairs

Other Organizations

President	American Samoa Community College
Director	Center for Marine Conservation
President	Coral Fish Hawaii
Director	Earth Justice Legal Defense Fund
Director	Environmental Defense Fund
Director	EnviroWatch, Inc
President	Guam Diving Industry Association
President	Guam's Fishermen's Cooperative Association
President	Hawaii Audubon Society
President	Hawaii Fishermen's Foundation
President	Hawaii Sport Fishing Club
President	Kawaihae Fishing Club
President	Keehi Sport Fishing Club
President	Kona Coast Divers
Director	Living Oceans Program, National Audubon Society
President	Maalaea Boat & Fishing Club
President	Mariana's Underwater Fishing Federation
Director	Natural Resources Defense Council
Director	Nature Conservancy, Hawaii
President	Northern Marianas College
Director	Ocean Wildlife Campaign
Director	Sierra Club, Hawaii
Director	United Fishing Agency, Hawaii
Director	UH School of Law, Environmental Law Program
Director	University of Guam Marine Laboratory
Director	University of Hawaii Institute of Marine Biology
Director	Western Pacific Fisheries Coalition
President	Windward Sport Fishing Club
Director	World Wildlife Fund

Individuals

Bill Bradford	Guam Cooperative Fisherman's Association
Paul Bartram	FMP contractor, Hawaii
Jim Berdach	FMP contractor, Hawaii
Tony Costa	Nearshore Commercial Fishing, Hawaii
Peter Craig	National Park Service,American Samoa
Gerry Davis	Division of Aquatic & Wildlife Resources, Guam
Matt Dunlap	FMP contractor, Hawaii
Tisa Faamuli	Alega Village Conservation, American Samoa
Mike Fleming	Fisherman, CNMI
Scott Glover	U.S. Coast Guard, Guam
Tom Graham	FMP contractor, Palau
Wayne Haight	FMP contractor, Hawaii
Ernest Kanehailua, Jr.	Native Hawaiian Fishing Council
Lily Kong	Citizen, Hawaii
Edward Lovell	FMP contractor, Fiji
Melvin Makaiwi	Star of the Sea Fisheries, American Samoa
Jim Manohe	Diver, Hawaii
William McCue	Fisherman, CNMI
Scott Moncrief	Fisherman, Hawaii
Leo Ohai	Fisherman, Hawaii
Joseph Pangelinan	Fisherman, CNMI
Tom Parker	Diver, Hawaii
Dave Raney	Sierra Club, Hawaii
Steve Smith	Naval Base, Pearl Harbor
Bob Smythe	Potomac Resource Consultants
Carolyn Stewart	FMP contractor, Hawaii
Mike Sur	Fisherman, Hawaii
Wallace Thompson	Swain's Island Representative, American Samoa
Tim Timoney	F/V Laysan, Hawaii
Eric Wagenman	Commercial Fisherman, Hawaii

Council Groups

Executive Directors	Regional Fishery Management Council
Council Members	Western Pacific Regional Fishery Management Council
Members	WPRFMC Bottomfish Advisory Panel
Members	WPRFMC Bottomfish & Seamount Groundfish Plan Team
Members	WPRFMC Coral Reef Ecosystem Plan Team
Members	WPRFMC Crustaceans Advisory Panel
Members	WPRFMC Crustaceans Plan Team
Members	WPRFMC Demonstration Projects Advisory Panel

Members	WPRFMC Ecosystem & Habitat Advisory Panel
Members	WPRFMC Fishery Rights of Indigenous People Advisory Panel
Members	WPRFMC Pelagics Advisory Panel
Members	WPRFMC Pelagics Plan Team
Members	WPRFMC Precious Corals Advisory Panel
Members	WPRFMC Precious Corals Plan Team
Members	WPRFMC Scientific and Statistical Committee

Media

News Editor	Associated Press, Hawaii
Editor	Environment Hawaii
Editor	Hawaii Fishing News
Editor	Hawaii Tribune-Herald
Editor	Honolulu Advertiser (Oahu, Kauai and Maui offices)
Editor	Honolulu Star Bulletin (Oahu, Kauai and Maui offices)
Editor	Honolulu Weekly
Editor	Kauai Times
Editor	Marianas Variety
Editor	Maui News
Editor	Molokai Advertiser-News
Editor	Pacific Daily News, Guam
Director	Public Libraries (American Samoa, Guam, Hawaii, CNMI)
Editor	Samoa News
Editor	The Garden Island, Kauai

CHAPTER 8

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CHAPTER 9

RESPONSE TO PUBLIC COMMENTS

9.1 Comments Received During Scoping

The following public scoping hearings and meetings related to the FMP/DEIS were held around the Western Pacific region:

Public Scoping Hearing - Honolulu (Council Meeting)	16 June 1999
Public Scoping Hearing - Honolulu (Plan Team Meeting)	15 July 1999
Public Scoping Hearing - Guam	28 July 1999
Public Scoping Hearing - CNMI	29 July 1999
Public Scoping Hearing - Honolulu (Ecosystem and Habitat Advisory Panel (EHAP) Meeting)	5 August 1999
Public Scoping Hearing - American Samoa	19 August 1999
Public Scoping Hearing - Kona (Hawaii)	31 August 1999
Public Scoping Hearing - Honolulu (Plan Team and EHAP Meeting)	17 September 1999
Public Scoping Hearing - Honolulu (SSC Meeting)	12 October 1999
Public Scoping Hearing - Honolulu (Council Meeting)	18 October 1999
Public Meeting - American Samoa	20 December 1999
Public Meeting - Guam	28 December 1999
Public Meeting - Kona, Hawaii	28 December 1999
Public Meeting - Commonwealth of the Northern Mariana Islands	29 December 1999
Public Meeting - Hilo, Hawaii	29 December 19
Public Meeting - Kahului, Maui	4 January 2000
Public Meeting - Haleiwa, Oahu	5 January 2000
Public Meeting - Lihue, Kauai	6 January 2000
Public Meeting - Waianae	10 January 2000
Public Meeting - Lanai City, Lanai	11 January 2000
Public Meeting - Molokai	12 January 2000
Public Meeting - Honolulu	13 January 2000
Public Meeting - Honolulu (Hawaii Plan Teams and Advisory Panel Meetings)	
Public Meeting - Honolulu (Plan Team Meeting)	25 April 2000
Public Meeting - Honolulu (Joint Plan Teams and Advisory Panels Meeting)	26 April 2000
Public Comment - Honolulu (Council Meeting)	28 Feb - Mar 2 2000

Public Meeting - Honolulu (SSC Meeting)	16 - 18 May 2000
Public Comment - Maui (Council Meeting)	14 - 16 June 2000
Public Meeting - Honolulu (Council Meeting)	10 - 12 July 2000
Public Meeting - Honolulu (SSC meeting)	12 October 2000
Public Meeting - Honolulu (Council meeting)	1 December 2000

9.1.1 Comments on Fishing Permit and Reporting Requirements

1. Would like to add a management measure to the FMP that bans the possession or collection for commercial purposes of wild live rock and coral. The collection of live rock or live coral for scientific and research purposes could be allowed by permit, as well as the collection of small amounts of live coral as brood stock for captive breeding and aquaculture.

Response: The Preferred Alternative for the permit process specifies that no permits will be issued under these permit processes for the possession or collection for commercial purposes of wild "live rock" and live hexacorals (hard corals). The collection of wild live rock or live hexacoral for scientific and research purposes would be allowed by special permit. Collection of small amounts of live hexacoral as brood-stock for captive breeding/aquaculture would be allowed by special permit, except where it is not consistent with State and territorial laws regulating such collection in the adjoining State or territorial waters.

2. It is premature to ban the collection of live coral and live rock. The potential for commercial fisheries of these resources would help the local fishing communities.

Response: While prohibiting the commercial harvest of "wild" live rock and hard corals, the FMP will allow collection of small amounts for aquaculture broodstock and scientific research under a special permit, except where it is not consistent with State and territorial laws regulating such collection.. Further, the FMP will allow the commercial harvest of soft corals through a special permit provided such collection is sustainable. The harvest of other coral reef resources in Federal waters will be managed under a proposed special permit process or through collaboration with local resource agencies.

3. Concerned about standard conditions that would be attached to any permit issued for the fishery. Thinks conditions should be developed specifically for each particular fishery proposal on a case-by-case basis. Supports reporting requirements. Believes NOAA should not regulate the coral reef fishery out of business because the new fishery will provide data to the Federal government to assist in management decisions.

Response: For species/taxa that are currently harvested or that are believed to be subject to immediate harvest, a general permit will be considered as future framework option to harvest MUS outside MPAs in the EEZ, if existing local reporting systems are found to be in adequate. A special permit will be required to harvest MUS within low-use MPAs. A special permit will be required to harvest any non-targeted coral reef ecosystem taxa. Species that are less-well-known (non-targeted taxa) are managed more carefully, with a case-by-case analysis of the impact of each proposed fishing activity. This process allows for a precautionary approach for the collection of unknown or poorly understood species and for tightly controlled collection of harvested species within MPAs. For non-targeted species, appropriate levels of collection may be established once individual species or taxa are better understood. The permit process is designed to meet requirements of the Magnuson-Stevens Act (MSFCMA)

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4. Will "outsiders" be able to get a permit to harvest coral reef resources in American Samoan waters?

Response: The MSFCMA prohibit discrimination against fishermen from any state or territory fishing in EEZ waters. The American Samoan government may have local rules that apply to waters under its management authority.

5. The FMP should address the issue of indigenous rights. Will indigenous people that want to fish be subject to permits and all the Federal regulations? Native Hawaiians should have a special right to fish and not need a special license.

Response: The preferred alternatives in the FMP provide for indigenous people to continue harvesting coral reef resources with minimal new regulatory burdens and costs. For fishing on currently harvested coral reef taxa, there will be no new permits required, a general permit for fishing will be developed under a framework process if needed. In addition, special exemptions are given to indigenous people to be able to collect small amounts of live rock/coral for customary and traditional uses, as well as fishing activities allowed in low-use MPAs for indigenous people by special permit. It is important for management purposes to be able to keep accurate data on fishery resources harvested.

6. Sportfishing is much more of a threat to the coral reef resources of Hawaii than commercial fishers, because the combined impact of recreational thrill craft and sport fishers far outweighs the few commercial fishers.

Response: The permit process established in the FMP will affect all types of fishing activities. It is beyond the scope of authority in the FMP under the MSFCMA, however, to manage non-fishing recreational activities.

7. Can some executive action be taken right away to adopt permit requirements to provide a safeguard against immediate, unregulated harvest of coral reef resources?

Response: A moratorium on harvesting in the interim while the FMP is being approved would protect coral reef resources in the EEZ. However, such an action would require as much justification as an FMP, and could be delayed as long or longer than the FMP itself.

8. Requiring a special permit to fish in MPAs turns most authority over to the RA. There is a concern about the NMFS and their permitting process, given that they are the permitting authority, the approving authority, all authorities.

Response: Permits will be issued by the RA in consultation with the Council. A detailed list of information will be required to be provided with the permit application. The RA will consult with the Council and the Director of the affected state fishery management agency; the Council will then recommend approval or disapproval of the application. The applicant can appear at the Council meeting to support his application with verbal testimony.

9. The FMP should address fishing for mollusks, recreational fishing, and the collection of shellfish and coral for the jewelry and ornamental trade.

Response: Mollusks and corals are addressed in the FMP as proposed MUS, with the FMP recognizing that MUS are utilized for a variety of purposes, including food, ornamental and bioprospecting. Recreational fishing is addressed in section 3.3. of the FMP.

10. Due to the unknown nature of "permitting" new fisheries or gears, a coral reef fishery permit applicant will not likely make any substantial investment in outfitting vessels that would be used under the permit. Therefore, a lag time will likely exist after permit issuance (if issued) and before fishing can realistically commence. The proposed one year timeframe for the exploratory permit should be extended three months to accommodate preparation by the fisher.

Response: At this time, no permit timeframes have been established in the FMP.

11. There should be some mechanism established to allow for the transfer of the permit.

Response: Permit transfer is irrelevant as no limited entry fishery is proposed.

12. It might be wise to examine the extent of the impacts of small-scale subsistence fishing before exempting it from the proposed permit process, since the cumulative impacts of such fishing might be substantial.

Response: Subsistence fishing in the EEZ is not exempt from permit process under the Council's preferred alternative. There will not be additional permits required for currently harvested MUS in the populated island areas, however this applies to everyone not simply subsistence fishermen.

13. The cumulative harvest represented by the permits should represent the minimum required to obtain the data necessary to determine allowable catch limits, in keeping with the strong emphasis on the precautionary approach in the FMP. An alternative harvest policy to MSY, perhaps an ecosystem overfishing threshold (cast in terms of species composition shifts) with a buffer (for uncertainty), is needed given the unsuitability of MSY to coral reef ecosystems and the paucity of knowledge available.

Response: Overfishing thresholds based on MSY definitions are required by the MSFCMA. These are described in FMP Section 4.2, which discusses overfishing. Refinement of ecosystems monitoring parameters is a priority of the plan.

14. Does not want to pay for permits to fish around Molokai. Would like to establish a *kapu* system which the island would self-regulate, allowing people to fish in certain areas and not in others. A lot of overfishing for *onaga* and *opakapaka* is occurring around Molokai.

Response: There are no additional permits required for currently harvested taxa around Molokai, and reporting will continue to occur via local monitoring and coordination.

15. Bottomfishing should be exempted from the 50 fathom no-take rule.

Response: The 50 fathom no-take rule applies in federal waters to MPAs designated in French Frigate Shoals, Laysan, Northern half of Midway Atoll, Howland Island, Baker Island, Jarvis Island, Kingman Reef, and Rose Atoll. Under the preferred alternative, these areas would remain closed to all fishing, due to the sensitive nature of these ecosystems. For example, they contain significant monk seal pupping and breeding habitat, seabird nesting and feeding areas, and unique coral reef ecosystems as well.

16. Bottomfish boats already permitted do not have to be permitted under the new coral reef FMP?

Response: The existing FMP fisheries for bottomfish, crustacean and precious corals follow the regulations in their existing FMPs not the coral reef FMP, but cannot fish in no-take MPAs.

17. Shell collectors do a lot of damage to the coral reefs, turning over the coral looking for certain species. They can do as much damage in an area that is known to have a particular species of shell as an anchor from a boat can do. Some of the finest shell collecting in the world outside of three miles in the NWHI is.

Response: In the NWHI EEZ, no-take MPAs would extend to a depth of 10 fathoms offshore of all islands except French Frigate Shoals, Laysan and the northern half of Midway Atoll which would extend to a depth of 50 fathoms. As these areas have been designated as no-take, harvesting of shells in these areas would be prohibited. In all other areas, a special permit would be required for all emerging fisheries, and the effects on the ecosystem would be explored at that time.

18. Does a "special permit" mean the fishermen needs to specify the type of fish he is catching, or a given amount of time, or the area being fished?

Response: With a special permit, the fishermen would be required to complete a detailed logbook documenting types and quantity of gear used, number and weights of species kept, number released alive, number released unknown, area fished, length of trip, specific effort information and other information required as a condition of holding the permit.

19. If Rose Atoll is a wildlife refuge in American Samoa, and its co-managed by the Department of Marine and Wildlife Resources and U.S. Fish and Wildlife Service, what are the laws on fishing in the area, and who needs a permit?

Response: Under the Councils preferred alternative, Rose Atoll would be designated a no-take MPA and no fishing of any kind would be allowed. The only exemption to this rule is the preferred alternative of allowing take of small collections of coral reef organisms for scientific research.

20. Who is going to benefit financially from the fees that are charged to the local fishermen?

Response: Generally, the fees that are charged to the local fishermen simply cover the administrative costs of the permitting system.

21. It seems as though the small local fishermen in Guam are being lumped in with the larger commercial industry with 180 foot vessels. Most fishermen in Guam fish with 20 foot skiffs.

Response: The Magnuson Steven Act specifies that a fisherman is considered to be a commercial fisherman if he sells any portion of his catch, and the Coral Reef Ecosystem FMP must follow the guidelines of the Magnuson Stevens Act.

22. Thanks to WPRFMC for coming and discussing the future regulations for fishing. However, the locals should be able to manage the fisheries themselves without regulations from the federal government. If a fishermen wants to go out one morning and fish when it is nice weather, he should not have to first go get a permit from NMFS. It is difficult to support the Federal Government when they cannot enforce the EEZ, when they cannot stop the Chinese and Taiwanese from overfishing the waters.

Response: The Council's preferred alternative specifies that there will be no new permits required for fishing for currently harvested coral reef taxa in the populated island areas. A general permit and reporting system will be developed at a later date if there is a need, i.e. if there is a gap in the system and data are not being accurately recorded.

23. Will the permit required for trapping be above and beyond what the state requires?

Response: The Councils Coral Reef Ecosystem FMP does not apply to state waters, so if the trapping occurs within 0-3 miles from shore there will be no additional requirements. Traps are listed as an allowable gear type in the FMP, however they will be allowed in appropriate areas and with appropriate conditions (e.g., negligible habitat impact, minimize potential for derelict traps) and traps must be permanently marked to identify the owner.

24. The same regulations could be passed for state waters within a short time. The state will be getting a lot of money for coral reef research and management.

Response: The state will certainly look at the regulations imposed by the Council's Coral Reef Ecosystem FMP, however there are no laws which compel the state to adopt the same measures.

25. Regarding reporting, filling forms is time consuming and fishermen do not have time to properly fill them out.

Response: It is imperative for proper management of fisheries to have accurate reporting of the resources that are removed from the ecosystem. NMFS has attempted to streamline the permitting process so it obtains the necessary information for proper fishery management, yet is not too much of a burden on the fishermen.

26. Instead of the permitting process where fishing activity inside MPAs would be permitted by NMFS, and outside MPAs anyone who meets basic safety and citizen requirements would be eligible for a permit, the Council should institute a two-tiered permitting approach where poorly understood species are managed on a case-by-case basis, and better known species are managed using a system with built in precaution and ecosystem considerations.

Response: The Council has instituted a permit process where better known species are managed by local data collection and monitoring, using built in precaution and ecosystem considerations. Species which are poorly understood are managed by special permit.

27. Concern with the overall effects and restrictions of this FMP that would apply to existing nearshore fisheries in Hawaii and to the substantial dive and fish trap fishery in the Auou Channel between Maui, Molokai, and Lanai outside of three miles.

Response: The FMP does not apply to nearshore waters. The State of Hawaii, Department of Land and Natural Resources is responsible for managing fisheries from 0-3 nm. Fishing beyond 3 nm will be allowed for currently harvested coral reef species by the populated island areas, which will not require permits as of now. Depending on the species harvested and area fished, special permit may be required.

28. Does not support federal rules or FMPs that have provisions that are weaker than the adjacent state or territory, especially with respect to coral and live rock.

Response: The Council agrees. In fact, the regulations that will be implemented under this FMP are generally more stringent then any existing state or territorial regulations pertaining to coral reef management. Further, enforcement of federal fisheries regulation is generally more effective then state or territorial enforcement. Every effort has been made to ensure that the management measures proposed in the FMP are consistent with state/ territorial/ commonwealth laws and policies in order to simplify implementation and assist enforcement efforts.

9.1.2 Comments on Fishing Gear and Methods

1. Supports banning any kind of spearfishing using scuba. If this ban is implemented in Federal waters, would it be possible to have a similar ban in territorial waters?

Response: The FMP proposes banning the use of spear fishing with scuba at night in the EEZ around the NWHI and PRIA. The Council considered banning the use of Scuba in the EEZ around the main inhabited island groups, however this was not supported. It is beyond the authority of the WPRFMC to implement a ban on Scuba in state and territorial waters. Such a ban would be under the purview of the state/territorial/commonwealth governments.

2. Does rod-and-line (under proposed listed gear) include motorized reels?

Response: Yes, motorized reels are included under the proposed listed gear (rod-and-line).

3. Trolling and purse seining should be banned under this Plan because they are extremely destructive to coral reef resources.

Response: Neither trolling nor purse seines interact with the bottom during normal deployment and retrieval procedures. Under the FMP only non-destructive, selective gear types will be allowed. The following allowable gears are proposed in the FMP: ROV/submersibles, hand harvest, handline, hook-and-line, rod and reel, spear, slurp gun, hand net/dip net, barrier net (aquarium), hoop net (for kona crab) and surround/purse net (for targeted schools such as akule, weke, and baitfish). Nets must be tended at all times. Traps will be allowed in appropriate areas and with appropriate conditions if permanently marked to identify the owner. The gear types specified in the plan were identified by the Council as the least destructive to coral reef resources and their habitats, while being effective at targeting desired species.

4. The list of allowable fishing gear types may be far too permissive if coral reef ecosystem protection is the goal of the FMP. Passive or active fishing gears that are detrimental to any coral reef ecosystem they come into contact with should not be allowed to remain on the list of allowable gear types.

Response: The gear types specified were identified by the Council as the least destructive to coral reef resources and their habitats, while being effective at targeting desired species.

5. Supports the addition of surround/purse net (for akule and aku bait fishing only) to the list of allowable gear.

Response: Surround/purse net, with conditions, has been included on the allowable gear list.

6. Concerned that fish traps are not listed as allowable gear because, in the years that the akule do not run in inshore waters, the fishers turn to fish trapping, which occurs in some places beyond three miles. Recommends WPRFMC incorporate a limited entry program for trap fishing for existing trap fishers.

Response: Traps will be allowed by permit in appropriate areas and with appropriate conditions if permanently marked to identify the owner.

7. Allowable gear listed and existing FMP fisheries should not be exempt in coral reef ecosystem areas.

Response: The Council considered this option but selected against it. Existing EEZ fisheries are considered to be sufficiently regulated under their respective FMP which must comply with all MSFCMA and Sustainable Fisheries Act requirements. The Council's preferred alternative also includes a formal coordination process among plan teams to consider possible fishery-ecosystem impacts.

8. Traps for Kona crab and other crabs should be allowed in the EEZ.

Response: Under the Council's preferred alternative traps are allowed only in appropriate areas/conditions if permanently marked with the owners identification. "Appropriate" implies using the gear in ways that are selective, do not incur large bycatch mortality and do not damage habitat.

9. The Council should consider using performance standards for controlling which kinds of gear can be used in coral reefs, rather than using a list of allowed and/or prohibited gear types.

Response: Federal regulations require that the FMP list allowable gear types. The allowable gears listed in section 5.4 (Fishing Gears and Method) have been included due to its selective nature and minimal impact to habitat.

10. On the North Shore of Molokai, they are seeing a lot of nets from foreign fishermen.

Response: The trawl nets are coming from North Pacific fisheries, not Hawaiian. In August 2000 Hawaii held a conference where all the countries that have those fleets fisheries discussed ways to reduce marine debris.

11. Fish traps and bait nets should not be on the list of allowable gear, as they result in bycatch and habitat damage. Recommends removing fish traps, surround/purse nets, and scuba with spear from the list of allowable gear types.

Response: Fish traps are only allowed under the CREFMP under the conditions that they shall be allowed in appropriate areas and with appropriate conditions, for instance the traps must produce negligible habitat impact. To minimize the potential for derelict traps, the traps must be permanently marked to identify the owner. The preferred alternative for scuba with spear is that this method be prohibited at night in the NWHI PRIA when the fish are the most vulnerable. In developing the Councils preferred alternatives, the Council considered trade-offs of benefits between utilization of coral reef resources by controlled fishing and preservation of coral reef ecosystems. It determined that the list of allowable gear would best meet this compromise.

12. Most of the coral reef and damage is being incurred well inside of three miles. Diving beyond three miles with scuba at night would be rare.

Response: The Councils CREFMP does not have jurisdiction 0 - 3 miles from shore surrounding the populated island areas, these areas are controlled by state/territorial laws.

13. How was it determined to prohibit the use of spear with scuba at night?

Response: It was determined to prohibit the use of spear with scuba at night in the NWHI and PRIA due to the vulnerability of target species. At night, this method allows no refuge because the target species are vulnerable to capture while sleeping in their holes, and there is a much greater likelihood of certain species becoming overharvested.

14. There is a concern that the state will follow the federal regulation to ban scuba spearfishing at night. This will leave Hawaii fishermen no way to feed their families.

Response: While the state will certainly be aware of the regulations imposed by the Council in federal waters, there is no guarantee that any of the regulations will be similarly adopted in state/territorial waters 0-3 miles from shore. State will allow opportunity for public comment if such a role is proposed.

15. Nets should be allowed for weke and other fish, not just akule bait fishing.

Response: The Council modified its preferred alternative regarding nets to allow harvesting of all species on the condition that the nets do not damage coral or bottom habitat, and also that they be tended at all times.

16. Fish traps and surround or purse nets can actually cause quite a bit of damage to the ecosystem, if not used responsibly. Traps and purse nets should only be permitted when their use has been screened to insure minimal bycatch mortality, negligible habitat impacts and provisions to minimize the possibility of ghost fishing.

Response: The Council agrees, and is required by the MSFCMA to prevent, mitigate, or minimize any adverse effects from fishing gear if there is evidence that a fishing practice is having an identifiable adverse effect on essential fish habitat. Adverse fishing impacts may include physical, chemical, or biological alterations of the substrate and loss of, or injury to, benthic organisms, prey species, and their habitat and other components of the ecosystem. Controls on fishing gear are an effective tool for mitigating such impacts.

9.1.3 Comments on Marine Protected Areas

1. Is fundamentally opposed to area closures and gear restrictions.

Response: Marine protected areas (MPA) are an attractive option for ecosystem-based fisheries management because they do not require detailed knowledge of the protected species while being holistic in conserving multi-species resources and the functional attributes of marine ecosystems. They can also provide "insurance" against periods of poor recruitment at individual populations.

MPAs can range in scope and extent. They can be areas designated for limited use, seasonal use or areas that are completely restricted from consumptive use. Although completely restricted areas are thought to provide the highest degree of protection to marine ecosystems, less restrictive areas also provide some protection and may be economically and socially more acceptable. The optimum size of a MPA depends on many factors: the resources managed, the management goals, the enforcement possible and social and economic constraints.

There is little understanding of what size of MPA would provide ecologically complete coral reef ecosystem protection. Even small MPA have been shown to be effective in increasing standing stocks and sizes of reef fish, especially of species that are exceptionally vulnerable to fishing and of older individuals which are critical components of spawning stock biomass. To be of utility to fisheries and to promote the conservation of coral reef resources on a broader scale, MPA should serve as sources of reproductive output to replenish larger surrounding or down current areas. The current approach of establishing small and isolated MPA is inadequate for this purpose.

2. It is premature to designate any MPAs in CNMI waters. The WPRFMC needs to undertake a public participatory process to identify areas appropriate for designation.

Response: At this time, no MPAs are proposed in federal waters around CNMI. Any MPA designation in CNMI waters will be implemented under the FMPs amendment process. The Council is required to provide numerous opportunities for public comment and participation. The Council would seek the input and advice of local government officials, fishermen and other resource users as part of any effort to identify candidate areas as MPA in any of the areas under its jurisdiction.

3. It is premature and unnecessary to designate the Farallon de Medinilla as a Habitat Area of Particular Concern (HAPC) because it does not meet any of the four qualifying criteria.

Response: The Council has endorsed the concept of designating Habitat Areas of Particular Concern (HAPC). The FMP lists *potential* areas within the Council's jurisdiction that meet one or more of the criteria for HAPC designation. Farallon de Medinilla has been included as one of these potential areas, since the Coral Reef Ecosystem Plan Team believes the ecological function provided by the habitat is important and that the area is susceptible to human impacts.

4. Does not support closed area in Hawaii (MHI or NWHI), especially when area is closed for fishing but not marine recreation.

Response: The Council does not have the authority to restrict activities other than U.S. fishing activities in areas within its jurisdiction. The state, which has management authority over waters 0 - 3 miles from shore, may restrict such activities. The state is aware of regulations being adopted by this FMP, and may choose to adopt similar regulations.

5. There seems to be a discrepancy between the definition of the EEZ (3-200 nm) and the proposed designation for Essential Fish Habitat of 0-200 nm. Will the Federal government be managing EFH in the territorial waters of American Samoa? How does the designation of 0-200 nm as EFH affect American Samoa management of its own territorial waters?

Response: Essential Fish Habitat (EFH) identifies important areas that the fishery management unit species use at some point during their life cycles. While NMFS does not have jurisdiction over the territorial waters between 0-3 nm, it can make recommendations to minimize impacts to EFH from proposed projects within these waters that are federally-funded or require a federal permit. The recommendations, however, are not legally binding.

6. Swain's Island and Rose Atoll should be deleted as candidate areas for MPA designation.

Response: At this time, Rose Atoll is targeted under the Councils preferred alternatives as a no-take MPA. The criteria considered for the selection of MPAs included: natural resource values, human use and historical values, impacts of human activities values, and management concerns values.

7. Who are the people that would benefit from closed areas (MPAs)?

Response: Fishermen and scientists are among those who benefit from no-take zones. Marine protected areas (MPA) are an attractive option for ecosystem-based fisheries management because they do not require detailed knowledge of the protected species while being holistic in conserving multi-species resources and the functional attributes of marine ecosystems. They can also provide "insurance" against periods of poor recruitment by individual populations.

MPAs can range in scope and extent. They can be areas designated for limited use, seasonal use or areas that are completely restricted from consumptive use. Although completely restricted areas are thought to provide the highest degree of protection to marine ecosystems, less restrictive areas also provide some protection and may be economically and socially more acceptable. The optimum size of a MPA depends on many factors: the resources managed, the management goals, the enforcement possible and social and economic constraints.

There is little understanding of what size of MPA would provide ecologically complete coral reef ecosystem protection. Even small MPA have been shown to be effective in increasing standing stocks and sizes of reef fish, especially of species that are exceptionally vulnerable to fishing and of older individuals which are critical components of spawning stock biomass. To be of utility to fisheries and to promote the conservation of coral reef resources on a broader scale, MPA should serve as sources of reproductive output to replenish larger surrounding or down current areas. The current approach of establishing small and isolated MPA is inadequate for this purpose.

Few, if any, studies have sought to verify whether marine protected areas established in the U.S. Pacific islands do actually benefit nearby fisheries. It is clear that fish populations which build up in small areas (Hawaii, Philippines) temporarily closed to fishing are quickly reduced when fishing is resumed. Criticisms of the existing marine protected areas in the U.S. Pacific islands are that they are either too small and fragmented or they do not encompass sufficient depth range and high quality habitat to provide broad coral reef ecosystem protection or recruitment benefits to fisheries.

It has been suggested that linking populations among MPAs over a broad area is necessary to assure long-term sustainability of coral reef fisheries. Some argue for complete protection from fishing, whereas others believe MPAs are more valuable when they can serve as natural laboratories for fishing experiments and testing of management strategies.

8. At least 30% of the management area under consideration by the Council should be considered for no fishing zones.

Response: Under the Councils preferred alternatives, 13% of all coral reef area under Council jurisdiction in the Western Pacific region will be closed to all fishing, and 14% of all coral reefs around the NWHI would be closed. If the state takes consistent action and designates adjacent reefs around the NWHI, the percent of "no-take" area would total 24%.

9. Twenty-five percent of the species in the coral reef areas of the Hawaiian Islands are known to be endemic. These need special consideration.

Response: In the Hawaiian Islands, the entire coral reef ecosystem in the EEZ of the NWHI will be designated as no-take or low-use MPAs. Endemics will be protected from overfishing under the requirements of the MSFCMA. For endemics that do not already have a history of harvest, a special permit will be required.

10. A "no-take" MPA to 50 fathoms in the NWHI will significantly and detrimentally affect existing fisheries managed under other FMPs.

Response: In the NWHI, federal waters shallower than 10 fathoms are designated as "no-take" for all fishing. The waters shallower than 50 fathoms are designated as "no-take" at French Frigate Shoals, Laysan, and the northern half of Midway Atoll. In the other areas of the NWHI, fishermen would be required to obtain a special permit to fish for coral reef taxa. However,

vessels already fishing for species regulated under another existing FMP would be exempt from the requirements of the CREFMP exception no-take zones.

11. Establishing a MPA to 50 fathoms in the NWHI where there are existing fisheries will create enforcement problems. In areas where the bottom is relatively flat, where will the 50 fathom contour be delineated? In areas where the bank drops off steeply at 50 fathoms, where will fishers anchor to fish in deeper waters?

Response: Vessels already fishing for species regulated under another existing FMP will be exempted from the permit requirements of this FMP. Most existing permitted vessels in NWHI have VMS, which facilitates enforcement. Vessels permitted under this FMP must comply with all regulations promulgated under the FMP.

12. Existing FMP fisheries should not be exempt from MPAs.

Response: The Council considered this option and choose to exempt existing FMPs, except form no-take MPAs. If not exempted the current designation of MPAs to 50 fm in the remote atolls and NWHI and associated restrictions would represent a significant impact to existing permitted FMP fisheries. Potential impacts of existing FMP fisheries on coral reef ecosystems will be considered through formal inter-plan team consultation.

13. EPA strongly supports the designation of MPAs; identification of Essential Fish Habitat, HAPC, and fishing and non-fishing threats; and clarification of allowable coral reef harvesting gear. Because information regarding the harvest of coral reef resources in the EEZ is largely unknown, EPA would like a clearly defined research component as part of the FMP.

Response: The designation of MPAs, identification of Essential Fish Habitat, HAPC, and fishing and non-fishing threats, and list of allowable harvest gear are primary aspects of the FMP. FMP Chapter 7 discusses research, monitoring, and assessment needs. Specific research projects are identified and listed as high, medium or low priority. Research needs for EFH are also defined in the FMP. The Plan Team will continue to refine the identified research priorities of the FMP.

14. It would be useful to add up the areas that the proposed MPAs would comprise and compare it to the total area of reef under the Council's jurisdiction. The total area must be large enough to realize the intended benefits of MPA management.

Response: The Council did so, and determined that 13% of all coral reef areas in federal waters are designated as "no-take" MPAs.

15. It might be useful to integrate MPA management with traditional management systems that employed closed areas to protect fish stocks, to incorporate traditional knowledge, to respect tradition and culture, and to build confidence in the MPAs.

Response: There is increasing awareness about the value of traditional management techniques. While traditional management systems typically employed closed areas in nearshore waters, the Council may consider the possibility of working with local indigenous peoples to extend these systems into offshore waters.

16. No-take zones should be expanded to include the area up to three miles from shore.

Response: Generally, the area from the shoreline to three nautical miles offshore is managed by the State and territories and is not under the purview of the FMP. CNMI presents a special case. However, this plan proposed management regulations only for beyond 3 miles around CNMI. With a few exceptions, the nearshore areas of the NWHI are managed jointly by the State of Hawaii and Federal Department of Interior and the nearshore areas of the Pacific Remote Islands are managed jointly by WPRFMC and other Federal agencies. No-take MPAs have been proposed for 0 - 50 fathoms in EEZ waters surrounding, Jarvis Island, Howland Island, Baker Island, Kingman Reef and Palmyra Atoll (Pacific Remote Islands); Rose Atoll in American Samoa; 0 to10 fathoms in all the NWHI and up to 50 fathoms in French Frigate Shoals, Laysan and half of Midway. The Council will utilize the amendment process to modify existing MPAs and designate additional MPAs. In doing this, the Council will actively work with local island communities and appropriate local government agencies (Federal, state, territorial and/or commonwealth) to create additional MPAs of size, location, and management measures appropriate to that community and locale, and to the level of permitted fishing.

17. Want to propose a MPA for Molokai.

Response: The alternative to designate MPAs in the EEZ around the main inhabited island groups was discussed but was not preferred. In these areas, fishing activities are concentrated on adjacent nearshore reefs under state/territory government authority, and designation of no-take areas in the EEZ alone would have little impact on target resources.

18. If the coral reef plan covers zero to 50 fathoms, and all the protected areas are 0 to 50 fathoms also, then everything is a Marine Protected Area except for Guam?

Response: The CREFMP applies to all areas in the Western Pacific region under the Councils jurisdiction, which is generally from 3 - 200 miles from the shoreline in the EEZ. The preferred alternatives for MPAs are designated in the EEZ around the NWHI out to 10 fathoms, Rose Atoll in American Samoa and the PRIAs would extend form the shoreline to 50 fathoms. In the NWHI, also extended to 50 fathoms in the EEZ would be French Frigate Shoals, Laysan and the northern half of Midway.

19. Does the Council have a position on the relevance or importance of mangroves in the Main Hawaiian Islands coral reef ecosystem? In Hawaii the mangroves are an introduced species and many people want to eradicate the mangroves.

Response: Generally, mangroves do not occur in areas where the Council has jurisdiction (in federal waters, which are usually 3-200 miles from shore).

20. MPA's should be strictly no-take.

Response: While strict no-take MPAs are thought to provide the highest degree of protection for the marine ecosystem, low-use MPAs also provide protection from harvesting and in some areas may be more economically and socially feasible. The Council feels the no-take MPAs that are designated under the preferred alternatives balances the competing needs of the resource users with strong ecosystem protection.

21. The Magnuson Act does not provide authority to prevent scientific research; scientific research is excluded from the definition of fishing.

Response: While the Council does not have authority to regulate scientific collecting under FMPs, (NMFS does so directly), the Council will advise on appropriate collecting methods, case-by-case, consistent with objectives of the plan.

22. MPAs should be designated by the island group where the MPAs would be located. The specific management strategy should balance the needs of the existing fishermen with resource conservation.

Response: The Council relies heavily on public input, and strives to work closely with the residents of the areas where any regulations will be implemented.

23. A broad-based "no-take" zone for the NWHI which would result in the involuntary closure of existing fisheries is an unacceptable management strategy, as it is a precedent setting situation which closes an existing fishery. This would effect more than just Hawaii.

Response: Existing fisheries who are regulated by another FMP, such as the bottomfish, crustaceans or precious corals FMP, are exempt from the requirements of the CREFMP. However, in the zones designated "no-take" in the NWHI there is no fishing of any kind (including FMP fisheries) allowed except for small quantities for scientific research after a special permit is obtained. These areas were determined to be small enough to not severely effect existing fisheries. For example, the bottomfish fishery and precious coral fishery generally utilize areas deeper than the no-take zone within 10 fathoms. Some of the no-take areas were already designated as protected species zones under the crustacean fishery.

24. The NWHI MPAs should address the effects of coral harvesting on monk seal populations.

Response: An increasingly important issue in fishery management today is the impacts on protected species by fishing activities. The monk seal population was one of the main reasons for designating specific areas in the NWHI as MPAs. Specifically, coral harvesting is addressed in the Precious Corals FMP, and the effects of the coral harvesting on monk seal populations is explored in detail.

25. The FMP/EIS should identify what measures will be taken to protect critical fish and wildlife habitat areas from potential adverse effects of proposed management actions. The feasibility of proposed mitigation measures should be full demonstrated.

Response: The FMP describes Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPCs). In addition, the FMP proposes a management measure to designate MPAs for important coral reef resource areas. The area where critical habitat occurs in the NWHI is largely designated as a MPA. The Council does not expect the proposed management measures to detrimentally affect habitat areas; however, if damage begins to occur, then additional protective measures can be taken by the Council through the framework or regulatory process.

26. The DEIS and CREFMP may be contrary to other existing applicable Federal statutes. The greatest concern is the lack of analysis given to the significance of national wildlife refuges (NWRs) with marine boundaries. NWRs are closed to all uses until they are specifically opened for such uses. The USFWS is solely charged with making the decisions whether to open NWRs for specific uses.

Response: The USFWS has expressed uncertainty as to the authority of its marine boundaries for the NWHI NWR. The Council has asked USFWS to articulate its authority on a number of occasions, only to be told it is based on USFWS policy. Council FMP-managed commercial fishing for lobsters and bottomfish, under the authority of the MSFCMA has occurred in the NWR of the NWHI since the FMPs were implemented in 1983 and 1986, respectively. In addition, critical habitat has been designated for the Hawaiian monk seal in the NWHI out to a depth of 20 fathoms around Kure, Midway, Pearl& Hermes, Laysan, Maro, Gardner, French Frigate Shoals, Necker and Nihoa. However, fishing still occurs in these areas.

27. The DEIS and CREFMP propose some level of fishing or other types of marine extraction within established NWR boundaries at Rose, Howland, Baker, Jarvis, Johnston, NWHI and Midway. It is not possible for those refuges or any NWR to be opened to a commercial or recreational use or be liberalized by action taken under the MSFCMA. The proposed FMP seeks to close, open, or otherwise manage specific coral reef fisheries of the U.S. flag Pacific Ocean.

Response: The CREFMP would not encourage any level of fishing nor open any area to fishing, as the opportunity to fish most coral reef resources is currently open. In fact the FMP would only impose new restrictions on the allowable level of fishing, for example by closing the aforementioned areas altogether, through no-take MPAs (except recreational fishing and

subsistence take on half of Midway and subsistence take at Johnston, both already allowed by USFWS). The FMP would restrict fishing in other areas through special permit requirements and other regulatory restrictions. Currently, fishing for coral reef resources in the EEZ is nearly non-existent. Except perhaps for restrictions in NWRs of areas under DOD control, there are no other Federal regulations governing the taking of coral reef resources in the U.S. EEZ of the Pacific islands. The CREFMP is largely precautionary and proposes to prevent overfishing, and impacts to coral reef ecosystems, habitat and protected species that might occur should any possible reef-directed fisheries develop in the future. Therefore, the CREFMP in fact substantially enhances the conservation goals of the NWRs.

28. No justification is given for the selection of the proposed 'no-take' areas and depths by the Council. No-take'areas should be selected based upon a set of sound biological criteria and include representation of all reef ecosystem types found in the NWHIs, as is recommended in the National Action Plan to Conserve Coral Reefs and the President's Executive Order for Marine Protected Areas. The CREFMP does not select the proposed 'no take' areas based on a sound biological process.

Response: The Council's preferred alternative for no-take MPAs follows the Scientific and Statistical Committee recommendation for French Frigate Shoals, Laysan and the northern half of Midway to be no-take MPAs to 50 fm. These locations were selected to achieve representative habitat types characteristic of the south, middle and north subregions of the NWHI archipelago. Additionally, they balance ecological criteria with socioeconomic concerns and needs.

Further justification for the selection of no-take MPAs is described in the DEIS. For example, establishment of these no-take zones would provide a form of "insurance" against possible recruitment failure in some sub-populations of the NWHI. Closing these areas to all fishing may also provide additional protection to protected species (i.e., monk seals at FFS and Laysan).

The preferred alternatives for locations and depth ranges of no-take MPAs would conserve a large reservoir of spawning biomass and genetic material for multi-resource coral reef resources, including endemic and rare species.

Restrictions on how vessels operate in no-take areas would reduce the risk of groundings. Existing bottomfish and lobster fishing activities would be displaced from no-take areas around French Frigate Shoals and Laysan.

Further research is needed to improve understanding of ecosystem processes and to validate other criteria for establishment of MPAs. Such research is ongoing and planned by federal agencies. The 20% no-take MPA figure proposed by the National Action Plan itself needs further scientific validation to quantify actual benefits.

29. The majority of waters proposed as no-take areas under the CREFMP are already designated as no-take areas. The Council does not really need to give up much harvested

area as the access to waters from 0-10 fathoms is already tightly managed under the Hawaiian Islands and Midway Wildlife Refuges. The Council claims that if the State and federal agencies comply with their recommendations, that 24% of the area will be set aside as 'no take'. However, the bulk of the 'no take' areas being proposed are within State waters and are not under Council jurisdiction. Without the State and federal Wildlife Refuge waters included, the Council is proposing only a minimal amount of 'no take' area, which is less than 14% of the harvestable resource area.

Response: As authorized by the MSFCMA, the Western Pacific Fishery Management Council has primary responsibility for conserving and managing fisheries in federal waters, which include waters up to the shoreline at Midway. The Council also has the responsibility for essential fish habitat.

Fishery management plans developed by the Council for crustaceans, bottomfish, precious coral and pelagic fisheries have been enforced in the NWHI since the 1980s. Currently, there are no areas in the NWHI designated as total no-take zones. There are 0-to-10 fathom no-take zones for lobsters throughout the NWHI islands except at Laysan, where the no-take for lobsters is 0 to 20 miles. There are also proposed and established no-take refugia for precious coral species in the NWHI.

The Council's preferred alternatives for its Coral Reef Ecosystem FMP includes a network of no-take zones in the NWHI. The extent of the no-take zones were based on the National Action Plan for Coral Reefs, which calls for 20% no-take MPAs to be established within 10 years. The Council has taken the lead by identifying 14% of the NWHI coral reef habitat as no-take zones. These waters are in federal waters and constitutes 70 percent of the no-take MPA recommended by the National Action Plan (hardly a "minimal amount"). If the State of Hawaii and USFWS agree to similar no-take areas in state waters (0 to 3 miles, except at Midway), the additional 30 percent of the National Action Plan would nearly be met for the NWHI.

Management in waters 0 to 10 fathoms in the Hawaiian Islands NWR by USFWS appears to center around regulating the take of certain marine species by NMFS, which is conducting prey research and shark eradication to help with recovery of the Hawaiian monk seal. At Midway Atoll NWR, critical habitat for monk seals has not been designated and USFWS has signed a long-term contract with Midway Phoenix Corp., which promotes recreational and charter fishing and allows subsistence fishing. While USFWS has developed a set of fishing regulations for residents and guests at Midway Atoll NWR, they are poorly enforced and recent surveys indicate an unusually low ulua population there.

30. Reefs deeper than 10 fathoms around Kure Atoll are given no protection and this is the most isolated atoll, least impacted by fishing and at the Darwin Point. It is amongst the most fragile, complex and unique resources in the NWHIs and is a State Wildlife Sanctuary. Additional protection for this resource area should be considered and was recommended by the plan team but not adopted by the Council.

Response: The SSC recommended half of Midway over Kure for a no-take MPA to 50 fm as both atolls have similar characteristics, and Kure is considered important to commercial fishermen, while Midway has already been closed to such fishing for decades. Half of Midway has been reserved as a low-use MPA to accommodate recreational fishing for ecotourism by the USFWS.

The State could provide protection to reefs around Kure from 0-3 miles from shore, where most reef habitat occurs, but has not done so.

31. The Council has designated all waters from 10-50 fathoms as Special Permit Zones and has indicated they are to be classified as 'low take' areas. However, any vessel that is issued a permit for access to harvest targeted species is allowed to take as many of that species as they want. The restrictions are for gear types or fishing methods not for limits on harvestable quotas.

Response: Issuance of a special permit requires numerous qualifying and operating conditions. Some will require a case-by-case evaluation. The Council is mandated to prevent overfishing of any stock or species, and to restore stocks where overfishing has occurred. Fishery-dependent data will facilitate research to determine what take levels are appropriate to achieve sustainability with ecosystem sensitivity. Harvest quotas may be implemented in the future through the amendment process upon determination of the need.

9.1.4 Comments on Framework Actions

1. VMS should be required on all vessels permitted to fish coral reef resources. VMS would provide a cost-effective increase in enforcement presence.

Response: Requiring VMS on vessels is a preferred alternative for future framework action by the Council for vessels transiting MPAs, if the VMS system is federally funded by NMFS.

2. Vessels should be required to post bonds to cover removal of vessel and gear in the event of a grounding. This bonding process should be modeled after the oil spill version.

Response: Requiring permitted vessels to post bonds is one issue that was considered as a framework measure, but was rejected as infeasible. Instead, the Council developed the preferred alternative where fishing vessels operating or transiting MPAs will be required to have insurance to cover the cost of vessel removal and pollution liability in the event of a grounding, depending on type of permit and fishing area. Also, non-fishing vessels transiting the MPA would be required under the Councils preferred alternative to have insurance to cover the cost of vessel removal and pollution liability in the event of a grounding. This, however, is beyond the Council's direct authority and will require coordination with other authorities.

3. How hard is it going to be to change a non-targeted taxa to harvested? Is it included as a framework provision?

Response: That particular item is included as a framework provision, so it would take 2 Council meetings.

4. Recommends that any designation of new MPAs should be done through the formal amendment process rather than under a framework process so that people have more time to comment on proposed changes.

Response: The Council concurs. Measures such as this, which are highly controversial for the entire fishery or a substantial sector are not suited to the framework process and must be addressed through the FMP amendment process to allow sufficient public comment.

9.1.5 Comments on Non-regulatory Actions

1. Concern that comments of Coral Reef Ecosystem Plan Team members were not incorporated into subsequent drafts of the FMP.

Response: The recommendations of the Coral Reef Plan Team and Ecosystem and Habitat Advisory Panel were incorporated into a draft FMP and were reviewed by the Scientific and Statistical Committee and the Council. The current draft of the FMP describes the management measure alternatives that were endorsed including some proposed by the CREFMP and other alternatives considered by the Council.

2. There is a need to coordinate among agencies and educate decision-makers with respect to the management of coral reef resources.

Response: The FMP identifies non-regulatory measures to help with the effective management of coral reef resources, including: facilitating consistent state and territorial level management of coral reef resources; creating social, economic and political incentives for sustainable use and disincentives for unsustainable use of coral reef resources; and conducting education, public outreach, and "coral reef management diplomacy."

3. Would like every effort made to disseminate information through existing organizations and channels.

Response: Information about the FMP has been disseminated through WPRFMC's existing channels, and public meetings have been advertised in local newspapers and the *Federal Register* and notices distributed to WPRFMC's mailing list.

4. Would like WPRFMC to collaborate with the West Hawaii Fishery Council and other organizations concerned with the conservation of coral reefs to assist in gathering input from the community on the proposed FMP.

Response: The Council process provides numerous opportunities for public participation in the fishery management process. The Council endeavors to notify all interested parties of all pending council actions. One of the non-regulatory goals of the Council is the collaboration with public-private organizations concerned with reefs.

5. Concerned that rules that start in Federal waters may be adopted by the State in the future, affecting fishing in nearshore waters.

Response: This is a valid concern. The goal of the FMP, and numerous state/territory agencies is to achieve consistency in regulation, which facilitates efficiency.

6. Strongly supports objectives of the FMP, which is taking proactive action to protect Federal resources. Also supports the ecosystem-based approach and the implementation of the precautionary principle. Recognizes difficulty in fitting an innovative ecosystem-based plan into the more traditional requirements of the MSFCMA. The November U.S. Coral Reef Task Force meeting in the Virgin Islands provides an opportunity for WPRFMC to draw attention to these problems.

Response: Council Executive Director updated the task force in St. Croix regarding progress with the FMP.

7. The CRE Plan Team should have more management authority over existing FMPs/MUS and formal process for collaboration regarding ecosystem approach.

Response: The Council endorsed the formal process for inter-team collaboration. Existing FMPs sufficiently manage their respective MUS for fishery purposes.

8. Several commentary spoke in support of and encouraged the Council to accept the Plan Team's recommendations.

Response: The Council heard and carefully considered recommendations of the Plan Team; some recommendations were endorsed. Others lacked sufficient justification or were otherwise lacking in meeting the basic goals of the plan for balancing economic productivity and social acceptability with ecological integrity. Specific recommendations of the Plan Team were detailed in the October 6, 1999, and August drafts of the FMP reviewed by the Council.

9. Several commentary spoke in support of and encouraged the Council to accept the Advisory Panel's recommendations.

Response: The Council heard and carefully considered recommendations of the Advisory Panel; a number of these recommendations were endorsed. The Council preferred some adjustments to other recommendations to improve conformity with the goals of the plan. Specific

recommendations of the Advisory Panel were detailed in the October 6, 1999, and August 2000 drafts of the FMP reviewed by the Council.

10. The ecosystem concept of management needs more work.

Response: This plan manages fisheries in coral reef ecosystems, and includes measures to protect ecosystems (gear/method restrictions, MPAs, EFH). Council advisory bodies will continue to meet to better understand and incorporate ecosystem principles in coral reef fishery management; the Plan will be amended in the future to refine the ecosystem management concept. The November draft of the FMP includes an expanded review of ecosystem management concepts.

11. Impacts of proposed regulations on existing fisheries would be significant (i.e., NWHI full time fishermen).

Response: The Council's preferred alternative intends to maintain a balance between ecosystem protection and economic and social impacts. Some of the regulations proposed would indeed have had highly significant economic impacts on NWHI commercial fishermen, which is why (in part) the Council selected against them.

12. NMFS should describe, evaluate, and highlight mechanisms for integrating coral reef management and conservation measures into non-federal and non-fishing actions.

Response: These issues are addressed in Chapter 5 on "Management Measures" and Section 6.4 on "Non-Fishing Impacts" of the FMP, respectively.

13. All other FMPs developed by the WPRFMC and implemented by NMFS should be modified as necessary to meet the requirements of the Coral Reef Ecosystem FMP for activities within the coral reef ecosystem boundaries or for activities outside the boundaries that might still result in impacts on MUS.

Response: The FMP describes a formal process for coordination among plan teams to identify and address impacts of other fisheries to coral reef ecosystems. Some MUS in the FMP are included under the Council's other four FMPs, under which their MSY/OY, EFH, and other fishery characteristics are identified. For these MUS, fishery-level effects and management should be the primary responsibility of the other FMP processes, while ecosystem effects should be the primary responsibility of the coral reef ecosystem FMP process.

14. FMP species managed under other FMPs should not be excluded from the Coral Reef Ecosystem FMP if they spend all or part of their life cycles on coral reefs.

Response: Although this FMP does not necessarily address managed species under other FMPs individually, many may be part of the coral reef ecosystem during at least a portion of their life

cycles and may be key components of the system's health. Some MUS in the FMP are included under the Council's other four FMPs, under which their MSY/OY, EFH, and other fishery characteristics are identified. For these MUS, fishery-level effects and management should be the primary responsibility of the other FMP processes, while ecosystem effects should be the primary responsibility of the coral reef ecosystem FMP process. FMP Section 5.5.3 on non-regulatory measures describes a formal process for coordination among plan teams.

15. WPRFMC should institute a more formal process for future amendments to the draft FMP, wherein any changes must be approved by the recorded vote of Plan Team members.

Response: The Plan Team is one of several advisory bodies to the Council. While the Plan Team and others may recommend changes to the FMP, the Council is responsible for adopting which measures and amendments are appropriate to implement.

16. Lobster fishing should be prohibited in areas out to three miles from shore to protect lobsters and their role in the coral ecosystem and to prevent gear impacts to corals.

Response: Lobster fishing is managed under the Crustacean FMP. For these species, fishery-level effects and management should be the primary responsibility of the FMP processes, while ecosystem effects should be the primary responsibility of the coral reef ecosystem FMP process. The FMP describes a formal process for coordination among plan teams to identify and address impacts of other fisheries to coral reef ecosystems. In the NWHI, lobster fishery is prohibited from 0-10 fm.

17. Both the FMP and research component should include extensive public outreach and collaboration with the respective governments of the U.S. Pacific Islands, all potentially affected communities, and other interested private, local, State, and Federal entities.

Response: Under the management program for the Council's preferred alternative proposed management actions include facilitating consistent state/territory/commonwealth level management of coral reef resources and conducting education, public outreach and "coral reef management diplomacy". These actions are described in the FMP.

18. The DEIS should include a separate section describing specific actions and techniques which will be used to ensure coordination with U.S. Pacific Island governments, public participation, and inter-agency/intra-agency coordination throughout the FMP management and planning process.

Response: The FMP identifies non-regulatory measures to help with the effective management of coral reef resources, including: facilitating consistent state and territorial level management of coral reef resources; creating social, economic and political incentives for sustainable use and

disincentives for unsustainable use of coral reef resources; and conducting education, public outreach, and "coral reef management diplomacy."

19. NMFS should continue to coordinate with the Hawaii Department of Land and Natural Resources, American Samoa Department of Marine and Wildlife Resources, Guam Division of Aquatic and Wildlife Resources, and the CNMI Division of Fish and Wildlife regarding impacts to all native species and habitats.

Response: NMFS will continue to coordinate with local resource agencies on issues that affect native species and habitats. Interagency coordination is a goal of the Plan.

20. A range of non-fishing impacts occur withing the complex coral reef ecosystems of the Northwestern Hawaiian Islands (NWHI). The MSFCMA only authorizes the Western Pacific Regional Fishery Management Council to manage fishing activities. Non-fishing interests do not have representation in the Council Plan development process. Given different user groups interested in obtaining access to the region, strong questions remain whether a Fishery Management Council is the best way to manage federal coral reef resources where multiple uses are occurring among multiple stakeholders, some who have no say in plan development.

Response: By Federal statute the Council is the authority to manage living marine resources in the EEZ. The draft Coral Reef Ecosystem Fishery Management Plan (CREFMP) acknowledges its authority is limited to managing fishing vessels and fishing activities within Federal waters.

The MSFCMA also requires the Council to identify and describe non-fishing impacts to essential fish habitat (EFH) and recommend measures to mitigate any such impacts. The entire NWHI has been designated as EFH by the Council. The Council and NMFS are required to comment on any potential development activities, including non-fishing related activities, that may impact essential fish habitat within the NWHI.

The Council recognizes that comprehensive management of a region (e.g., the NWHI) requires interagency cooperation, considering the various agencies with respective jurisdictional authorities. The current draft of the FMP encourages such cooperation.

Amendments proposed for the re-authorization of the MSFCMA may expand the Council's authority beyond fishing activities.

The Council's advisory bodies include members with no direct connection to the fishing industry sector. The Coral Reef Ecosystem Plan Team is comprised largely of representatives from non-fishing interests, as are the Scientific and Statistical Committee and Ecosystem and Habitat Advisory Panel. Members of the public, including diverse stakeholders and non-government organization representatives, also provide public comment at Council and related meetings. In the process of developing the CREFMP, the Council has worked with the Department of Interior, the Department of Commerce, the State of Hawaii, as well as numerous other agencies.

The composition of the Council includes members from DOI, DOC, and Hawaii. This is consistent with Executive Order 13158, where the President directed the Secretary of Interior and the Secretary of Commerce to work cooperatively with these agencies to develop recommendations for protection and sustainable use of the NWHI.

9.1.6 Comments on Research, Monitoring, and Assessment:

1. There is a need for extensive mapping of the coral reef areas around American Samoa. Mapping of reefs is also a major focus of Task Force working group.

Response: Mapping of coral reef areas has been identified as a high priority research need.

2. A lot more research needs to be conducted on coral reef resources. In addition, research needs to be done on the effects of introduced species on coral reef resources.

Response: The FMP identifies recommended research, monitoring and assessment projects that will help obtain information necessary to more effectively manage coral reef resources.

3. The FMP should clearly state the baseline which will be used to evaluate the potential impacts of the various management alternatives. The baseline should be clearly defined, scientifically credible, local, and have general support from all stakeholders.

Response: Baseline is the current condition of the stocks and ecosystem. Research and monitoring are proposed to better define this. The referenced report by A. Green(1997) provides useful information on the current status of reef resources. The document on "MUS/EFH Descriptions". Also additional information is contained in the DEIS.

4. The FMP/EIS should discuss specific monitoring programs that will be implemented before and after proposed management actions to determine potential impacts on water quality and beneficial uses, and whether maintenance and protection of water quality can be guaranteed.

Response: The FMP is not expected to significantly affect water quality. The Plan Team will continue to evaluate and recommend improvements to the monitoring program after the proposed management actions are in place. An annual report will be produced that summarizes existing fishing activities and impacts.

5. There are currently fewer and fewer fish on the offshore reefs, only sharks. The fishers are not bringing in much fish on a consistent basis. Would like to see a study on the cause of these changes. Also, placing some fish aggregation devices (FADs) on the southern banks, where anchor damage has affected habitat, might help attract the fish back.

Response: The FMP identifies and prioritizes research, monitoring and assessment projects that should be undertaken to obtain information necessary to develop a sustainable coral reef fishery and effectively manage the coral reef ecosystem of the EEZ. One high priority project is to survey and assess biological resources in the EEZ, beginning with areas that are currently being fished. FADs are used to aggregate pelagic species of fish such as tunas, mahi mahi and billfish. The deployment of FADs would do little if anything to mitigate damage caused to bottom habitat caused by vessel anchoring or enhance coral reef/bottom dwelling species of fish.

6. There is a debate on the issue of overfishing in American Samoa waters. One study, using market data, concluded there was a decline in fishing resources, though it could have been an indication of market behavior at the time and not necessarily a decline in stock abundance. More research on this topic is needed.

Response: High priority research needs identified in the FMP include the survey and assessment of biological resources in the EEZ, beginning with areas that are currently being fished.

9.1.7 Comments on the Draft Environmental Impact Statement

1. The draft Environmental Impact Statement (DEIS) should address water quality implications, if any, aquatic resources, threatened and endangered species, subsequent environmental reviews, environmental justice issues, and adequate binational collaboration. Full disclosure of direct, indirect, and cumulative impacts of all proposed actions is critical. The EIS should clearly describe other past, present, and reasonably foreseeable future planning and construction activities in the project area.

Response: These issues are addressed in the revised DEIS, as appropriate.

2. The DEIS should provide full disclosure of possible funding, implementation, enforcement, and monitoring commitments, assurances, and mechanisms for the proposed management actions. The reliability of these mechanisms and legal methods to ensure implementation of FMP commitments should be evaluated. The FMP/DEIS should describe potential options if funding and/or resources prove to be inadequate to ensure full implementation of the proposed management actions.

Response: The DEIS has been prepared following standard NEPA requirements. Alternatives (options) are also discussed and evaluated.

3. The DEIS should describe the measures taken by the Council and NMFS to fully analyze the environmental effects of the proposed action on minority communities (e.g., Pacific Islanders and low-income populations), and present opportunities for affected communities to provide input into the NEPA process.

Response: These issues are addressed in the DEIS. Also see, for a detailed synopsis of community social and economic impacts is included in the FMP and in the "Fishery Impact

Statement" and Appendix B "Regulatory Impact Review and Initial Regulatory Flexibility Analysis". Public hearings will be held in low income communities.

4. The DEIS should include a section on potential effects on local, State and Federal ordinances, regulations, legislation, and laws.

Response: Every effort has been made to ensure that the management measures proposed in the FMP are consistent with state and territorial laws and policies to the degree practicable in order to simplify implementation and assist enforcement efforts.

5. The DEIS should address fishery-related impacts to fish and wildlife resources and habitats associated with each proposed geographic fishery area. USFWS recommends that particular attention be given in the DEIS to addressing fishery-related impacts on endangered and threatened species, migratory birds, coral reefs, and rare, native species and habitats.

Response: These issues are addressed in the DEIS. Fourteen percent of the NWHI reef area is designated as "no-take" zones, and fishing is already restricted in many areas of the NWHI that serve as critical habitats for monk seals and green sea turtles.

6. With regard to federally-listed endangered and threatened species, a biological assessment that (1) evaluates the impacts of the proposed and existing fisheries on listed species and (2) determines whether any such species are likely to be adversely affected by the fisheries must be prepared in accordance with the interagency consultation regulations found at 50 CFR Part 402.

Response: Under the ESA, NMFS is required to prepare and provide an impact assessment, which may serve as the biological assessment for consultation under Section 7 of the ESA, on the impacts of the fishery, as it would operate under this FMP, upon endangered and threatened species and their critical habitats. The NMFS will conduct a consultation under ESA Section 7.

7. The DEIS should identify the federally-protected resource areas that exist either within or near EEZ waters, including their established administrative boundaries. The DEIS should discuss how the impacts to these protected resources from the fisheries activities and management measures will be avoided. The DEIS should discuss the cumulative effects of these impacts over time and propose potential measures to mitigate these impacts.

Response: Impact of fishing activities are addressed in the DEIS (see "Environmental Consequences of Alternatives").

8. The DEIS should discuss the potential for removal of indigenous coral species and establishment of marine alien species, assuming that harvesting platforms and gear could serve as vectors for the introduction of marine alien species. The DEIS should assess the potential for coral reef harvesting to open up substrate for colonization by marine alien

species that already exist in the area or that might be introduced by some other vector (e.g., fishing nets) and the potential for these species to become established and proliferate.

Response: The collection of live hard coral is prohibited for commercial purposes in the plan. Most permitted vessels could be expected to be locally based thus minimizing the threat of introductions. Additional research is needed to better quantify the significance of such proposed threats.

9. Since the FMP is ecosystem-based and there is species overlap among the Plan and other existing FMPs, the DEIS should discuss how and to what extent overlapping species would be managed under various plans. In addition, the DEIS should include a discussion of how the entire coral reef ecosystem would be managed effectively on a sustainable basis under the proposed FMP.

Response: The FMP describes a formal process for coordination among plan teams to identify and address impacts of other fisheries to coral reef ecosystems. Some MUS in the FMP are included under the Council's other four FMPs, under which their MSY/OY, EFH, and other fishery characteristics are identified. For these MUS, fishery-level effects and management should be the primary responsibility of the other FMP processes, while ecosystem effects should be the primary responsibility of the coral reef ecosystem FMP process. This is also discussed in the DEIS.

10. Because of the inter-relationships, the Coral Reef Ecosystem FMP and EIS should not be dealt with separately from the other existing FMPs.

Response: Although this FMP does not necessarily address managed species under other FMPs individually, many may be part of the coral reef ecosystem during at least a portion of their life cycles and may be key components of the system's health. Some MUS in the FMP are included under the Council's other four FMPs, under which their MSY/OY, EFH, and other fishery characteristics are identified. For these MUS, fishery-level effects and management should be the primary responsibility of the other FMP processes, while ecosystem effects should be the primary responsibility of the coral reef ecosystem FMP process. FMP Section 5.5.3 on non-regulatory measures describes a formal process for coordination among plan teams.

11. The FMP may be in violation of NEPA because the commentator believes it is impossible to hold scoping sessions on an EIS when the Council has not determined what actions will be included in the final document.

Response: The scoping meetings were intended to get public input about the issues, problems and range of alternative that should be addressed in the FMP and SEIS. Public hearings and public comment periods will be forthcoming to provide an opportunity for the public to review and comment on the draft FMP/EIS.

12. The DEIS and CREFMP do not appear to adhere to standards of full disclosure when measured against the potential impacts of other draft FMPs which are now in preparation by the Council.

Response: The Council is not preparing any new FMPs aside from the CREFMP, and its accompanying DEIS does consider the impacts of existing fisheries. The Council is only preparing EISs for existing FMPs. These EISs are not associated with significant changes to the management of these fisheries.

9.1.8 Comments on Enforcement

1. At night, the local fishermen see lights out on the water, other non-local boats fishing on the offshore banks. These are the boats that need to be regulated. There is a real need for enforcement with respect to coral reef fishing.

Response: Like all other FMPs implemented by the WPRFMC, NMFS, and the U.S. Coast Guard will be jointly responsible for the enforcement of the Coral Reef Ecosystem FMP. If applicable, cooperative agreements could be developed to deputize local enforcement officers to assist in the enforcement of regulations. Both the USCG and the NMFS agencies undertake surveillance of EEZ waters and have the authority to board vessels at sea and inspect vessels when they come into port.

2. Instead of closing down fishing areas, NMFS should conduct fish surveys to determine which species have been depleted over the last 20 years at FDM, Agrihan and Esmeralda.

Response: The FMP will not close any areas in the CNMI. High priority research needs identified in the FMP include the survey and assessment of biological resources in the EEZ, beginning with areas that are currently being fished.

3. The distinction between Federal and State waters was mentioned, which brings up the concern about enforcement. If the plan is not able to effectively enforce the rules, it is meaningless.

Response: The U.S. Coast Guard and NMFS will be conducting enforcement, and the State will be doing enforcement. One of the goals of the Council is to try to maintain consistency between the actions of the Council, the federal government and the state of Hawaii.

4. The proposed plan does not require automated vessel monitoring systems (VMS) installations. It also does not require that a bond be posted to cover the immediate costs of vessel removal due to groundings. Vessel insurance should also be required for all permit holders in any area in the NWHIs, and not be dependent on the type of permit held, category of vessel, etc. as is currently proposed in the CREFMP. Given that three Council permitted fishing vessels have run aground in State waters either in the NWHIs

or in transit to the area in the past 20 months, the bonds and insurance should be mandatory.

Response: VMS, bonds and insurance were discussed at meetings of the advisory bodies with recommendations made to the Council.

All fishing vessels operating in or transiting no-take MPAs would be required to have insurance through the CREFMP so that in the event of a grounding they could pay for the cost of vessel removal and any legal liability for mitigation of habitat impacts.

VMS can be part of an effective monitoring and enforcement system for state and federal agencies, depending on category of vessel, type of permit and fishing area. A requirement for fishing vessels operating in MPAs to carry remote electronic vessel monitoring systems (VMS), if funded by NMFS, is included for future consideration, for implementation under the framework process.

Bonding was determined to be a socially and economically unfeasible alternative.

9.1.9 Other Comments

1. How will this FMP affect existing, nearshore fisheries in Hawaii?

Response: Under the MSFCMA, the Council has the authority to regulate fishing and other associated activities in federal waters. The management measures contained in the FMP apply only to fishing activities in federal waters. Management of living marine resources in state and territorial waters is the responsibility of the respective state resource management agencies; American Samoa, Department of Marine and Wildlife Resources; Guam, the Department of Aquatic and Wildlife Resources; Hawaii, the State Department of Land and Natural Resources; Northern Mariana Islands, Department of Lands and Natural Resources. The WPRFMC has designated essential fish habitat (EFH), as all bottom habitat and the adjacent water column, from the shoreline to the outer limits of the EEZ to a depth of 50 fm. The designation of EFH in and of itself will not have any biological impact. However, the proposed NMFS and Council consultation process should have an overall beneficial effect on habitats important to managed fisheries in the western Pacific region. A direct benefit of the FMP is the compilation of information on the habitats and life history characteristics of managed species. This information should facilitate the efforts of the Council and NMFS to assess cumulative impacts to EFH and propose measures to mitigate or avoid adverse impacts. Additionally, the review and compilation of the best available scientific data will serve to guide future research necessary to further describe and protect EFH. Second, EFH designation establishes a framework for NMFS and the Council to cooperatively comment on state and Federal agency actions affecting EFH. The comments of these agencies will, in turn, provide more specific guidance on how adverse impacts to EFH can be avoided or mitigated.

2. What do other countries, such as the French Territories and Fiji, do with regard to the management of their EEZ?

Response: French Territories have some closed areas. Fiji has a mixture of contemporary and traditional management, exercised through chiefly authority. The French government has given the Territorial legislature of French Polynesia full management and exploitation authority. The Ministry of Oceans, and in particular the Aquatic Resources Service (ARS) has the task of managing the total EEZ, from 0 - 200 nm, as well as lagoon and reef resources. In addition, the ARS is responsible for managing aquaculture. The Territorial legislature has the authority to negotiate bi- or multilateral fisheries arrangements, as long as the initiative, does not compromise France's international position, especially on defense. The Territorial government has the authority to establish reserves in lagoons or on reefs to protect fisheries resources. There is currently a professional lagoon fisher permit. In addition, the Ministry of the Environment sometimes gets involved when it comes to endangered species, such as sea turtles or endemic species such as the freshwater gobies in our rivers or even the "long-eared" eels. The Territorial government is in the process of establishing coastal or lagoon zone management for Moorea and Bora Bora, with appropriate legal language so that eventually some type of control and enforcement can be attached to it. In these plans there are provisions for zones of restricted activity, such as shark feeding only and no fishing. There have been efforts made to explore the possibility of same sort of reserve zone for stock replenishment in the Society Islands, (hopefully being able to overlap already established Kapu zones so as not to confound or duplicate enforcement) and the Tuamotus in an effort to sustain exploitable populations of things like giant clams, sea cucumbers, trochus, top and green snails. Fiji has reserve provision in their coastal/reef resources management plans. Fiji is an independent country within the Commonwealth of Nations and therefore has full authority of the 0-200 nm EEZ.

3. How does the management of the nearshore resources affect the offshore fisheries and vice versa?

Response: The movement and interaction between marine organisms found in shallow coastal waters and deeper offshore waters is highly species specific and dependent on a multitude of factors. Demersal species typically have a much more restrictive home range then do highly migratory pelagic species such as tuna and billfish. Therefore exchange between populations present in shallow coastal waters and those of deeper offshore waters is relatively limited. Conversely, most coral reef associated species of fish have a pelagic larval phase that may last up to several months. Tunas and other pelagic species of fish range freely throughout the ocean and are often found in shallow coastal waters. More research is needed to quantify the magnitude and importance of these relationships for most species. The Council has strived to develop and implement regulations consistent and complement existing state and territorial fishery management regulations where ever possible. Where state and federal fishery regulations are inconsistent undesirable consequences may occur. For instance, if nearshore fishery resources are mismanaged, overfishing is likely to occur. As overfishing occurs and populations of commercially important marine organisms decline in abundance, fishermen will be forced to move further offshore and in to new areas to fish. This can put unforseen pressure on the fishery

resources found in federal waters and underscores the need for implementing a management regime for coral reef resources found in federal waters.

4. Would vessels from other island areas be able to fish in the EEZ waters of CNMI?

Response: Yes, the Magnuson-Stevens prohibits discrimination between fishermen or residents from different state or territories fishing in EEZ waters. The CNMI government has the authority to promulgate rules and regulations that apply to waters under its management authority.

5. In Hawaii, what is considered State versus Federal Waters?

Response: In Hawaii, State waters extend from the shoreline to 3 nautical miles offshore. Federal waters (the EEZ) extend from 3 to 200 nautical miles offshore.

6. What is the scope of management of the FMP?

Response: The FMP proposes active management, under Federal regulations, of the coral reef fisheries in the waters of the EEZ (3-200 nm) around American Samoa, CNMI, Guam, Hawaii, and the other unincorporated U.S. Pacific Islands.

7. The WPRFMC should be concerned about reef pollution because pollution will wipe out the coral reefs.

Response: The FMP identified pollution and contamination as non-fishing impacts to coral reef resources and recommends conservation measures to minimize these impacts. The MSFCMA does not provide councils authority to regulate sources of pollution or their impacts.

8. Is the intent of WPRFMC to manage the coral reef ecosystem as a whole or simply to manage the fisheries within that ecosystem?

Response: The FMP is the first ecosystem-based plan developed by any of the eight regional Fishery Management Councils. The overall goal of the FMP is to manage coral reef ecosystem on an ecosystem basis to achieve a sustainable balance of economic productivity, ecological integrity and social acceptability. The FMP is consistent with the objectives of the MSFCMA, international *Code of Conduct for Responsible Fisheries*, the report by the NMFS Ecosystem Principles Advisory Panel, the President's Executive Order on coral reefs and the U.S. Coral Reef Task Force efforts. An ecosystem approach to fishery management shifts the burden of proof from determining if proposed harvests will be detrimental to establishing prior to harvest that such activities will not jeopardize the health and sustainability of the ecosystem. A precautionary management approach (as presented in the *Technical Guidance on the Use of Precautionary Approaches to Implementing National Standard 1 of the MSFCMA* and the FAO Fisheries Department *Code of Conduct for Responsible Fisheries*) is employed and steps are taken to ensure against unforeseen impacts to the ecosystem. Fishery management under this FMP is adaptive and builds upon local and regional experiences. A coral reef ecosystem has

ecological integrity if it retains its biological diversity, size structure and abundance over time and when all the elements in the ecosystem, along with the processes and functions that support these elements, are maintained. Solid scientific justification and the power of legal regulation must be coupled with the sincere belief by the resource users, especially those living in closest proximity to the resource, that the management policy is suitable. This suitability must take into account the culture, traditions and political perspectives of all resource users. Another goal of the FMP is to maintain consistency with state and territorial fishing regulations and landing laws, to the degree practicable.

9. Sportfishing needs to be discussed as a use of coral reef resources because it currently attracts many visitors to the management area.

Response: Charter fishing, which includes sportfishing, is discussed in the FMP.

10. How will the WPRFMC handle differences between State and Federal rules?

Response: The Council intends to maintain consistence in state/territorial laws, to the degree practicable.

11. Definition of subsistence should include displacement of indigenous peoples. Indigenous peoples who fish on a subsistence basis should be allowed to sell a portion of their catch.

Response: The FMP must follow the MSFCMA definitions. The MSFCMA defines any catch that is sold as commercial.

12. Management efforts should be based on sound scientific rationale and equitable rationale.

Response: National Standard 2 of the MSFCMA requires that conservation and management measures be based on the best scientific information available. At the same time, the precautionary principle specifies that conservation measures should be implemented even in the absence of scientific certainty that fish stocks are being overexploited. The FMP is consistent with both National Standard 2 and the precautionary principle. In addition, the permit system and other conservation and management measures will not discriminate between residents of different states and territories, consistent with National Standard 4.

13. Plan should apply different regulations to different geographic units.

Response: It does. Some proposed regulations are general for the whole region. Others are more specific, such as MPAs with geographic subzones with special requirements.

14. It is difficult to estimate MSY for most coral reef species.

Response: FMP Chapter 4 includes a section that addresses requirements to prevent overfishing. Harvested taxa with a history of exploitation have catch data that can be used to estimate MSY.

Where this is insufficient data form other similar areas can be used. Where no information exists proxies can be used for MSY with stated assumptions.

15. Restrictions on nearshore fisheries would impact fishermen who are using resources in environmentally sensitive ways.

Response: This FMP will not restrict fishing in most nearshore areas. If the state/territories implement consistent or more stringent regulations in their inshore waters (generally 0-3 nm) existing nearshore fishermen would be impacted; control of such is beyond the scope of this federal plan.

16. Ocean recreation uses and sportfishermen have greater cumulative impact than do the few commercial fishermen.

Response: This criticism has merit in terms of impacts to coral reef ecosystems, especially in nearshore state/territory waters. Management of ocean recreation users is not under the authority of the MSFCMA. Sport or recreational fishing in the EEZ will need to comply with the measures of the plan.

17. The process of developing the FMP may in itself stimulate the types of unregulated activities it seeks to prevent by describing the valuable coral reef resources currently unregulated.

Response: It may, but is assumed to be small. The fact that very little fishing for coral reef management unit species currently exist in the EEZ suggests that it is not economically attractive under present conditions. The plan is being developed as a high priority, following required timetables; regulations should be in effect by mid to late 2001.

18. The standard condition requiring the prohibition of ballast water discharge from fishing vessels should be deleted. It is the commentor's understanding that current USCG regulations fully address this issue and have required vessels to discharge ballast water in the open seas and not in static bay or lagoon environments. Prohibiting ballast discharge by fishing vessels in the EEZ is a rather extreme measure which cannot be enforced.

Response: This standard condition was proposed in an alternative measure that has since been rejected by the Council. Discharge of ballast water is regulated by the USCG, not the MSFCMA.

19. A full analysis of the present status of corals in the Western Pacific, including potential threats, present levels of harvesting, and areas needing protection, should be included in the FMP.

Response: Information about existing coral reef fishing is provided for each island area. Fishing and non-fishing impacts to Essential Fish Habitat (i.e., coral reefs) are described in the FMP. The FMP also identifies EFH and Habitat Areas of Particular Concern (HAPCs).

20. A full analysis of how the FMP complies with the recent Presidential Executive Order to protect corals to the extent practicable should be included in the FMP.

Response: The FMP discusses the relationship between the FMP and Executive Order No. 13089.

21. Concern about where the FMP will be implemented, including limitations to the FMP to federally-controlled waters (3-200 miles). If this is the case, a large portion of the NWHI, FDM, and other areas of significant importance to indigenous communities will not be afforded protection under the Plan. Under Executive Order 13089 all coral reefs should be provided protection.

Response: Executive Order No. 13089 applies to the WPRFMC only in its areas of jurisdiction. Other coral reef areas are managed by other Federal, state, territorial, and commonwealth agencies. These other Federal agencies are also subject to the directive of the Executive Order.

22. Recommends revising the definition of "subsistence fishing" to read: "harvest of resources for non-commercial use, with the exception of indigenous residents who may sell their harvest; such subsistence sales are not to exceed $30,000 per person, per year."

Response: The MSFCMA, which councils are mandated to follow defines any catch that is sold as commercial.

23. What is the definition of sportfishing, recreational fishing, commercial fishing and charter fishing? Fishermen do not support the fact that if they sell one fish during the year, they are considered commercial rather than subsistence fishermen.

Response: The Council derives it authority to manage fishing activities in federal waters from the MSFCMA. The MSFCMA defines commercial fishing as follows: The term "commercial fishing" means fishing in which the fish harvested, either in whole or in part, are intended to enter commerce through sale, barter or trade. Therefore, if a fishermen sells any portion of his/her catch by definition he is a commercial fishermen under the MSFCMA. The Act defines recreational fishing as "....fishing for sport or pleasure."

24. Considering the FMP document is extremely long and technical, the time period for public comments is far too short.

Response: The Administrative Procedure Act requires a 45-day comment period for proposed rules that would implement a FMP. The proposed rules for this FMP will be published for public comment with the requisite comment period after NMFS receives the proposed FMP and regulations.

25. How can the mandate of the Magnuson act regarding essential fish habitat affect the plan for polluted runoff in Hawaii? When commentor read the mandate from congress, it only specifies that the NMFS has the power to advise states and their actions, but could this be extended to advise the states in their regulation of private actions that would affect the water? In other words, how far does essential fish habitat provisions reach?

Response: The MSFCMA states that Councils are required to describe and identify essential fish habitat (EFH) based on all life stages of the managed species, with no limitations placed on the geographic location of EFH. EFH may be designated in state or federal waters depending on the biological requirements of the species. Regarding actions that occur in state waters that may adversely affect EFH, the Magnuson Act provides authority for NMFS and the Councils to provide EFH conservation recommendations. The Council has designated EFH and Habitat Areas of Particular Concern (HAPC) for its four existing FMP. The Coral Reef Ecosystem FMP proposes to designate additional areas as EFH and HAPC. Once EFH designations are approved by the Secretary of Commerce, NMFS is required to undertake consultation with federal and state agencies that authorize, fund or undertake actions that may adversely effect EFH. The MSFCMA Sections directs NMFS and the Councils to provide comments and EFH conservation recommendations to Federal or state agencies on actions that would adversely affect EFH. Such recommendations may include measures to avoid, minimize, mitigate, effects on EFH resulting from actions or proposed actions authorized, funded, or undertaken by that agency. The MSFCMA requires all Federal agencies to consult with NMFS on all actions, or proposed actions, authorized, funded, or undertaken by the agency, that may adversely affect EFH. Federal agencies are required to respond in writing to EFH comments. States are not required to respond to the NMFS or Council's recommendations for measures to avoid, minimize or mitigate adverse impacts to EFH, including non-point source pollution from run-off from upland areas in coastal water sheds.

26. Whatever can be done to encourage federal and state cooperation in maintaining essential fish habitat is going to be important in the future.

Response: The Council agrees. Coral reef ecosystems occur within all jurisdictional boundaries throughout the U.S. EEZ in the western Pacific. Therefore, the implementation of this FMP will require federal, state, territorial, and other governmental agencies to work together to address mutual management concerns and collaborate on the needs for effective coral reef research and management. This inter-agency collaboration is consistent with the goals of the Coral Reef Task Force, to create a nationally coordinated, long-term coral reef protection program.

27. In CNMI, all federal waters go to the shoreline. However, the Council recommends no exception be granted for subsistence fishermen from permitting and reporting requirements. There is a group of truly subsistence fishermen in Saipan Lagoon who have practiced their own sort of community bases mechanisms of management. Therefore, it is important to address this jurisdictional issue clearly in the plan.

Response: The Fishery Rights of Indigenous Peoples Advisory Panel discussed the issue of permitting and reporting for subsistence fishermen in waters under the Council's jurisdiction. They understood the reasoning for exempting subsistence fishermen from a permitting process, but felt that the information produced from reporting was necessary for effective fishery management. Therefore, the panel recommended to the Council that true subsistence fishermen should be exempt from permitting requirements, however they would be required to report catch data. The FMP intends to apply to waters 3-200 miles from shore around CNMI

28. What Guam needs is a patrol boat, as many foreign fishing boats come to the islands and fish without the VMS on. They are able to fish in rougher water when the local fishermen cannot make it out.

Response: Foreign fishing is prohibited within the EEZ unless it is authorized by an international fishery agreement that existed prior to the passage of the Magnuson Act, or it is authorized by a Governing International Fishery Agreement. However, no such agreement exists in both the CNMI and Guam. None the less, the Council does not require fishing boats to carry electronic VMS with the exception of the Hawaii-based longline fishery. A framework measure is proposed in the FMP, certain types of fishing vessels (i.e., dependent on category of vessel, type of permit or fishing area) transiting through MPAs to carry remote electronic VMS, if funded by NMFS. Regarding enforcement, the U.S. Coast Guard has 2 cutters which patrol the EEZ of Guam and the CNMI. In addition, aerial reconnaissance are also conducted by Coast Guard aircraft around both EEZs.

29. Through the coral reef initiative from the President's executive order, perhaps there could be a way to approach the Coral Reef Plan Team management and maybe modify the Magnuson Act to allow a better approach

Response: The Coral Reef Ecosystem FMP embodies many of the goals set forth in the Presidential order. The Magnuson Act is up for re-authorization and a number of modifications to the Act are being considered to help further the goal of ecosystem management.

30. In the EIS, there should be a clarification of the relationship of the U.S. federal jurisdiction and any authority of Guam of the 200 mile zone.

Response: In Guam, the relationship between territory and federal jurisdiction are clearly delineated. (0-3 miles for Territory; 3-200 miles for federal).

31. Is there some mechanism to get the U.S. Coast Guard involved, and have their resources available for groundings? In Guam, ships bearing Chinese aliens ran aground on reefs, and the U.S. Coast Guard would take responsibility until the oil that was leaking out was gone. It would not take responsibility for the damage that was occurring from the ship up on the reef.

Response: The Coast Guard's mission is for marine safety and environmental protection. Their first duty is to protect America's interests on the seas. Their response to a mission is based upon priority determined by their command. Their highest priority is protection of human life and then the environment. A decision was made to limit the expenditure of their resources to mitigating the environmental damage caused by the spill. Comments can be made directly to the U.S. Coast Guard through their regional commands or the Department of Transportation by phone, fax , mail or electronically.

32. According to the Magnuson Act, it supports cultural sensitivity, so if there was no Hawaiian cultural member of the Plan Team then the process has been in error.

Response: The MSFCMA recognizes that there are unique historical, cultural, legal, political and geographical circumstances in the Pacific Insular Areas. Individual Councils are responsible for establishing and administering plans for the management and stewardship of fisheries. The Councils are responsible for ensuring a wide participation in the process. It is a democratic process that calls for participation by the State, fishing industry, environmental organizations, consumer organizations, native representatives and other interested persons. The Council advisory panel on Native and Indigenous Rights have reviewed and comments on the plan. The Council may choose to agree with recommendations made by the participants or may not. It is the Council's decision. The Western Pacific Regional Fishery Management Council has been fair in balancing the needs of the industry with the concerns of the participants.

33. There may be an error in the statement regarding 94% of the coral reefs lies within U.S. jurisdiction. Under the Hawaiian Homes Commission Act 5F, in Hawaii some of these submerged lands exceed the three mile limit, so there is a problem with jurisdiction there.

Response: The Hawaiian Homes Commission Act was passed by the U.S. Congress in 1920. Currently, the Hawaiian Homes Commission Act is administered by the State of Hawaii with oversight by the Department of Interior. Section 5f of the Admission Act, identifies five uses that proceeds from the ceded lands trust, the former Crown and Government lands of the Kingdom of Hawaii, can be used. Submerged lands are dealt with under section 5i of the Admission Act. Submerged lands are a special class of lands defined by the U.S. Supreme Court. Submerged lands are those lands under navigable waters of the state that can be put to uses that benefit the public, e.g., piers, runways, etc. In Hawaii, it is argued that the submerged lands are part of the ceded lands trust. The 20% of the Ceded Lands trust is set aside for Native Hawaiians. Jurisdiction is an issue that remains unresolved.

34. There is a concern that the Council has intentionally excluded species listed under existing fishery management plans from coverage by the CREFMP. This decision is contrary to an ecosystem approach. The Presidential Executive Order 13089 provides that the Council must "ensure that any action authorized, funded, or carried out will not degrade the conditions of coral reef ecosystems." Therefore, the CREFMP should be developed in a manner that protects the marine ecosystems of the Western Pacific, and species listed under other FMPs must be included.

Response: Species were excluded because they were managed under another FMP. In an attempt to avoid overlapping jurisdictions they were excluded from the CREFMP. We will re-examine their exclusion and review the standards developed by the Ecosystems Principles Advisory Panel in their submission to Congress in April 1999. FMP's have been managed on a species basis. What we are finding is that there is very little research and data available for the large amount of species that are extant in the Coral Reef Ecosystem. Without sufficient data it is difficult to make recommendations for their management. The change from Management Unit Species to Ecosystem Based Management will be difficult transition. The EFH provisions of the MSFCMA requires Councils to move beyond traditional single-species and multi-species management and to begin to consider a broader, ecosystem-based approach to fishery management. The Councils are now required to begin to consider the ecological role (e.g., prey, competitors, trophic links within food webs etc) played by MUS. Further, Councils are now required to identify and minimize adverse impacts to EFH that result from both fishing and non-fishing activities. Throughout CREFMP ecosystem impacts of all FMP fisheries are consisted and addressed through a formal process of plan team coordination.

35. Would rather see money spent on stiffer regulations for longliners and tuna boats than studies on inshore fishing where mainly subsistence fishing occurs.

Response: The Longline Fishery is a managed fishery that occurs in the EEZ of the United States. The MSFCMA mandates the Council to establish Fishery Management plans for the fisheries in the U.S. EEZ - 3 to 200 miles offshore. Inshore fishing is an unregulated harvesting of the resource under the State's jurisdiction - 0 to 3 miles. We need data on shore fishing to determine the sustainable amount that can be taken from shore. What and how much is taken? How much is sold? Where is it taken?

36. It should be noted that the 200 mile zone is under protection of local Guam laws, what is the relationship of U.S. Federal jurisdiction?

Response: The Federal Government claims 3 miles to 200 miles as the U.S. EEZ. Federal laws apply in that area and are enforced by the U.S. in that area. Problems will arise where there might be conflict between federal laws and local laws governing those areas. The best way to avoid the conflicts would be to negotiate and amend those laws to reduce the conflict.

37. Providing fixed moorings is a good idea, especially in places like Palmyra and Kingman where anchor chain can damage pristine coral areas. The U.S. navigational charts list an extensive shallow coral bank as a mooring area.

Response: Fixed moorings are a good idea. There are problems associated with fixed moorings but they will be examined for applicability and are considered in the FMP as a framework option.

38. The 50 fathom rule does not make sense, because the drop off is from seven fathoms to 200 in about 10 feet around Palmyra and Kingman Reef.

Response: The 50 fathom rule was adopted because it is the extreme of where algae and coral will grow and of course there will be exceptions and amendments needed to fully protect the Coral Reef Ecosystem.

39. Sudden storms may require anchoring in shallow areas.

Response: The prevention of loss of life is provided for in Maritime Law through exemption for emergency anchoring.

40. Satellites should have been put up to identify every boat that comes within our boundaries.

Response: Identifying boats by satellite would be very difficult. However, there is an effort to establish an international Vessel Monitoring System for all vessels. Every boat owner must agree to have a VMS installed on their boat for effective and efficient monitoring. VMS is included as a framework measure for possible future implementation.

41. The regulations coming down might not affect us right now, but will before long; the market demand is always going to be there.

Response: The effort of the Council is always to balance the interests of the stakeholders in the resource, including the general public. Rules and Regulations are established to allow the sustained use of the resource for the benefit of the people.

42. Need to work out jurisdictional issues before the Council can enforce regulations in the NWHI.

Response: The effort is to get the federal and other agencies to work together in the planning for and the management of the resource, possibly through Memorandum of Agreements.

43. Ulua should be included as a management unit species list.

Response: Ulua is included as a MUS under the bottomfish FMP.

44. The current version of the Coral Reef Ecosystem Management Plan (CREFMP) still exempts existing Fishery Management Plans (primarily bottomfish, crustaceans and precious corals) from inclusion in the management measures proposed under the CREFMP. All species of groupers, jacks, and snappers (which represent the majority of apex predators) were recently moved into inclusion in the Bottomfish FMP. The organisms are clearly part of the coral reef ecosystem, and this type of fragmenting of reef organisms into separate management plans points to the inadequacies associated with the CREFMP in managing resources at an ecosystem level. Inclusion of other FMPs under the CREFMP is a necessity if the plan is to be considered as an ecosystem management plan.

Response: The current version of the FMP prohibits all fishing in no-take MPAs (i.e., no exemptions for existing FMP fisheries). Elsewhere, current fisheries are subject to management restrictions under their respective FMP, which include consideration of habitat impacts.

Prior to the establishment of the Coral Reef Ecosystem Plan Team the Council requested that all species of emperors, snappers, jacks and groupers be added to the BMUS list in the Bottomfish FMP. Most of these species are from CNMI, Guam and American Samoa and have been reported in the catch from these bottomfish fisheries for years. The required amendment has not yet been completed.

A formal process for Plan Team coordination, as recommended by the Coral Reef Ecosystem Plan Team, is included in the CREFMP to address any potential ecosystem concerns from existing fisheries.

The CREFMP was developed as a mechanism for incorporating ecosystem approaches into the present regulatory structure created through earlier FMPs for bottomfish, lobster and precious corals. The FMP is intended to serve as a demonstration "Fisheries Ecosystem Plan."

Aspects of the FMP that contribute to the ecosystem approach include: 1) measures to prevent overfishing and reef degradation; 2) prohibition on destructive and non-selective fishing methods; 3) characterization and protection of essential fish habitat; 4) no-take (i.e., no fishing) and low-use MPAs; 4) permit and reporting requirement to monitor changes in coral reef health; 6) insurance for fishing vessels in MPAs; and 7) interagency collaboration for reef protection against other impacts.

There is poor understanding of the basics, much less the intricacies, of coral reef ecosystems. Ecosystem-based management, therefore, is a long-term goal that can only be achieved over time as new information allows for improved decision-making. Collection of new data and feedback for adaptive management are key elements of the proposed FMP. Comprehensive research is necessary to support ecosystem-based management; ongoing programs must continue and be expanded.

45. Existing impacts, such as the continuous dropping of lobster traps on coral reefs, have not been addressed under the CREFMP nor are they considered under the existing Crustacean FMP. Observer data clearly show that some live coral is being brought up in the traps, yet the Council considers traps to be a non-destructive fishing gear in the CREFMP. Destruction of the coral reef habitat and substrate clearly has the potential to affect the overall integrity of the ecosystem, yet management measures to assess this impact are not addressed in either FMP. The plan also permits fishing with other types of non-selective gear such as gill nets, which and has few limitations on the types of fishing gear. Questions regarding what other impacts are not being addressed due to gaps in the plans, and the exempting the fishing specific plans from the CREFMP remain.

Response: The current draft of the CREFMP includes a "Fishing Gear Catalog", which discusses habitat impacts from lobster traps and other gear. Research is proposed to investigate such anecdotal observations.

Typically, lobster traps are set in areas of relatively low structural relief, away from coral reef habitat. If traps are set too close to coral reef and other high relief habitats, lobsters cannot be enticed to enter the traps. The occurrence of live coral in lobster traps is rare. Damage to the coral reef ecosystem is also not considered significant as the fishery typically includes less than 8 vessels and lasts only a few weeks per year.

The existing Crustaceans FMP includes a requirement to prevent significant impacts to essential fish habitat. The allowable gear list in the FMP has been chosen based on selective non-destructive characteristics of gear and its usage. Fishing for coral reef resources in the NWHI is practically non-existent outside of current FMP-regulated fisheries. Current State regulations also allow most of these gear types.

46. Coral reefs represent the most complex community of species on earth. There is a very tight inter-dependency of the organisms found on coral reefs. As such reef ecosystems are more susceptible to the impacts of any harvest than that seen with a single species. In addition, the significantly lower rates of coral growth found in the NWHI makes the area more susceptible to all impacts as the corals are at the edge of their range of tolerances. It is important to recognize these factors and develop a fisheries management plan that is truly ecosystem based, without myriad other fisheries covered by separate management plans.

Response: Fishing has occurred in the NWHI for hundreds of years yet the area is still referred by many as "pristine." Coral reefs are in good-to-excellent condition there. Commercial fishing activity is at an all-time low, due largely to regulations implemented by the Council, including limited entry. The NWHI lobster fishery is currently closed.

The coral reef ecosystem FMP was developed over a period of about six years through a collaborative effort of contractors, Council staff, Council advisory bodies and public input. Nine advisory bodies and the S.C. deliberated several times over the past two years over successive drafts of the CREFMP to formulate recommendations to the Council. The Council's present preferred alternative for the FMP represents the best balance of concerns from its diverse constituency to manage coral reef ecosystems consistent with the goal of the plan to balance ecological integrity, economic productivity and social acceptability. (Further ecosystem aspects of the plan are introduced above.)

47. The CREFMP permits harvesting of live rock and coral, despite a state law prohibiting such activity.

Response: The CREFMP prohibits the commercial take of live rock or live coral, including bulk harvesting or extractive activities, since it would result in the removal of habitat essential to fish and other benthic resources.

The Council also found it reasonable to allow take of small amounts of live rock/coral by indigenous peoples, under a special permit, for traditional and ceremonial use, and by aquaculture operators, under special permit, for use as seed stock. Limited collecting, under a special permit, would also be allowed for scientific research and management activities, including single harvest of a particular species (i.e., bioprospecting).

9.2 Public Comments and Hearings on the CREFMP DEIS

Between January 16th and February 5th, 2001, ten public hearings were held on the Coral Reef Ecosystem DEIS. Approximately 100 people attended the public hearings. The Council also received 23 written comments by February 26th, 2001, the end of the 45 day public comment period.

Agana, Guam	16 January 2001
Saipan, CNMI	17 January 2001
Kahului, Maui	19 January 2001
Kaunakakai, Molokai	22 January 2001
Kona, Hawaii	23 January 2001
Hilo, Hawaii	24 January 2001
Lihue, Kauai	25 January 2001
Lanai City, Lanai	26 January 2001
Honolulu, Oahu	29 January 2001
Fagatogo, American Samoa	05 February2001

9.2.1 Summary of Public Comments on the Draft Coral Reef Ecosystem FMP Environmental Impact Statement

Ten public hearings were held on the Coral Reef Ecosystem DEIS in American Samoa, Guam, CNMI, Hilo, Kona, Oahu, Maui, Molokai, Lanai, and Kauai between January 16, and February 5, 2001. Approximately 100 people attended the public hearings. The Council also received 23 written comments by February 26, 2001, the end of the 45-day public comment period.

Many comments recommended that the Coral Reef Ecosystem FMP and EIS be made fully consistent with President Clinton's Executive Orders 13178 and 13196 for the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve (NWHI CRE Reserve). Due to the complexity of issues and uncertainties contained in the executive orders, the Secretary of Commerce has not made a final determination on the interpretation of its provisions while President George W. Bush's administration currently reviews the executive orders. The Coral Reef Ecosystem FMP and EIS now address the provisions of the executive orders to the extent possible. The NWHI Reserve will be further addressed when the Department of Commerce has clarified its interpretation of the provisions contained in the executive orders and establishes final departmental policy on all issues.

On March 8, 2001, the Coral Reef Ecosystem Plan Team and the Ecosystems and Habitat Advisory Panel was jointly convened to discuss and provide comments on public comments pertaining to the Coral Reef Ecosystem FMP and EIS. On March 12, the Council reviewed an initial draft of this document and agreed to allow more time for review of the public comments. The Coral Reef Ecosystem Plan Team met again on April 11-12, 2001 to further discussed these comments and comments provided by the Department of the Interior and make recommendations to the Council. In May, the Council's Scientific and Statistical Committee (SSC) also reviewed the public comments and provided their recommendations to the Council.

On June 21, 2001, based on evaluation of public comments and recommendations by the SSC, Plan Team and Advisory Panel, the Council endorsed the preferred alternatives of the FMP and EIS with several modifications, and directed staff to incorporate the necessary and appropriate hanges in the final documents.

The following is a list of comments submitted during the public comment period and responses prepared by Council staff as interpreted, based on the language contained in FMP and EIS and justification of the Council's preferred alternative.

9.2.2 Comments on Marine Protected Areas

1. The Council should not create a marine protected area around Rose Atoll, as Rose Atoll and its surrounding three miles are Territorial lands and seas, and the Council has no jurisdiction in these waters. Rose Atoll also makes a significant contribution to the 20% no-take marine protected area relating to Clinton's Coral Reef Initiative. (T. Sunia)

Response: The lands and waters of Rose Atoll were specifically withheld from transfer to the Territory of American Samoa. On February 1, 1975, President Gerald Ford, by Proclamation No. 4347, exempted Rose Atoll from a general conveyance of submerged lands around American Samoa to the American Samoan government. Submerged lands out to 3 miles around Rose Atoll would be under the joint jurisdiction of the Department of Commerce and the Department of Interior. Pursuant to this joint jurisdiction and in cooperation with the government of American Samoa, fishing is not permitted within the 3 mile USFWS Refuge boundary.

2. If Rose Atoll is designated a "no-take" MPA to a 50 fm depth, this action would reduce by over 90% the size of the existing no-take area already in place (Rose Atoll NWR). This would not provide the "substantial additional protection" that it claims. (National Parks Service)

Response: Designation of the 50 fathom area around Rose Atoll as an MPA does not replace or reduce the protection offered by its designation as a NWR. This provision would have an overlay effect, providing additional protection such as requiring vessel insurance.

3. Although no coral reefs occur in deeper portions of the existing refuge at Rose Atoll, that area is needed as a no-take buffer zone for enforcement purposes. Proposed MPA

boundaries facilitate poaching. A no-take buffer zone at least 1 mile wide (seaward of the 50 fm line) would improve protection from poaching. (NPS)

Response: See above two responses.

4. Proposed boundaries may impact threatened species, as Rose Atoll is probably the last remaining place in AS where green turtles nest. The proposed reduction in the Refuge would increase the potential for adverse interactions between fishing activities and turtles. (NPS)

Response See response to first comment.

5. The map of Rose Atoll is misleading, as it shows only the two small islands but neglects to show the rest of the atoll even though the whole atoll is exposed at low tide. If the missing parts are added, it shows more clearly how the fishing vessels could fish as close as about 500 m around the whole atoll under the preferred alternative. (NPS)

Response The map of Rose Atoll showing the extent of emergent land and coral reef habitat 0-50 fathoms was generated using existing NOAA Mercator projection charts.

6. How will the executive orders establishing the NWHI Coral Reef Reserve affect the MPA portion of the CREFMP? (National Audubon Society-NAS, USFWS, D. Raney, DLNR, Environmental Defense Fund (EDF) & others)

Response Discussion of executive orders 13178 and 13196 are contained in FMP Section 9.2-Other applicable laws and policies. At this time, there are numerous provisions of the orders which remain to be clarified by NOAA. In addition, the EO establishing the NWHI CRER is under review per letter received from the Secretary of Commerce dated June 30, 2001. Therefore, the FMP will be revised, as appropriate, to be consistent with NOAA's interpretation of these Executive Orders.

7. Support the use of marine zoning and establishing no-take and low-use zones in the NWHI, as it demonstrates a precautionary and proactive approach. (NAS)

Response The CREFMP incorporates the concept of marine zoning and will continue to use zoning in the management regime based on user group needs, ecosystem concepts and available scientific information.

8. The draft CREFMP helped to advance much of the no-take areas identified in EO 13178. (Center for Marine Conservation- CMC)

Response The Council recognizes this, as well as the use of the 50 mile Protected Species Zone to define the NWHI Reserve boundaries.

9. The entire NWHI should be "no take" from 0-50 fm until research can determine the needs of monk seals are met while also being able to support a commercial fishery. (W. Gilmartin)

Response: Designated as no-take, shallow water 0-10 fm represent the majority of the developed coral reef ecosystems in the NWHI which provides habitat for the majority of coral reef species of which, many are believed to be utilize by monk seals as a source of prey. Additionally, French Frigate Shoals and Laysan Islands represents important areas for monk seals and have been established as no-take MPAs from 0-50 fm along with the Northern half of Midway Atoll. Under alternative 4, the Council considered maximum additional protection to a depth of 100 fathoms however, chose to provide for a management plan which balances conservation and protection with sustainable use of resources under a special permit system in NWHI waters (10-50 fathoms).

10. The NWHI should be fully protected from all taking. (D. Dresie)

Response: See comment above. This alternative was analyzed in the EIS. Under NEPA, a range of alternatives are analyzed from a no-action alternative to a no-take designation out to 100 fm.

11. There are no "no-take" areas because 0-10 fm are all under state waters.

Response: In Federal waters, no-take areas between 0-10 fathoms occur in a number of locations including Nihoa, Necker, Lisianski Islands, French Frigate Shoals, Maro Reef Midway Atoll and other areas.

12. The NWHI are our last opportunity to save an ecosystem that needs strict and enforceable restrictions. Restrict all fishing except subsistence, tag and release off Midway, and scientific research. (Hilo Public Hearing)

Response: The reefs of the NWHI sustain a healthy ecosystem, based on numerous inter-agency studies conducted in the early 1980s and over the past few years. A comprehensive survey of the NWHI completed in late 2000, described the ecosystem as "pristine." This is true in large part because of the implementation of limited-entry fisheries under a strict management regime by the WPRFMC. Implementation of the CREFMP will provide for additional conservation and protection of coral reefs and coral reef associated species. Additionally, the CREFMP also allows for a means to assess the impacts of activities conducted in the coral reef ecosystem including commercial and subsistence fishing, tag and release, and scientific research.

13. The DEIS provides no site-specific justification for the selection of the three "no-take"areas at French Frigate Shoals (FFS), Laysan Island and the northern portion of Midway. Midway should not be included as no-take, instead, Kure Atoll and Pearl and Hermes should be designated as no-take to a depth of 50 fm.(D. Gulko)

Response: The selection of the northern half of Midway, Laysan and FFS as MPA were chosen based on a number of reasons including the Coral Reef Task Force (CRTF) recommendation that MPAs be established by criteria such as representative habitat types. French Frigate Shoals was selected as it represents unique geological characteristic as well as being an important monk seal colony. Laysan Island represents a habitat in the middle of the chain as well as a sensitive monk seal pupping location. The northern half of Midway Atoll was selected as it represents a northern coral reef habitat in the chain. The selection of these areas also takes in to account compromises by fishermen giving up other fishing grounds. This approach allows for a balance of preservation of the ecosystem in the closed area with minimal negative socioeconomic impacts, and the potential for benefits resulting from spillover. The three areas also make an important contribution towards protecting 20 percent of the NWHI, a CRTF 10 year goal. At its 77th meeting in May, the SSC found this site-specific justification to be adequate for the present and recommends continued support for the Council's preferred alternative.

14. The no-take MPAs should be 25 fathoms or deeper. (D. Gulko)

Response: The Draft CREFMP analyzed a range of alternatives, including no-take 0-100 fm. In developing the MPAs for the CREFMP, the Plan Team and Advisory Panel, recommended no-take MPAs to be established 0-10 fm because it represents the majority of the developed coral reef ecosystems in the NWHI, and is considered habitat important to both monk seals and sea turtles. Additionally, under the preferred alternative, the Council selected no-take MPA 0-50 fm around Laysan, French Frigate and the northern portion of Midway, taking into account, fishing activity, representative habitat types of the NWHI and the existing marine resources and monk seals populations located there.

15. All involved with the public hearings on the NWHI marveled at the pristine beauty of the area, and for 25 years WPRFMC has managed fisheries of the NWHI in a responsible and sustainable way. The CREFMP continues this excellence. (J. Cook)

Response: Noted.

16. The EO issued by President Clinton in his quest for legacy does not serve the interests of the American people. (S. Martin)

Response: Noted. The Council is required to abide by all existing executive orders, rules, statutes, and codified regulations.

17. The measures proposed in the DFMP should not prohibit the development of a low-impact catch and release shallow-water recreational fishery at Palmyra. Should reclassify the Palmyra designation to "low-use." (C. Cook)

Response: At its June 2001 meeting, the Council evaluated all advisory group recommendations on this comment and chose to re-designate Palmyra Atoll from a "no-take" to a "low-use" MPA.

18. A recreational fishery around Palmyra could serve as a deterrent and policing device for illegal fishing. (C. Cook)

Response: Valid point. See comment above.

19. The FMP should be revised to accept the seaward boundaries as asserted by the USFWS of all National Wildlife Refuge units in the Hawaiian islands and U.S. Pacific Remote Island Areas, including the recently established refuges at Kingman Reef and Palmyra Atoll, and acknowledge that the Refuges have the authority to manage all activities within these refuge boundaries. (E. Gilman, NAS, D. Gulko)

Response: The Department of Commerce (NMFS) has joint jurisdiction with the Department of the Interior (USFWS) in certain marine areas and will continue to work in cooperation to manage fisheries in accordance with the requirements of the MSFCMA and other applicable laws.

20. The restrictions on anchoring at Guam's southern banks is a good idea, but why is this limited to large vessels and only one location? (W. Gilmartin)

Response: The Council was made aware that this is where the problem occurs, and the source of the problem is limited to large vessels.

21. The military's activities at Farallon de Medinilla have made it a "de facto MPA", so why should fishermen be given access to an area that has been serving as a replenishment zone for years, then create new restricted MPAs in an adjacent area? (U.S. Navy)

Response: Council and SSC are unaware that FDM serves as an MPA or replenishment zone. According to the EIS- Military Training in the Marianas, the ocean areas surrounding FDM are presently accessed and used by commercial and sports fishermen. However, it is noted that access is restricted to an area of 5 km while live ammunition training is being conducted at FDM.

22. At FDM, the Navy has surveyed the nearshore marine resources and shown that the military training has had minimal impact on the marine communities. (U.S. Navy)

Response: Noted.

23. Lack of analysis is given to the significance of national wildlife refuges with marine boundaries. The DEIS proposes some level of fishing within established boundaries of some of the refuges. (USFWS, E. Gilman)

Response: See FMP section 9.3 and EIS section 5.5. The EIS does not propose fishing within any of the refuges. The Department of Commerce (NMFS) has joint jurisdiction with the Department of the Interior (USFWS) in federal waters and will continue to work in cooperation to manage fisheries in accordance with the requirements of the MSFCMA and other applicable laws.

24. Any research conducted in a no-take MPA should be directly related to the management of the no-take MPA itself. (DLNR)

Response: Noted. Bonafide research from a scientific research vessel cannot be restricted or managed under the MSFCMA. Further, studies to determine the health of fishery resources within no-take MPAs could establish a baseline which then could be used to evaluate the efficacy of the no-take MPA or to determine fishing impacts in non-MPA areas.

25. The proposed MPAs would constitute the sole ecosystem protection mechanism in the CREFMP, therefore it should be larger. (Kauai Public Hearing)

Response: Many other ecosystem protective measures are included in the preferred alternative, including permitting and data collection, allowing only selective gear and adaptive management to address unforeseen ecosystem issues should coral reef fisheries in the EEZ develop in the future.

26. In MPAs, there was no stock assessment completed to understand the biological diversity in the area, and since they are closed it will be impossible to open them again. (Guam Public Hearing)

Response: The preferred alternative would simply restrict anchoring by large vessels and not ban fishing. Further, stock assessments are most cost-effectively conducted through collaboration with existing fishing activity. Boundaries of no-take and low-use MPAs can be modified through amendment once they are better understood.

27. The public is denied access to a resource, but the scientists are getting more and more money to conduct research in the area that is closed. (Guam Public Hearing)

Response: Social and economic impacts of the no-take MPAs are considered by the plan. Designated no-take areas does not mean that the public is denied access to visit the resources, it only means that the public is not permitted to remove the resource from those particular areas.

28. Questioned the authority of Federal control over Guam's EEZ and marine resources found therein. Stated that several laws were passed in Guam claiming jurisdiction over all living and non-living resources within the entire EEZ. (Organization of People for Indigenous Rights- OPIR)

Response: Pursuant to the Territorial Submerged Lands Act of 1974, the Governments of Guam, and American Samoa own and have management responsibility for submerged lands and coral out to three geographic miles (except at Rose Atoll, American Samoa). Submerged lands and corals seaward of this three mile boundary are owned and controlled by the United States government.

9.2.3 Comments on Fishing Permits and Reporting Requirements

1. How will the general permit system assess capacity limits for the fishery, as it is ecosystem based. (DLNR)

Response: This FMP creates a framework structure to implement the general permit and facilitate specific data collection requirements for assessing fishing effort, methods, total pounds of target and all bycatch species. Additionally, as done in other fisheries, the Council, through the Secretary, may also implement other management tools such as moratoriums and limited-entry programs to address possible over capacity concerns should the data indicate such actions are necessary.

2. The reasons for denial of a general permit are inadequate, and none of the grounds for denial of a special permit deal with ecosystem-level impacts. (DLNR, D. Raney)

Response: The purpose of general permits is to monitor fishing effort and methods for given target species and associated bycatch if existing local data collection systems are deemed inadequate. Should data collected by general permits indicate ecosystem and/or resource concerns, general permits can be denied to safeguard the resource or special permits (issued on a case by case basis) may be required.

In FMP Section 5.3.1- Special Permits, the second ground for denial of special permits deal specifically with ecosystem-level impacts. Special permits may be denied if the best scientific information available indicates that harvest conducted under the permit would be significantly detrimental to the population of any species of fish.

3. There should be provisions for denying a General Permit for potential overfishing or damage to coral reef habitat. (D. Gulko)

Response: See previous comment.

4. A special permit for harvest of all coral reef resources should be implemented. (Hilo Public Hearing)

Response: At its April meeting, the CRE Plan Team also recommended the institution of special permits to harvest any resources in take areas of the EEZ (except for incidental catch). However, requiring special permit to harvest any coral reef MUS would be difficult given the varying cultural issues and current management capabilities, although representatives from each island area may request this from the Council at any time.

Under the preferred alternative, special permits are required for areas of special concern (i.e., low-use MPAs) determined by the Council as well as for resources of which virtually nothing is currently known (i.e., potentially harvested coral reef taxa anywhere where fishing is allowed.) At its 77th meeting in May, the SSC reviewed this suggestion and recommended continued support for the Council's preferred alternative.

5. Several agencies support the proposed prohibition of cruise ships and uninsured fishing vessels from operating in protected areas. (U.S. Navy)

Response: Under this plan, all fishing vessels will be required to have insurance to cover clean-up and wreck removal from accidental groundings in MPAs. However, the Council has no authority over non-fishing vessels, but has stated that it would like to consult with the proper authorities regarding operation of other vessels within the Coral Reef Ecosystem.

6. The CREFMP does not adequately cap the number of vessels or individuals fishing under special permits for potentially-harvested species. (EDF)

Response: Issuance of special permits are granted on a case-by-case basis and take into account fishing location, estimated levels of catch by trip, gear to be used and total harvest capabilities of the potential permitee. At present, fishing for coral reef resources is currently light to non-existent in the EEZ therefore, it would be premature to cap the number of vessels without a valid data and/or rationale.

7. The CREFMP affords strong protection to vulnerable areas via a rigorous permit. The plan also implements no-fishing zones around sensitive monk seal habitat. (T. Timoney)

Response: Noted.

8. Having a limited-take MPA requiring a Special Permit is a positive step. (CMC)

Response: This FMP is the first step to managing coral reefs and the management regime should be viewed as a dynamic process requiring on-going assessment.

9. The preferred alternative should not exempt all existing FMPs from requiring a special permit to fish in the NWHI. (D. Gulko)

Response: The benefit of requiring special permits for existing FMP permitted fisheries in the NWHI was not substantiated. The Council decided to have a formal process for the Coral Reef Plan Team to discuss ecosystem issues with the Plan Teams of other FMP fisheries operating in the NWHI and offer solutions to any emerging ecosystem concerns. The primary concern for requiring special permits for all existing FMP permitted fishers in the NWHI involved monitoring and reporting of CREMUS incidentally caught by those fisheries. However, reporting requirements are already mandatory for existing fisheries.

10. Concerns exist regarding the definition of "research" in terms of live rock and its possible use for commercial purposes including bioprospecting. (Hawaii hearing)

Response: The emerging field of bioprospecting is being discussed in regional, national and international fora, including code of conduct for harvest, consideration of conservation measures and property rights. However, research is not subject to control of the MSFCMA and therefore granting research permits is outside the scope of Council authority.

11. To what extent were the Ecosystem Principles Advisory Panel recommendations used in developing the preferred alternative. The Ecosystem Principles Advisory Panel recommended to place the burden of proof on the fishermen as opposed to on the resource. (K. Miller)

Response: By requiring a special permit, the FMP requires that fishermen demonstrate the burden of proof to fish for all MUS listed as Potentially Harvested Coral Reef Taxa, and if fishing is to be conducted in a low-use MPAs. Approval of a special permit will require a thorough description of all aspects of the fishing operation including gear type and deployment methods and other information prior to the permit being issued. Each application for a special permit would require NMFS and the Council's approval based upon the available scientific and commercial information and the case by the fisherman. Logbook requirements will also be defined at this time.

12. The decision not to require additional permitting or reporting requirements for harvesting of coral reef resources is questionable if the intention is to manage at an ecosystem level. (K. Miller)

Response: See responses to two previous comments. Because the harvest of coral reef ecosystem species is light to non-existent in the EEZ, the Council proposes to require special permits to fish in low-use MPAs and harvest species listed in the FMP as Potentially Harvested Coral Reef Taxa. The Council will allow local agencies to continue collecting data on those listed as Currently Harvested Coral Reef Taxa. However, should local permitting and reporting requirements be deemed inadequate, there is a framework measure in place which would allow for implementation of federal permitting under a general permit system.

In addition, the Council understands forcing dramatic changes in fishing practices among island people will likely be difficult as cooperation is essential. The Council feels that a more effective means to gather data and manage cultural/indigenous fishing practices would be to work cooperatively with these local agencies.

13. Several agencies support the permitting system proposed in the preferred alternative as this system would provide only limited opportunities to fish for poorly understood fish and to fish in the proposed low-use areas using individually reviewed special permits, while allowing general permits for better understood stocks that can sustain fishing pressure. (CMC)

Response: Noted.

14. Recommend that scientific research only be permitted to occur in no-take and low-use areas if the applicant demonstrates that it is not practicable to conduct the proposed research outside of these areas, the research will not result in significant adverse environmental impacts individually or from cumulative impacts, and the research will result in support for the conservation and sustainable management of coral reefs. (NAS)

Response: The Council concurs with the first point for no-take MPAs and with the remaining points in whole. Nevertheless, the Council and this FMP does not have authority over scientific research which is granted directly through the NMFS regional office. The Council requests to be briefed on all proposed scientific research which may be relevant to fishery management issues and advices NMFS to conduct the appropriate environmental assessments as required under NEPA.

15. No details are provided on how NMFS verifies the accuracy of the information obtained in catch reports. A different approach is needed by managing agencies to obtain accurate and reliable marine resource information on which to base management decisions. (L. Kasaoka)

Response: Inconsistencies, when they are brought to light to the Council, are discussed and appropriate action is taken. Data reporting has always been a high priority of the Council.

16. It is vital to the long-term health and sustainability of any fishery resource to have accurate data about the standing crop of the resource before allowing exploitation, yet none of the federal or state fisheries agencies can provide this for the targeted species that have FMPs and/or permit requirements. (L. Kasaoka)

Response: Closely controlled and monitored fishing is a cost-effective way to obtain information on the resource to improve management. The special permit process for potentially harvested coral reef taxa will allow collection of data on developing fisheries so as to prevent overfishing, as well as to provide valuable information on the status of the marine environment.

9.2.4 Comments on Fishing Gear and Methods

1. The ban on scuba fishing at night is consistent with other management regimes which are attempting to ban this practice in state waters around American Samoa. (American Samoa Public Hearing)

Response: Under the preferred alternative, the CREFMP prohibits spear fishing using Scuba at night only in the PRIAs and NWHI. However, regarding the recently enacted ban in territorial waters around American Samoa, the Council, after reviewing the recommendations made by its advisory bodies, chose to endorse the preferred alternative.

2. There should be a prohibition on the use of spear with Scuba at day and night in the Pacific Remote Island Areas and the NWHI. (CMC, T. Harp)

Response: The Council discussed this issue at length, and determined that it was important to protect the fish while sleeping because at this time they have no refuge from fishing gear. Prohibiting the use of spear with Scuba at night and not during the day, strikes a balance between the interests of the fishermen with concerns for potential over-harvesting of highly prized species.

3. There should not be a ban on spearfishing using scuba gear. (Hilo Public Hearing)

Response: See previous response. The CREFMP prohibits spearfishing for CREMUS with scuba at night in the EEZ of the NWHI and PRIA, but does not currently prohibit this practice during the day or around populated island areas.

4. The ban on spearfishing with Scuba or hookah at night should be expanded to a total prohibition against spearfishing with Scuba or hookah. (U.S. Navy)

Response: See above responses.

5. Supports limiting allowable gear to those types listed in the draft plan, however if the Council feels it is beneficial to provide opportunity to use unlisted gear, it is recommended that the draft plan should specify criteria for its use. Specifically, unlisted gear should not be permitted unless it provides nearly no opportunity for bycatch or habitat impacts, while maintaining an appropriate fishing capacity based on ecological and social considerations. (CMC)

Response: The list of allowable gears in the CREFMP were rated based on (1) selectivity (how it catches the target species) (2) potential impacts to EFH, and (3) refuge (does the method allow for refuge for the species. Should new gear types be considered for use in the coral reef ecosystem, a special permit application is required prior to using unlisted gear, and must fully describe the gear and method of deployment. The NMFS and the Council can then evaluate and assess the new gears or fishing methods prior to permitting the action to ensure it meets the standards listed above.

6. The CREFMP includes pursenets and lobster traps in its list of allowable "selective" gears. These are not selective gears. (DLNR, D. Gulko, T. Harp)

Response: These gear types, when used properly are selective and non-destructive to resources and habitat.

7. Should not exempt existing FMPs gear (i.e., lobster traps), does not deal with known existing gear impacts. (D. Gulko)

Response: Existing FMP fisheries are prohibited in no-take MPAs. Also, should information regarding ecosystem impacts of existing fisheries gear become available, these concerns can be considered and addressed through plan team coordination and meetings.

8. There is no mesh size listed for the lobster traps, only dimensions. (T. Harp)

Response: The lobster fishery is managed under the Crustacean FMP and existing regulations, including the size of escape vents, are detailed in that FMP. These details are included in the final version of the CREFMP gear catalogue.

9. Gillnets are not a selective type of gear. (T. Harp)

Response: Gillnets are specifically prohibited for harvesting CRE MUS in the CREFMP; they are not included in the allowable gear list.

10. Indigenous people were not using inefficient gear, they made use of materials that were available to them and took only what was needed. (T. Harp)

Response: Noted.

11. Loopholes exist in the measures proposing that vessels carry insurance in the event of a grounding. As such, they will probably be ineffective. (D. Derise)

Response: No loopholes in the plan exist for vessels under Council and NMFS jurisdiction. Any fishing vessel operating in or transiting through any designated MPA must have insurance to cover accidental groundings. The Council will also work with appropriate agencies to protect coral reefs from damage by other vessels.

12. Minimum insurance needs must be stated in the FMP.

Response: Amount of insurance required will be dependant upon category of vessel, type of permit and fishing area. Monetary cost of insurance is likely to be higher for larger vessels and vessels operating near islands (i.e., Midway harbor). This cost is to be worked out by the vessel owner and the insuring company.

9.2.5 Comments on Framework Actions

1. VMS should have the potential to be enacted even if the cost of such a system is not fully subsidized with federal funding. Under certain circumstances it may be appropriate to ask fishing vessel owners to contribute to the cost, and other private or non-federal government funding might be made available for such a program. (CMC)

Response: As a framework measure, VMS will be fully analyzed, including an environmental assessment, before it can be implemented. Thus, these options will be explored.

2. Should modify the DEIS to include a measure requiring VMS for all fishing vessels operating in the NWHI. (DLNR, D. Gulko)

Response: The Western Pacific Council was the first fishery council to implement VMS and will continue to promote its implementation as appropriate. VMS is a controversial issue nationwide and decisions regarding the nature of its implementation are ongoing. The Council plays an active participant in these negotiations.

3. The CREFMP could include requirements for automatic 24hr/7 day VMS systems which report to several agencies and to the ships captain when approaching an MPA, reef, bank or atoll, and the loss of permit privileges as a result of careless vessel operation could occur. (EDF)

Response: See above comment.

4. Criteria should be established for moving MUS from the potentially harvested to the currently harvested list. It should only happen if: there exists a reliable estimate of the unfished abundance of the species or stock or can otherwise choose a safe abundance target for management; there exists a regular and frequent monitoring to count the abundance of the species or stock; there exists an estimate or reliable proxy for the maximum sustainable yield of the species or stock; and there is good information on the likely ecosystem function of the species or stock, and knowledge that this function can be reduced without causing adverse ecosystem impacts. (CMC)

Response: These are valid points that were considered for inclusion in the Final FMP and EIS. However, due to the paucity of information on the standing stock of many coral reef species, there is a need to lump many species into categories by taxa. Therefore, as more information becomes available through fishery dependent and independent data collection, flexibility to redefine each species based upon unique aspects may be more appropriate.

5. The ban on anchoring except where the WPRFMC allows appears to be inserting a loophole. (D. Gulko)

Response: Uncertain as to what loophole is being created as there are no regulations to restrict anchoring of fishing vessels in the EEZ at this time. The framework measure to install mooring buoys and restrict anchoring where mooring buoys are available will need coordination with U.S. Coast Guard, NMFS, Navy, USFWS, fishermen and other state and federal agencies to determine their appropriate locations. None the less, fishermen are required to abide by all laws and regulations.

9.2.6 Comments on Enforcement

1. The FMP does not adequately address jurisdictional disputes regarding management of the NWHI. (NAS)

Response: Jurisdictional Issues are addressed in Section 9.3 of the FMP. Regarding the management of marine resources the NWHI, the MSFCMA tasks the Council to protect fishery resources in the U.S. Exclusive Economic Zones (generally 3-200 miles offshore). In Federal waters designated as part of the National Wildlife Refuge System, management over marine resources is shared between the Department of Commerce and the Department of the Interior. Pursuant to the Submerged Lands Act of 1953, the State of Hawaii was granted title and ownership of the lands beneath the navigable waters from the mean low water line, seaward to a distance of three geographic miles from the coast, as well as to the natural resources within such

lands and waters. For this reason, the CREFMP does not apply lands and waters owned by the State of Hawaii.

2. Increased enforcement will be needed in the NWHI once the CREFMP and the presidential EO take effect; the U.S. Coast Guard Enforcement Division is severely underfunded. (T. Harp)

Response: Noted. A goal of the FMP is to collaborate with other agencies to address enforcement concerns and to promote the importance of funding enforcement needs.

3. Patchwork of different depths that may or may not be fished promotes misconduct from commercial fisherman. (Kauai Public Hearing)

Response: Fishermen are required to abide by all codified regulations.

9.2.7 Comments on Overfishing/MSY

1. The CREFMP would lump many species into broad categories, which can mask overfishing. (EDF)

Response: Due to the paucity of information on the standing stock of many coral reef species, there is a need to lump many species into categories by taxa to facilitate data collection. As scientific and/or fishery data emerges and is analyzed, a framework process is available to address species-specific overfishing. Ecosystem overfishing will also be considered. Further, the management of the coral reef environment is a dynamic process with on-going assessments, thus the CREFMP is also a dynamic document with on-going analyses and assessments.

2. Chapter 4 contains little information on how the Council proposes to calculate MSY, OY and overfishing limits for the coral reef ecosystem as a whole. (K. Miller)

Response: Quantitative assessment cannot be made for the ecosystem as a whole. Reference points may be estimated by proxy using data collected from the fisheries. To prevent ecosystem overfishing, changes in species abundance and composition in exploited ecosystems will be monitored over time using the best available scientific and commercial information.

3. The Council should set a default OY at three-quarters of MSY for well studied fish stocks, with the potential to reduce OY based on the particular economic, social, and environmental conditions affecting any particular stock. (CMC)

Response: Noted.

4. The CREFMP does not include measures to control or measure total fishing mortality. (CMC)

Response: The plan includes adequate controls (MSY control rules) to prevent overfishing and reporting and monitoring provisions through existing mechanisms or through general or special permits. Criteria to define overfishing are based on effort as a proxy.

5. The CREFMP does not include any measures to control fishing capacity, but instead relies on gear and use restrictions. (EDF)

Response: Fishing on coral reef resources is presently light to non-existent in most of the EEZ. If expansion of the fisheries suggests that capacity limitations are needed, the FMP could be amended as such. The special permit requirements and associated controls for Potentially Harvested Coral Reef Taxa will also limit fishing capacity. Additionally, special permits are issued on a case by case basis.

6. The MSFCMA requires the overfished threshold to be set at MSY levels, but one group would prefer to see a robust control rule as a means to avoid overfishing. (CMC)

Response: Noted.

7. The Council should define overfishing as any fishing rate that is greater than MSY or any fishing mortality rate that is greater than the fishing mortality rate (i.e., percent per year). (CMC)

Response: Noted.

8. Cap maximum fishing mortality rate for stocks that are above B_{MSY}, and set it equal to F_{MSY} for stocks below B_{MSY}. If a direct estimate of F_{MSY} is unavailable, E_{MSY} may be used as a proxy, but additional precaution must be built into management somewhere to account for this uncertainty. (CMC)

Response: Noted.

9. Set F_{OY} equal to 75% of MSY for stocks that are above B_{OY} to 75% OF $\{(B-aB_{OY})/(B_{OY}-aB_{OY})\}$ MSY for stocks below B_{OY} but above B_{OY}, and to zero for stocks below a B_{OY}. In these equations, B is the current abundance level and a is the fraction of B_{OY} at which fishing ends. Values of a should range from close to 1 when there is high uncertainty to a minimum of 0.2 when uncertainty is relatively low, but should generally trend towards 0.5 or higher. (CMC)

Response: Noted.

10. Set B_{MSY} based on biology of the stock when possible. When B_{MSY} is unknown, a proxy equal to 50% of unfished biomass should be used. (CMC)

Response: Noted.

11. Set B_{OY} equal to 1.25 B_{MSY} when a direct estimate is available, or higher if we must rely on CPUE or if the stock is known to plan an especially important ecosystem role. (CMC)

Response: Noted.

12. Set MSST equal to B_{MSY}, as required under the MSFCMA. (CMC)

Response: Noted.

13. No flag is necessary. The flag identified in the draft serves no purpose because it does not trigger any management actions. It should be removed. (CMC)

Response: The minimum biomass flag is defined so that if biomass drops below it managers are then prompted to implement remedial action before biomass reaches the minimum stock size threshold.

14. Set MSY and OY based on impacts on trophic guilds one level above and below that of the species proposed for fishing. (DLNR, D. Gulko)

Response: Noted.

15. Who sets overfishing limits, and why were Napoleon wrasse and Humphead parrotfish not prohibited from take? (D. Raney)

Response: Chapter 4 of the FMP describes how Maximum Fishing Mortality Thresholds (MFMT) are determined. Although there have been observations that the Napoleon wrasse and the Humphead parrotfish are depleted in localized areas, it is not known whether these species are overfished in the EEZ. If such is the case, as identified in the first annual report for the Coral Reef Ecosystem FMP, by locality, management action is then required to place them in an overfished condition and prohibit take of these species.

9.2.8 Comments on Research, Monitoring, and Assessment

1. The CREFMP lacks a management structure that would allow the gathering of data sufficient even to assess minimal impacts of fishing on ecosystem functions. (K. Miller)

Response: The FMP proposes close coordination between the plan teams of existing FMP fisheries to identify ecosystem impacts and recommend mitigation measures. Research is also proposed to better understand and address ecosystem impacts.

2. The research from NOW RAMP 2000 expedition is not mentioned. (D. Gulko)

Response: No reports of results from the NOW-RAMP cruise are yet available from this assessment which took place in late 2000. Such information may be incorporated in the FMP when final reports become available.

3. Determining benthic productivity is unnecessary and unwarranted in most cases, and should not be included as a standard requirement. (U.S. Navy)

Response: Knowledge of benthic resource productivity is necessary and warranted for the management of coral reef resources. Ecosystem-based management requires information on numerous trophic levels and relationships, much of which is lacking.

4. The CRE-FMP should not exempt species covered under existing FMPs, or it does not achieve the ecosystem-level of management stated as a primary goal. (D. Gulko)

Response: Existing FMP fisheries have been managed successfully for decades under their respective fishery management plans. Stocks are healthy and interactions with habitat and protected species are considered, and minimized, as required by the MSFCMA, as well as the Endangered Species Act, the Marine Mammal Protection Act and the NEPA. Under the CRE-FMP, existing FMP fisheries are prohibited from fishing in no-take MPAs and are required to document and report all targeted and incidental catches, including CRE MUS.

5. Ocean CO2 sequestration projects should not be allowed at all in/around the NWHI. (T. Harp)

Response: The Council is unaware that such a project has been proposed for the NWHI. The Council's authority is restricted to the management of fishing vessels and fishing activities. However, the Council can make recommendation to the project under the EFH consultation provision should CO2 sequestration be proposed in the NWHI.

6. Need to know more about the resources before they are exploited. (L. Kasaoka)

Response: Closely controlled and monitored fishing is a cost-effective way to obtain information on the resource to improve management. The special permit process for potentially harvested coral reef taxa will allow collection of data on developing fisheries so as to prevent overfishing.

9.2.9 Overall General Comments

1. All offshore islets need to be included as HAPCs, as well as Kaliu Point and Mana Reef on Kauai, South and West Shore Reefs and embayments on Molokai, and all Kona Coast FRAs off Hawaii. (D. Gulko)

Response: To the extent that these locations fulfil the HAPC criteria for designation, the Council, may consider to include the areas as HAPC after review of the available scientific data and consultation with the various advisory groups and agencies.

2. The FMP appears to designate mangrove areas within the MHI as EFH, but if red mangrove qualify as EFH they should also qualify as HAPC. (U.S. Navy)

Response: Although mangroves themselves are not designated as EFH, mangroves do occur in areas which have been designated as EFH. In places where mangroves are native, such as American Samoa, they may provide important larval fish habitat. Should an area fulfill the HAPC criteria for designation, it may be considered for HAPC designation.

3. Is Inner Apra Harbor included in the boundaries of HAPC? (U.S. Navy)

Response: At present, the waters within Apra Harbor (0-50 fathoms) are designated as EFH. However, Inner Apra Harbor, including the Arote area has been identified as a candidate site meeting the criteria for designation as HAPC, and may be considered for designation by the Council.

4. Concerns were raised that Essential Fish Habitat provisions in the plan would hinder bottomfishing operations. (American Samoa Public Hearing)

Response: Bottomfishing under existing FMP permits is in compliance with EFH requirements.

5. Reference to Kaula Rock should be deleted, as the island and waters surrounding it are off limits to the public due to hazards from unexploded ordinances. The FMP should not promote access to this area. (U.S. Navy)

Response: Reference to Kaula Rock does not indicate the promotion of access to the waters around the area. The final FMP and EIS recognizes that the area is sanctuary for seabirds and a portion of the island is used for live fire training by the military.

6. The EPA rated the DEIS "LO, Lack of Objections", which is their highest rating, as it sufficiently addresses the environmental impacts of the proposed action. (Environmental Protection Agency-EPA)

Response: Noted.

7. The implementation of the EPAP recommendations is incomplete, i.e. the precautionary approach is not being implemented. (D. Gulko, K. Miller)

Response: Because the Council has developed a CRE FMP does not mean it is either promoting new coral reef fisheries or allowing for increased harvest of currently harvested species. Currently, there is no management of coral reef fishery resources in the EEZ. The plan proposes to establishes strong management measures for these species, including permitting and fishing requirements on a case-by-case basis. Varying degrees of resource uncertainty, resource utilization and management capabilities requires a flexible management regime as is outlined in the FMP.

8. Other Councils routinely divide allowable catch into trip limits for individual vessels, leaving some percentage of the allowable catch unallocated to prevent the trip limits from being designated as ITQs. (EDF)

Response: Unfortunately, total quotas are impractical for most species under the CRE FMP. Trip limits are a management option for Special Permit approval. Additionally, Congress has placed a moratorium on the establishment of any new ITQs until October 2002. In the future, this could be implemented into the management regime if appropriate.

9. The DOD should be included in all interagency coordination when addressing management of non-fishing related activity impacts. (US Navy)

Response: The DOD will be included.

10. It should be made clear that, except for the no-take areas, none of the management measures in the document apply to the other FMP's (the individual FMP management measures take precedence over those listed in the CREFMP). (D. Gulko)

Response: In addition to no-take areas, fishers managed by other FMPs are also required to have vessel insurance while fishing or transiting through MPAs.

11. The management plan proposes significant measures to address potential problems but is flexible to account for changing conditions in the future. NMFS and WPRFMC should be commended for integrating this FMP effort with ongoing updates to existing related FMPs in the Western Pacific Region. (EPA)

Response: Noted.

12. WPRFMC should modify its management measures to not exclude existing FMPs from coverage where they co-occur on federal coral reefs in the NWHI. (D. Gulko)

Response: Existing FMP fisheries are prohibited in no-take MPAs, are required to have vessel insurance and must document and report all species targeted and incidentally caught. Should data indicate that ecosystem impacts of existing fisheries are occurring, these concerns can be considered and addressed through plan team coordination and meetings.

13. Support objective 6 of the management plan, which seeks to collaborate with other agencies and organizations..., however feel the Council has sought to assert sole authority over the management of marine resources, including within NWR. (Sierra Club)

Response: The MSFCMA tasks the Council to protect fishery resources in the U.S. Exclusive Economic Zones. In Federal waters designated as part of the National Wildlife Refuge System, management over marine resources are shared between the Department of Commerce and the Department of the Interior.

14. It is unlawful to give preference to subsistence fishermen in American Samoa. (American Samoa Public Hearing)

Response: Nothing in the law prohibits allowing preference to a specific user group if the preference is justified and supported by administrative records. As such, this is not prohibited under the MSFCMA.

15. The Council and NMFS should suspend plans to proceed with the finalization of these documents until the NEPA process is adequately and faithfully carried out. (K. Miller)

Response: The Council has fulfilled the requirements of NEPA. EPA gave the CREFMP EIS its highest rating (lack-of objection).

16. The FMP does not comprehensively address all activities that could impact the NWHI coral reef ecosystem, and does not cover all habitats that comprise the NWHI ecosystem. As such, the plan should be titled a "fishery ecosystem plan" as it is referred to in the executive summary, not a true ecosystem-based management approach. (D. Gulko)

Response: The Council is mandated to regulate only fishing activities in the waters of the EEZ, it does not have authority to manage all activities that could impact the coral reef ecosystem. However, provisions in the MSFCMA related to conservation of EFH allow councils to make recommendations for potential non-fishing impacts regardless of jurisdictional authority.

17. WPRFMC should be commended for taking steps to move towards an improved management structure to achieve long-term conservation goals and sustainable use. (K. Miller)

Response: Noted.

18. Under NEPA, the document does not appear to adhere to standards of full disclosure when measured against the potential impacts of other draft FMP's which are now in preparation by the Council. (K. Miller)

Response: There are no other FMP's currently in preparation by the Council. Also, the Environmental Protection Agency reviewed the CREEIS and gave it a rating of "LO", meaning Lack of Objections, which is its highest rating.

19. Everyone talks about protecting the resources, but no one talks about giving back. For instance, replenishing the fish, growing seaweed, etc. (Kona Public Hearing)

Response: Noted.

20. The preferred alternative allows for continuing sustainable participation in the existing fisheries and demands consultation between the coral reef, bottomfish and crustacean plan teams to monitor these activities closely.

Response: Noted.

21. Pollution, run-off, and construction are to blame for killing the reefs, not the user groups. (OPIR)

Response: There is documentation that these activities are detrimental to coral reef ecosystems, however the MSFCMA does not provide council the authority to manage these activities directly. EFH provisions can be used to make recommendations to the appropriate agencies for non-fishing impacts to coral reefs.

22. The document is too long and has too little feeling for the Hawaiian spirit. It should coordinate with the local communities on the neighbor islands. (Hilo Public Hearing)

Response: The Council has several advisory councils and plan teams whose members represent a wide variety of groups, including indigenous peoples. In addition, the Council sought to obtain input through numerous public scoping meetings and hearings held throughout the Western Pacific Region during the development of the CREFMP.

23. It is important to seek the input from native Hawaiians, because if conservation is practiced now as it was hundreds of years ago, there would be no need for measures like the CREFMP. (Hilo Public Hearing)

Response: The Council sought input from the Fishery Rights of Indigenous Peoples Advisory Panel in the development of the CREFMP, as well as other native peoples of Hawaii, Guam, American Samoa, and the Commonwealth of the Northern Mariana Islands during the development of the CREFMP.

24. Nearly all significant adverse impacts to coral reefs occurred prior to, during or shortly after WWII. Since the 1970s most of the military's actions in the project area have had beneficial impacts, not degraded the reefs. (U.S. Navy)

Response: It is recognized that military activities, such as reclamation at Johnston Island and establishment of no access areas via Naval Defensive Seas Areas have had beneficial effects to coral reefs. However, military impacts are still reported to be significant in some areas (e.g., large anchor/chain damage in the CNMI, topsoil sedimentation due to bombing of Kaho'olawe).

25. A number of people showed support for Alternative 3, the preferred alternative, and others for Alternative 4, maximum protection. (Kauai, Kona and Maui Public Hearings, L. Kasaoka)

Response: Noted.

26. The suggestions by the Coral Reef Plan team and the new EO should be listed as alternatives. (K. Miller)

Response: These are addressed, indirectly, through the range of alternatives analyzed in the EIS (the No-action alternative, minimal additional protection, substantial additional protection and maximum additional protection).

27. This collection of words is not an ecosystem fishery management plan, simply because several species of marine-life have been excluded from consideration. (D. Gulko)

Response: See formal process for plan team coordination mentioned above.

28. It appears the Council fails to recognize that the State of Hawaii, Department of Land and Natural Resources has developed their own Fishery Management Area plan for state waters. (I. Harp)

Response: The Council has jurisdiction to manage fisheries in federal EEZ waters, not state waters. Recognition of the State of Hawaii's NWHI Fishery Management Area could be included in the CRE FMP when it is developed and released for public review.

29. The proposed FMP takes a proactive, but balanced approach to protecting coral reef ecosystems in the Western Pacific.

Response: Noted.

30. Support was given for the CREFMP, as the NWHI are a valuable asset to the people of the U.S. WPRFMC has proven to be an excellent steward to this unique region. By all accounts, the NWHI continue to be described as beautiful and pristine after 25 years of conservative and sustainable fishery management by WPRFMC. (J. Cook)

Response: Noted.

31. The coral reef ecosystems are a public trust to be administered for the benefit of current and future generations, not resources for a few under the exploitative mandate of the MSFCMA. (D. Raney)

Response: The MSFCMA was enacted by Congress to allow for the regional management and conservation of marine resources. Although the coral reef resources in certain areas of the EEZ in the western Pacific region have been minimally exploited to date, there is the potential for fisheries to expand into these areas and there are no regulations at present to conserve these resources. The CREFMP would establish management measures utilizing the precautionary approach to provide for conservation and sustainable utilization of these resources.

32. The existence value is defined in terms of fishing opportunity only, however ecosystem services provided by coral reefs can be extremely valuable. (EDF)

Response: Non-extractive values of reefs are noted in the plan.

33. The EIS focuses on negative economic impacts of conservation and management measures, and neglects the positive impacts of such measures. (EDF)

Response: The EIS considers both positive and negative impacts, as required by NEPA.

34. Given how little is known about the vulnerability of many coral reef species to overexploitaiton, the primary management principle should be conservation of biodiversity. In contrast, the goal of the CREFMP is sustainable use. (EDF)

Response: The FMP has eight major goals, including conservation and sustainable use of renewable living resources, consistent with the MSFCMA goals.

35. Exclusion of species covered by existing FMPs does not make sense, and as such the CREFMP cannot be considered an ecosystem plan. (K. Miller, D. Gulko)

Response: See formal process for plan team coordination above.

36. Preference should be given to Guam's local resource management initiatives. (Guam Public Hearing)

Response: A goal of the plan is to work collaboratively with local resource management agencies

37. None of the indigenous Chamorros groups were made aware of the Draft CREFMP or its impacts to the Chamorros. (OPIR)

Response: The Council held several public scoping hearings and public hearings in Guam and Saipan on the FMP/EIS over the years with advance notices advertised in the local papers as well as the federal register notice.

38. The conduct of the public meeting should be changed so there is dialogue between WPRFMC representatives and the attendees. (Guam Public Hearing)

Response: Noted.

9.3 Summary of Additional Comments on the Draft CREFMP/DEIS from the U.S. Department of the Interior

Additional comments on the draft CREFMP/DEIS were received from the Department of the Interior by fax 12 March (two weeks following the close of the formal public comment period). Comments are summarized below, together with draft responses.

9.3.1 Comments on Marine Protected Areas

1. Existing restrictions on fishing in the NWRs should have influenced the selection of the MPAs, yet no documentation of coordination or consideration of these is in the analysis. Recommend the DFMP include the MPA contributions made by the NWRs.

Response: Fishery resources in federal waters are under the management authority of the MSFCMA. In the NWHI, the U.S. Fish and Wildlife Service has asserted that the Hawaiian Islands NWR extends, for enforcement purposes, seaward to 10 fm around all emergent lands and 20 fm at Necker. The FMP designated all federal waters 0-10 fm in the NWHI and the northern half of Midway 0-50 fathoms as no-take MPAs. PRIAs are also MPAs to 50 fm in the FMP. The EIS also discusses environmental consequences of the alternatives for NWR resources in section 5.5. For a more detailed discussion on no-take and low-use MPAs designated by the CREFMP, see Section 5.2.

2. Recommend the MPAs be rethought with the goal of including the standards and criteria to demonstrate their function as real MPAs or be labeled, for example, as fishery areas requiring special permit."

Response: MPAs are defined by Executive Order 13158 as "any area of the marine environment that has been reserved by Federal, State, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein." Under this definition, MPAs may include both take types (i.e., Midway Atoll) and no-take types (i.e., Howland, Baker, Jarvis Islands). Additionally, the 50 mile Protected Species Zone around the NWHI (and later overlayed by the NWHI Reserve boundary) is identified as a MPA. Therefore, MPAs identified in the CREFMP meet the definition and intent of Executive Order 13158 on MPAs.

Special permits, which are often issued for activities within MPAs, have the ability to be a powerful tool for dictating the type and amount of fishing allowed, mandating specific prohibitions and data reporting.

3. Recommend that the DFMP discuss criteria used to select and designate no-take and low-use MPAs, and identify the differences between the two classes of MPAs and why they should be applied.

Response:. A detailed discussion of MPAs is found in section 5.2 of the FMP. Selection of MPAs and MPA types take into account among other things, natural resource values, human use and historical values, impacts of human activities, management concerns and representative habitat types. The no-take MPAs in the NWHI represent habitat types characteristic of the extent of the chain. Appropriately, as new information is acquired through resource monitoring, the initial MPA designations could be adjusted and additional MPAs added in the future through the adaptive management process.

4. Recommend the DEIS clearly discuss the circumstances under which fishers would be authorized to fish in low-use MPAs without a coral reef special permit.

Response: Any vessel of the United States directly harvesting or incidentally harvesting CRE-MUS within a low-use MPA around the NWHI and PRIA is required to have a coral reef special permit. The only circumstance where a fisher would be allowed to fish in a low-use MPA without a special permit would be vessels holding permits and targeting species managed under separate FMPs (Bottomfish, Crustacean, Pelagic or Precious Corals). For a detailed discussion on special permits, see section 5.3 of the FMP and section 2.7, Discussion of the Preferred Alternative, in the EIS.

5. Recommend that the DFMP expand the proposed MPA boundaries from 50 fathoms to 100 fathoms.

Response: The 50 fathom boundary for MPAs was selected based on the Coral Reef Plan Team's recommendation as the maximum depth of coral reefs. (See response to comment #3.)

6. The DEIS does not address the NWHI Coral Reef Ecosystem Reserve.
Believe the proposed action is not consistent with conservation measures that apply throughout the Reserve (such as commercial fishing except where allowed, capping the number of permits, limiting the level of take for a fishing method so that it does not exceed the aggregate take for that type of fishing, prohibiting the issuance of permits for fishing activity for which there were no permits issued the preceding year).

The EO prohibits activities in the Reserve including anchoring, discharging, damaging any living or non-living reserve resource except under limited circumstances.

Believe the Draft Plan may make it more difficult for the Service to manage the Reserve and the NWRs in cooperation with other Federal agencies. The Reserve is managed to complement existing management of resources in the Midway Atoll NWR, Hawaiian Islands NWR, and adjacent Hawaii state waters.

Recommend the revised DEIS incorporate a full discussion of the compatibility of actions proposed in the Draft Plan with the Reserve conservation measures.

Recommend the revised DEIS discuss the coordinated management of the Reserve and the Refuge and how the proposed action may supplement and complement stated refuge conservation goals, strategies, management areas and boundaries.

Response: The Executive Order which created the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve is under review, per letter received from the Secretary of Commerce dated 30 June 01. In his letter, the Secretary stated that "While the Sanctuary designation process and review of the Executive Order are underway, the Department will continue to use conservation and management measures under existing statutory authorities, including the MSFCMA, to meet the Act's requirement to manage marine resources in the NWHI consistent with the purposes and

policies of the National Marine Sanctuaries Act." The CREFMP will comply with the regulations of the order when they are finalized, as required. The CREFMP will make every effort to work with the federal agencies of the adjacent NWRs as it upholds the tenets of the MSFCMA.

7. Recommends that the DEIS clarify that the NWHI lobster fishery is now closed indefinitely due to a Federal court action and establishment of the new NWHI Reserve.

Response: The Service incorrectly asserts that Federal court action closed the lobster fishery due to overfishing and due to depleted stocks. To the contrary, the NMFS voluntarily closed the fishery for 2000 and 2001 as a precautionary measure due to uncertainty in the parameters used in the stock assessment models. Although there are uncertainties in the models, NMFS state's that there is no scientific evidence to support that the fishery is overfished.

With regard to the NWHI Reserve, there remains a number of uncertainties contained within Executive Order 13196 that have not been clarified by the National Ocean Service (NOS). In particular, lobster fishing permits have been issued to fishers for the fishing season of July 1, 1999 to December 31, 1999. As a result, NOS has yet to determine whether fisheries with active permits during the year prior to December 4, 2000 can be allowed to continue in areas not defined as Reserve Preservation Areas (0-100 fm).

8. Recommend that the DFMP discuss the use of Kaula Rock as a sanctuary for seabirds, although the Department of Defense uses a portion of the sanctuary as a bombing range.

Response: This is included in the document. Kaula Rock is designated as HAPC.

9. Recommended that the management measures proposed in the Draft Coral Reef FMP occur seaward of the 12 nmi refuge boundaries of Kingman Reef NWR and Palmyra Atoll NWR.

Response: By authority of the MSFCMA, the Department of Commerce, through the NMFS, manages fishery resource from the shoreline to 200 nm around all PRIAs. Within NWR boundaries, fishery management responsibilities are shared between the Department of Commerce and the Department of the Interior. Clarification is sought from DOC and DOI lawyers regarding the implementation of shared jurisdiction.

10. Recommend the revised DEIS include all comments concerning Service management responsibility for coral reef resources located within the management area of its NWRs in the Pacific region.

Response: The document titled *National Wildlife Refuges of the Pacific*, provided by the Department of Interior on August 29, 2000 and subsequently provided again on March 8, 2001, were included in the preparation of the CREFMP. Detailed discussion on jurisdictional issues is included in section 9.3 of the FMP.

11. Recommend that the revised DFMP discuss the management areas, fishing and harvest restrictions that apply to the Hawaiian Islands, Midway, Johnston, Jarvis, Palmyra, Kingman, Howland, Baker, and Rose NWRs.

Response: DOI's management of NWRs is addressed in section 9.2.2 and 9.3 of the FMP.

9.3.2 Comments on Permits and Reporting Requirements

1. Recommend that both General and Special Permit Forms and General and Special Coral Reef Taxa Daily Catch Reports include a specific reference to allowable by-catch, VMS, owner identification markings on all traps, and wreck or vessel removal insurance are needed in these permits.

Response: General Permits/Reporting and VMS are considered under framework for possible future implementation. See section 5.5.1 of the FMP for a detailed discussion on framework actions. Special permits will be used in areas designated as low-use MPAs, and for targeting of species listed as potentially harvested taxa. Also, NMFS can directly adjust permits and logbooks, without Council action. The MSFCMA requires bycatch to be reported and minimized. The FMP will require insurance for all fishing vessels transiting MPAs and all traps to be marked by the owner. The purpose of Special Permit Forms and Catch Reports is to evaluate each coral reef fishery harvest on a case by case basis. Requirements are determined prior to issuance of the permit and can address a wide range of concerns. Furthermore, binding regulations are counter to adaptive management which is a basis of the FMP.

2. Recommend that the DEIS discuss the potential for unrestricted and unpermitted harvest of coral reef resources beyond 50 fathoms especially areas that are part of our NWRs in the Pacific.

Response: The management area covered by the CREFMP includes the entire U.S. EEZ and therefore, all coral reef fisheries will be managed by the FMP.

3. Recommend harvest permits be issued to fishers on a per coral reef ecosystem basis to facilitate tracking and managing resource exploitation.

Response: The Special Permit is structured to allow for specific restrictions including location of fishing operation. For detailed discussion on special permits, see section 5.3.1 of the FMP and section 2.7, Discussion of the Preferred Alternative, in the EIS. Requiring this of currently practicing artisanal island fishers was determined inappropriate at this time, in favor of using existing local monitoring systems, although a framework measure in the FMP could require permits if needed.

4. Recommends that the Currently Harvested Coral Reef Taxa list contained in the DEIS indicate the status of vulnerable species as prescribed by the International Union for the Conservation of Nature (IUCN) or by Federal statutes.

Response: Status of stocks varies geographically around the Western Pacific Region and is largely unknown for most species locally. Overfishing definitions are discussed in Chapter 4 of the plan, as required. Status of species will be listed upon completion of the first annual report.

5. Recommend that depleted species be placed in a special protective category and not be targeted for harvest.

Response: To the degree this is known, species requiring special protection can be added to the prohibited list, as appropriate. Information compiled in the first annual report will contribute to this determination.

6. Recommend the DFMP include a discussion concerning information and data collection, and the need for independent verification concerning harvest data provided by fishers to insure quality control and accuracy.

Response: The CREFMP discusses reporting requirements in section 5.3. Collection of data where information is inadequate is a priority of the plan and will be addressed through research, fishery dependent and independent monitoring and special permits.

9.3.3 Comments on Fishing Gear and Methods

1. Recommend that the DFMP discuss any in-situ research involving monitoring or observations of individual traps to determine the effectiveness of prey escape in relation to trapped prey that are eaten in the traps by predators before they can escape.

Response: The Fishing Gear Catalogue (FMP Appendix A) contained in the FMP cites a study conducted by Parrish and Kazama (1992). These researchers found that while lobsters enter the traps, they were also able to exit and there were no observed mortalities associated with ghost fishing. They concluded that lobsters utilized the traps as shelter, possibly from predators. This information will be included in the FMP documents.

2. Recommend that the DFMP discuss banning gill nets and other seine nets from the list of proposed gear types to harvest reef fish.

Response: Gill nets are not on the list of allowable gear. Because any allowable gear type, if improperly used, has the potential to cause damage, specific conditions of operation are outlined in the gear description. For example, nets shall be tended at all times. If used properly, gear on the allowable list are non-damaging.

3. Recommend that the DEIS indicate whether there will be exemptions for the cultural use of natural poisons (e.g. awa or arrowroot poisons) to harvest coral reef resources.

Response: The Council's Indigenous Advisory Panel noted that the use of natural poisons are most effective in relatively shallow waters where concentration of the intoxicants are not easily diluted. Because this cultural practice is mainly conducted in state/territorial waters (0-3 miles),

the Indigenous Advisory Panel agreed that its use be banned in federal waters with no exemptions. The use of poisons and intoxicating substances are specifically banned through the FMP in all areas of the EEZ.

9.3.4 Comments on Framework Actions

1. Concerned that the DEIS does not clearly detail the insurance requirement for removing grounded and wrecked vessels. Concerned that the DEIS does not require anchoring restrictions except one small area off Guam, and concerned that VMS is not required throughout the proposed action area. Concerned that the DEIS does not discuss mitigation measures that may result in potential adverse impacts to coral reef resources.

Response: Regarding the insurance requirement, all fishing vessels operating within an area designated as MPA are required to carry insurance to cover the cost of wreck removal and pollution liability in the event of a grounding, as specified in the draft regulations (Section 8.1).

Regarding anchoring restrictions, VMS and potential adverse impacts to coral reef resources, the preferred alternative includes framework procedures for timely and regulatory adjustments based on feedback from monitoring of changing fisheries and resource conditions. Exact details of these measures will be determined upon their possible future implementation based on need.

2. Recommend that the DEIS include as a potential framework measure, prohibition of anchoring in any established MPA (including NWR, NOAA Reserves, State/territorial MPAs) unless anchoring zones are explicitly delineated by the responsible management authorities and eligible for use by the fishers.

Response: Anchoring restrictions in MPAs are considered as a framework action. (see Section 5.3.1)

9.3.5 Comments on Non-Regulatory Actions

1. Recommend the DFMP include a discussion concerning the need to cooperate with other agencies to integrate and combine proposed MPAs with those that already exist and not to undermine or add confusion interpreting other established MPAs that have the same purpose of conserving coral reef resources.

Response: A mechanism to strengthen inter-agency cooperation is outlined in the FMP. (section 5.5.3)

9.3.6 Comments on Research, Monitoring and Assessment

1. Recommend that the DFMP include new information from NOWRAMP expedition in Sept/Oct 2000.

Response: The DFMP will be revised to include this information when it becomes available.

2. Recommend that the DFMP discuss the considerable ongoing coral reef initiatives undertaken by the Service.

Response: Such details are included in section 7.3 the FMP or referenced by citation, as appropriate.

9.3.7 Comments on Overfishing/MSY

1. Harvest activities in the draft have been documented to adversely affect fish and wildlife resources similar to those that occur within and adjacent to the NWRs. Also, the DEIS fails to describe thoroughly Department trust resources and to document harvest-related impacts to those resources.

Response: No new harvest activity on coral reef resources is proposed through this EIS or FMP. The main objective of the Coral Reef Ecosystem Fishery Management Plan (CREFMP) is to implement a management regime for the conservation and protection of coral reef ecosystems in federal waters. Since there is no management regime for coral reef fisheries in place at this time, the CREFMP will immediately establish several management principles including: Management Unit Species (MUS), special permits, allowable gear types, marine protected areas and vessel insurance and reporting requirements. The CREFMP also incorporates an adaptive management approach through the framework process that can address future management needs as they arise. The EIS proposes only to monitor currently legal activities to allow for assessment of their effects. Unclear as to what deficiencies exist regarding trust resources. This EIS cannot describe all potential impacts, given essentially no coral reef fisheries currently exist near NWRs and natural fluctuations are unpredictable. EISs for existing FMP fisheries are currently being updated.

2. Recommend the revised DFMP include the sentence "There is also the need to take prompt action to head off the depletion and localized extinctions of many overfished or vulnerable species (e.g., giant clams, reef sharks, large groupers, pearl oysters, bumphead parrot fish, napoleon wrasse, lobsters, etc)."

Response: Overfishing definitions will be determined as prescribed in Chapter 4.0 of the FMP, which vary locally for species (e.g., lobsters are not overfished in the EEZ, according to NMFS). To the degree that the local EEZ status of such species is known, and based on the best available scientific and commercial data, those requiring special protection can be added to the prohibited list.

9.3.8 Comments on EFH/HAPC

1. Recommend the DFMP discuss why the HAPC is set at 10 fm for most reefs in the NWHI, yet is lowered to 50 fm for FFS, Laysan and Midway.

Response: Shallow water 0-10 fm represent the majority of the developed coral reef ecosystems in the NWHI and therefore serve an important ecological function for coral reef species including Hawaiian monk seals and sea turtles. Additionally, waters between 0-10 fathoms make up less than 10% of all of the benthic habitat found between 0-100 fathoms in the NWHI.

Further, according to the NMFS, French Frigate Shoals and Laysan Island, are sensitive pupping areas for monk seals. Since monk seals are known to prey upon a variety of coral reef ecosystem species, the Council selected these areas as HAPC and established a no-take MPA to a depth of 50 fathoms.

During the development of the CRE FMP, the Coral Reef Ecosystem Plan Team recommended that Midway Atoll be established as a HAPC is to a depth of 50 fathoms as it fulfills the criteria for designation of HAPC and due to the virtue of its existing protective status as a NWR.

2. Recommend that the DFMP add estuaries in the CNMI and Guam, and also add mangroves, patch reefs and reef communities/apron reefs and possibly sea grasses in Guam as EFH or HAPC.

Response: Currently, several areas in the CNMI and Guam with representative habitat types such as mangroves, patch reefs and sea grasses have been identified as areas which meet the criteria for designation of HAPC. See section 6.2 of the FMP for discussion on HAPC. For most areas, more information is required to validate or improve upon initial determinations. As this information becomes available, the Council will refine the extent of both EFH and HAPC.

3. Recommend that the criteria used for the candidate HAPC sites should include existing protective status, especially if the site is already established as an MPA.

Response: In designating HAPC for the DFMP, the Council included numerous areas with existing protective status including National Parks, MLCDs in the MHI, National Wildlife Refuges and CRAMP research sites. However, in determining whether an area within EFH should be designated as a HAPC, guidelines for selection provided in the MSFCMA state that one or more of the following criteria needs to be met: ecological function provided by the habitat is important; habitat is sensitive to human-induced environmental degradation; development activities are or will be stressing the habitat type; or habitat type is rare. Should an existing area designated as MPA fit the criteria outlined in the MSFCMA, it would be considered as a candidate site for HAPC designation.

9.3.9 Overall General Comments

1. The proposed action involves harvesting a wide variety of species of fish, coral, non-coral invertebrates, and algae that occur within coral-reef habitats.

Response: The CREFMP does not propose harvesting these species. The main objective of the Coral Reef Ecosystem Fishery Management Plan is to implement a management regime for the

conservation and protection of coral reef ecosystems in federal waters. Since there is no management regime for coral reef fisheries in place at this time, the CREFMP will immediately establish several management principles including: Management Unit Species, special permits, allowable gear types, marine protected areas and vessel insurance and reporting requirements. The CREFMP also incorporates an adaptive management approach through the framework process that can address future management needs as they arise.

2. The DEIS does not discuss the National Wildlife Refuge System Administration Act of 1966, nor does it analyze how that law may affect the implementation of the proposed Draft plan. Recommend that a revised DEIS completely analyze the proposed action for its compatibility with the primary purpose for which the NWR's were established, all legal instruments and the mission of the NWR system.

Response: The FMP discusses the National Wildlife Refuge System Administration Act in FMP Section 9.2- Other Applicable Laws and Policies. In addition, Section 9.3- Jurisdictional Issues addresses current jurisdictional authorities within the management area. The CREFMP proposes to prohibit the harvest of coral reef ecosystems resources via no-take MPAs within all national wildlife refuges, except those specifically requested by the U.S. Fish and Wildlife Service to be designated as low-use MPA. The MPA designations for coral reef ecosystems within refuges are consistent with the current protective status and also allows the U.S. Fish and Wildlife Service to continue recreational fishing opportunities and other wildlife dependent activities within National Wildlife Refuge Systems in the Pacific. The EIS discusses environmental consequences for National Wildlife Refuge Wilderness Resources in section 5.5. The compatibility of this Act with the MSFCMA has been discussed and requires resolution between the legal counsels of DOC and DOI. This issue and other jurisdictional issues are as yet unresolved.

3. Recommend that the revised EIS identify the Service as a cooperating agency, and request that the Service be included in future preparations of the EIS to provide input into proposed actions on or near NWRs identified in the EIS.

Response: The National Marine Fisheries Service is drafting a formal agency response for reciprocal cooperative participation between the NMFS and U.S. Fish and Wildlife Service in the preparation of NEPA documents.

4. The EIS should be revised to include complete information on the proposed action, an alternative analysis and impact assessment that is based on a commitment to avoid and minimize project-related impacts, and proposed mitigation measures that minimize unavoidable impacts and compensate for significant unavoidable impacts.

Response: The four alternative analyzed in the EIS cover a range from the No-action alternative to maximum additional protection for coral reef resources. The proposed action (1) creates a framework management plan with a permit system to allow for future management and data collection of various coral reef fisheries if and when they begin, (2) sets aside federal marine waters as no-take and low-use MPAs for the preservation of coral reef resources, (3) defines

allowable gear for any current or future coral reef fishery, and (4) requires insurance against groundings for fishing vessels transversing MPAs. This EIS is not associated with a proposed physical action and thus does not create physical impacts.

5. Each alternative, with the exception of the No-action alternative, appears to be incompatible with EO 13089 when it requires that all Federal agencies whose actions may affect U.S. coral reef ecosystems shall "ensure that any actions they authorize, fund, or carry out will not degrade the conditions of such ecosystems." The DEIS does not discuss the full impacts of the harvest activity upon target and non-target species in the coral reef ecosystem.

Recommend that the revised DEIS identify and discuss all non-target species and their relationships to target species.

Recommend the revised DEIS discuss the potential adverse effects that may result from the removal of target species and the effects of its removal upon prey/predator species.

Recommend that the revised DEIS describe each distinct coral reef ecosystem that occurs in the area of the proposed action and discuss the adverse effects upon each coral reef ecosystem that may result from the potential removal of target and non-target species.

Recommend the revised DEIS discuss mitigation for the potential unavoidable loss of target and non-target marine organisms and seabirds.

Recommend the revised DEIS discuss how vessel groundings may be reduced or eliminated from occurring in the NWHI in the future. Suggest the "safe transit corridors" be designated to allow fishing vessels to transit between the NWHI in a manner that reduces or eliminates accidental groundings.

Recommend the revised DEIS discuss compensatory mitigation as a possible consequence of causing significant adverse impacts to the federally protected resources.

Response: Under the no-action alternative, fisheries targeting coral reef ecosystem resources under the Council's jurisdiction would remain largely un-managed. There would be no management plan or regulations to balance sustainable use with protection of coral reef ecosystem resources. The proposed action is to establish a management regime that would allow for sustainable fisheries while preventing adverse impacts to coral reef ecosystems through the establishment of greater restrictions via special permit requirements, no-take MPA's, allowable gear types, management unit species, vessel insurance and reporting requirements. Therefore, management measures proposed in the CREFMP serve to mitigate potential adverse impacts to coral reef ecosystems from fishing activities.

The No-action alternative would be the least compatible with E.O. 13089. The management plan promotes interagency cooperation to address the above bulleted points. The EIS discusses

environmental consequences for target and non-target resources in section 5.2 and 5.3. Protected Species are discussed in section 3.2.4 and 5.4 of the EIS. Research on trophic level interactions are ongoing or proposed to allow more fuller description of coral reef ecosystems in parts of the region.

6. Recommend the revised DEIS address the threats of invasive species introduction, and discuss detailed measures for preventing the spread of alien species on refuge lands and waters, including eradication measures.

Response: All vessels transiting in areas adjacent to refuge lands have the potential to accidently introduce alien/invasive species. Measures to reduce the introduction of invasive species in island ecosystems are discussed in chapter 3.2.4. Alien species concerns are also discussed in section 5.5 (environmental consequences for NWR wilderness resources) of the EIS. Note that vessel removal and pollution clean up insurance is required for all fishing vessels operating in or transiting through MPAs. A discussion of EO 13112, Invasive Species, is included in Section 9.2-Other Applicable Laws and Policies.

7. Believe the actions may adversely effect the endangered Micronesian megapode, the short-tailed albatross, the green sea turtle, the hawksbill turtle, and five plants, and recommend NMFS initiate consultation under section 7 of the ESA.

Response: The establishment of management measures proposed under the preferred alternative of this plan is not likely to adversely affect the endangered Micronesian megapode, the short-tailed albatross, the green sea turtle, the hawksbill turtle, or five land-based plants. However, because all mariners have the right-of-passage in Federal waters, there is a potential for introduction of invasive species like rats, snakes, insects and plants to island ecosystems. The Council is considering an amendment process to all Fishery Management Plans under its jurisdiction to develop mitigation measures to reduce the potential introductions of invasive species to island ecosystems. Thus, for the purposes of this plan, an informal section 7 consultation under ESA may be appropriate.

8. The DFMP should not include Wake or any of the NWRs in the discussion on fishing communities, as none of the PRIAs have these which conform to the MSFCMA definitions and there is no evidence that these communities occur at these locations.

Response: The MSFCMA requires all fishing communities to be defined. A consistent population of people fish at Wake Island and for completeness the FMP describes this group. The Secretary of Commerce will determine whether this is a true fishing community and whether it should be included in the final document.

9. Recommend eliminating the phrase "all other coral reef ecosystem marine plants, invertebrates, and fishes not listed under existing FMPs."

Response: Elimination of the phrase would allow any unlisted or undescribed coral reef species to be unmanaged under this plan. Such an approach would not be consistent with an ecosystem management approach.

10. The DEIS violates NEPA by not considering the short- and long-term effects of each feasible alternative.

Response: This is considered under EIS Section 5.13.2, Resource Tradeoffs; Short-Term Uses Versus Long-Term Productivity.

11. Recommend the DEIS include discussion on the depth range and other characteristics of the bottomfish fishery.

Response: This information is already included in Section 3.3 of the EIS.

12. Recommend the DEIS discuss the adequacy of the MSFCMA to provide the Council with the ability to plan for fisheries management on an ecosystem basis.

Response: While the MSFCMA provides for fisheries to be managed on a species- or species-group basis, fisheries management is now expected to encompass an ecosystem approach. In the formulation of this plan, the Council followed the recent NMFS report to Congress by the Ecosystems Principles Advisory Panel, to the degree practicable.

13. Recommend the DFMP discuss the by-catch of sharks, and include estimated rates at which the pelagic fishery kills turtles, seals, seabirds, and discuss the Services BO for the Effects of the Hawaiian longline fishery on the short-tailed albatross.

Response: The pelagic longline fishery is restricted from within 50 nmi of the NWHI, well beyond most coral reef ecosystems. These issues are addressed in the pelagics final EIS.

9.4 Public Hearing Comments at the 109th Council Meeting, Ala Moana Hotel Honolulu, Hawaii, 13 March 2001

9.4.1 Overall General Comments

1. The Council should not take final action on the current draft CREFMP and EIS, as adequate time and attention were not given to the public comments submitted. (D. Raney)

Response: The Council voted to delay final action on the draft CREFMP and EIS to accommodate these concerns, in addition to reviewing more closely the comments from Department of Interior which were received the previous day.

2. The Council should not approve the plan before it is revised to be consistent with the EO. (S. Fried)

Response: The Council accommodated this request, and voted to delay final action on the draft CREFMP and EIS to review this issue. Currently the Coral Reef Ecosystem FMP and EIS address the provisions of the executive orders to the extent possible.

3. Recommended the Council defer final action on the CREFMP and EIS, as the document contained new information pertaining to Native Hawaiian issues that were not discussed with the Fishery Rights of Indigenous Peoples Advisory Panel or Ecosystems and Habitat Advisory Panel. (T. Harp)

Response: The Council voted to delay final action on the draft CREFMP and EIS to accommodate these concerns.

9.5 Public Hearing Comments at the 110th Council Meeting, Ala Moana Hotel Honolulu, Hawaii, 21, June 2001

9.5.1 Comments on Executive Order 13196- NWHI CRE- Reserve

1. Executive Order 13178 and 13196 is the law of the land and the CREFMP should be amended to conform with the executive orders as they are presently written. (D. Raney, S. Fried, C. Smith, I. Harp, R. Rufe- CMC letter of 18 June)

Response: Due to the complexity of issues and uncertainties contained in the executive orders, the Secretary of Commerce has not made a final determination on the interpretation of its provisions while President George W. Bush's administration currently reviews the executive orders. The Coral Reef Ecosystem FMP and EIS now address the provisions of the executive orders to the extent possible. The NWHI Reserve will be further addressed when the Department of Commerce has clarified its interpretation of the provisions contained in the executive orders and establishes final departmental policy on all issues.

2. The Council should work with the Executive Order, and not try to undermine it. (T. Harp)

Response: See response to comment # 1

3. The Council has done a good job balancing the sometimes opposing objectives of the EO and the MSFCMA in the CREFMP. (J. Gourley)

Response: Noted.

4. The Council's preferred alternative will allow the fishermen to continue with sustainable practices and offer protection to the coral reef. The EO closures restrict the fishermen's ability to react to changes in the fishing productivity of the different banks.(T. Timoney)

Response: Noted.

5. The bottomfish grounds are from 50 to 150 fathoms, and most areas in the Reserve are open to bottomfish to depths as shallow as 25 fathoms, therefore the fishery should not be affected. (S. Fried)

Response: Although deepwater bottomfish MUS are primarily caught at depths ranging from 50-150 fathoms, uku is a shallow species caught trolling in waters as shallow as 15 fathoms. In addition, due to the high bathymetric relief of most reefs and banks in the NWHI, the distance between the 25 fathom and the 100 fathom contour is sometimes as little as a few yards. To successfully target bottomfish, a vessel must be able to operate on either side of the preferred target depth. Apart from simply closing areas to fishing, the EO will constrain fishing operations in adjacent open areas.

9.5.2 Comments on Marine Protected Areas

1. Implementation of the 0-50 fathom no-take MPA for Rose Atoll would result in a 90% reduction of the existing protection provided under the National Wildlife Refuge Act. (D. Raney)

Response: Designation of Rose Atoll as an MPA does not replace the protection offered by its designation as a NWR. This provision would have an overlay effect, providing additional protection such as requiring vessel insurance.

2. The size of the boundaries of the no-take marine protected areas is a major weakness of the CREFMP. (D. Raney)

Response: In developing the MPAs for the CREFMP, the Plan Team and Advisory Panel recommended no-take MPAs to be established 0-10 fm because it represents the majority of the developed coral reef ecosystems, and is considered habitat important to both monk seals and sea turtles in the NWHI. Additionally, under the preferred alternative, the Council selected no-take MPA 0-50 fm around Laysan, French Frigate and the northern half of Midway, taking into account fishing activity, representative habitat types of the NWHI and the existing marine resources and monk seals populations located there.

3. The MPA boundaries in the CREFMP should conform with the outer boundaries of the National Wildlife Refuges and the National Park Service. (D. Raney)

Response: The Department of Commerce (NMFS) has joint jurisdiction with the Department of the Interior (USFWS) in certain marine areas and will continue to work in cooperation to manage fisheries in accordance with the requirements of the MSFCMA and other applicable laws.

4. During hurricanes, fishermen need to be able to anchor within French Frigate Shoals shallower than 50 fathoms. (W. Strickland)

Response: Regulations do not preclude anchoring in an emergency.

9.5.3 Comments on Jurisdiction

1. The CREFMP does not recognize the authorities of the State of Hawaii, U.S. Fish and Wildlife Service, or the NWHI Coral Reef Ecosystem Reserve. (I. Harp)

Response: The CREFMP recognizes the authority of the State of Hawaii to manage marine resources from 0-3 miles, and acknowledges the authority of the USFWS pursuant to the National Wildlife Refuge Act as amended. The NWHI Coral Reef Ecosystem Reserve is acknowledged and addressed in Section 9.3 of the FMP.

2. The CREFMP should recognize the sole management authority and protections currently afforded to marine resources within existing National Wildlife Refuges (NWR), and the plan should clarify that NWR authority to manage marine resources and address fishing activities within their boundaries extends throughout their full geographic extent. (R. Rufe)

Response: By authority of the MSFCMA, the Department of Commerce, through the NMFS, manages fishery resource from the shoreline to 200 nm around all PRIAs. Within NWR boundaries, fishery management responsibilities are shared between the Department of Commerce and the Department of the Interior. Clarification is sought from DOC and DOI lawyers regarding the implementation of shared jurisdiction. Jurisdictional issues are discussed in Section 9.3 of the FMP.

9.5.4 Comments on Permits and Reporting

1. The humphead parrotfish, other unidentified parrotfishes and the large Napoleon wrasse may be rare in nearshore non-federal waters surrounding Saipan and Tinian, however are not rare in other areas of CNMI, and should not be used to justify implementing special permits in federal waters. Special permits are not needed to manage coral reef MUS in CNMI federal waters. (J. Gourley)

Response: Under the preferred alternative, special permits are required for areas of special concern (i.e., low-use MPAs) determined by the Council as well as for resources of which virtually nothing is currently known (i.e., potentially harvested coral reef taxa anywhere where fishing is allowed.) Special permits are not required for currently harvested coral reef MUS. No MPAs have been designated for the CNMI.

2. The humphead parrotfish and the Napoleon wrasse should not be banned from capture in the EEZ of Guam. No studies have been conducted on the offshore banks, just inshore creel surveys. (M. Duenas)

Response: These species are not currently banned from capture in the EEZ. Available Information will be compiled and analyzed in the annual report to assess the status of these populations. If needed, further studies will be recommended.

9.5.5 Comments on Framework Action

1. The FMP is a dynamic document, and flexible enough to address unknown fishing issues as they arrive. (J. Gourley)

Response: Noted.

9.5.6 Comments on Fishing Gear and Methods

1. Scuba spearfishing during the day should not be prohibited. (J. Gourley)

Response: The Council discussed this issue at length, and determined that it was important to protect the fish while sleeping because at this time they have no refuge from fishing gear. Prohibiting the use of spear with Scuba at night and not during the day, strikes a balance between the interests of the fishermen with concerns for potential over-harvesting of highly prized species.

2. In support of the CREFMP, except for the framework provision for mirroring federal laws with the local laws with respect to spearfishing with scuba. This should not be banned, day or night. (T. Costa)

Response: See previous response.

3. Spearfishing with scuba tanks should not be banned in the EEZ. (D. Lui)

Response: Under the preferred alternative, spearfishing with scuba is banned only in the NWHI and PRIA, and only at night. This reflects a compromise between the interests of the fishermen with concerns for potential over-harvesting of highly prized species.

9.5.7 Overall General Comments

1. The NWHI serves as a replenishment area for the MHI. (I. Harp)

Response: Scientific evidence has not documented that this is the case. The circulation is very complex between the NWHI and the MHI, and does not go in one direction only. The larval transport phases also vary greatly between individual species.

2. Endemic marine mammals exist in the NWHI, and they should be given priority to take from the resource before the humans. (T. Harp)

Response: Designated as no take, shallow water 0-10 fm represent the majority of the developed coral reef ecosystems in the NWHI which provides habitat for the majority of coral reef species of which, many are believed to be utilize by monk seals as a source of prey. Additionally, French Frigate Shoals and Laysan Islands represents important areas for monk seals and have been established as no-take MPAs from 0-50 fm. Under alternative 4, the Council considered

maximum additional protection to a depth of 100 fathoms, however, chose to provide for a management plan which balances conservation and protection with sustainable use of resources under a special permit system in NWHI waters (10-50 fathoms), not designated as no-take.

3. All species should be included in an ecosystem plan, but the CREFMP does not include the deep-sea bottomfish stocks. (I. Harp)

Response: The deep-sea bottomfish stocks are managed under the bottomfish fishery management plan, and are subject to the management measures included in that FMP. In addition, existing FMP fisheries are prohibited in no-take MPAs, are required to have vessel insurance and must document and report all species targeted and incidentally caught. The FMP also includes a formal process for plan team coordination to identify and address ecosystem impacts of the existing FMPs.

9.6 Written Comments Received on the Draft Coral Reef Ecosystem FMP, Draft Environmental Impact Statement and Draft Essential Fish Habitat Fish Habitat for Management Unit Species

During the public comment period held between January 12 and February 26, 2001 (45 days), the Council received a total of 23 written public comments (provided below) on the Draft Coral Reef Ecosystem FMP, Draft Environmental Impact Statement and Draft Essential Fish Habitat Fish Habitat for Management Unit Species.

United States Department of the Interior

OFFICE OF THE SECRETARY
Washington, D.C. 20240

'01 JAN 29

WESP...

Ms. Kitty Simonds
Executive Director
Western Pacific Regional Fishery Management Council
1164 Bishop Street, Suite 1400
Honolulu, HI 96813

January 19, 2001

Dear Kitty:

The U.S. Department of the Interior will no doubt provide additional comments on the Draft Environmental Impact Statement (DEIS) for the Coral Reef Ecosystem of the Western Pacific Region.

Nevertheless, we provide the enclosed letter (and attachments) dated August 29, 2000 from the Director of the U.S. Fish and Wildlife Service to the Assistant Administrator for the National Marine Fisheries Service. These materials pertain to the jurisdictional issues raised by the DEIS and we request that the letter and the attachments be considered as "comments" on the DEIS for the record of the fishery management plan.

We appreciate the opportunity to comment on this initiative by the Western Pacific Regional Fishery Management Council and look forward to providing additional views prior to the February 26, 2001 deadline.

Sincerely,

Roger E. McManus
Senior Advisor for Oceans

cc: Susan B. Fruchter

United States Department of the Interior

OFFICE OF THE SECRETARY
Washington, D.C. 20240

In Reply Refer To:
ER 01/64

MAR 9 2001

Dr. Charles Karnella, Administrator
Pacific Islands Area Office, Southwest Region
National Marine Fisheries Service
1601 Kapiolani Blvd., Rm. 1110
Honolulu, Hawaii 96814

Dear Dr. Karnella:

The U. S. Department of the Interior (Department) has reviewed the Draft Fishery Management Plan for Coral Reef Ecosystems of the Western Pacific Region (Draft Plan) and Draft Environmental Impact Statement (DEIS).

This letter has been prepared under the authority of and in accordance with provisions of the National Environmental Policy Act (NEPA) of 1969 [42 U.S.C. 4321 *et seq.*; 83 Stat. 852], as amended, the Fish and Wildlife Coordination Act of 1934 [16 U.S.C. 661 *et seq.*; 48 Stat. 401], as amended, the Endangered Species Act of 1973 [16 U.S.C. 1531 *et seq.*; 87 Stat. 884], as amended, the Migratory Bird Treaty Act (16 U.S.C. 703-711), as amended, and other authorities mandating Department concern for environmental values. Based on these authorities, the Department offers the following comments for your consideration.

Proposed Action

The proposed action involves harvesting a wide variety of species of fish, coral, non-coral invertebrates, and algae that occur within coral-reef habitats. The action proposes to authorize new gear types and methods to harvest marine organisms which include: hand harvest, spear (Scuba assisted), slurp gun, hand/dip net, hoop net for kona crab, throw net, barrier net for aquarium fish, surround/purse set net, hook-and-line (powered and unpowered handlines, rod and reel, and trolling), traps, and remotely operated vehicles/submersibles. The action proposes to govern harvest activities that may occur throughout the U.S. Exclusive Economic Zones and adjacent to the territorial waters of the State of Hawaii, the territories of American Samoa and Guam, and the Commonwealth of the Northern Mariana Islands (CNMI). The action also proposes to direct the extraction of marine organisms from several National Wildlife Refuges (NWRs) in the Pacific region that are administered by the Department through the U.S. Fish and Wildlife Service (Service). The DEIS analyzes, among other things, various proposed

alternatives for the management of harvest activities and the environmental impacts they may have upon protected species and their habitat.

Our general comments on the Draft Plan and the DEIS are presented within this letter while our specific comments are contained in Enclosure 1. Enclosure 2 contains a summary of information on the National Wildlife Refuges of the Pacific; Enclosure 3 provides specific details on key items outlined in the main letter.

GENERAL COMMENTS

National Wildlife Refuge System Administration Act of 1966

The DEIS does not discuss the National Wildlife Refuge System Administration Act of 1966, as amended, nor does it analyze how that law may affect the implementation of the proposed Draft Plan. Similarly, the DEIS does not discuss the various Executive Orders (13178, 13196, 13089) that give the Department specific instructions for managing fish and wildlife resources that occur in the waters of the previously mentioned NWRs (Enclosure 2). The absence of a clear discussion of NWR marine boundaries, management responsibilities, and associated statutes may lead to confusion and may negatively impact federally protected resources that occur within these NWRs. We recommend that a revised DEIS fully and completely analyze the proposed action for its compatibility with the primary purpose or purposes for which the NWRs were established, all legal instruments pertaining to the establishment of the NWRs, and the mission of the National Wildlife Refuge System.

The DEIS proposes that the National Marine Fisheries Service (NMFS) administer the harvest of marine organisms that occur within the management area of many NWRs. In an August 29, 2000, memo to NMFS, the Service requested to be a cooperating agency under NEPA, if NMFS proposes actions that involve the resources within the established boundaries of NWRs. We recommend that the revised DEIS identify the Service as a cooperating agency. Furthermore, we recommend that the Service be included in future preparations of the DEIS to provide input into proposed actions on or near NWRs identified in this DEIS.

Fish and Wildlife Coordination Act

The DEIS is deficient in assessing the effects of the proposed action on fish and wildlife resources. In addition, the document does not propose mitigation measures commensurate with the range of potential adverse impacts anticipated to result from the proposed action. As a result, the deficiencies in the DEIS preclude its use as a basis for a meaningful analysis of anticipated project-related impacts to fish and wildlife resources identified in these comments. Therefore, we recommend that the DEIS be revised to include complete information on the proposed action,

an alternative analysis and impact assessment that is based on a commitment to avoid and minimize project-related impacts, and proposed mitigation measures that minimize unavoidable impacts and compensate for significant unavoidable impacts.

Harvest activities proposed in the Draft Plan and analyzed in the DEIS have been documented to adversely affect fish and wildlife resources similar to those that occur within and adjacent to the NWRs. The DEIS fails to describe thoroughly Department trust resources and to document harvest-related impacts to those resources. NWRs in the Pacific region that are potentially affected by the CREFMP include (Enclosure 2):

Hawaiian Islands NWR, Northwestern Hawaiian Islands
Midway Atoll NWR, Northwestern Hawaiian Islands
Baker Island NWR, Central Pacific
Howland Island NWR, Central Pacific
Jarvis Island NWR, Central Pacific
Johnston Atoll NWR, Central Pacific
Palmyra Atoll NWR, Central Pacific
Kingman Reef NWR, Central Pacific
Rose Atoll NWR, American Samoa
Guam NWR, Territory of Guam

Migratory Bird Act and Endangered Species Act

These NWRs support enormous numbers of nesting migratory seabirds. The NWRs provide breeding habitat for federally listed endangered Hawaiian monk seals (*Monachus shauinslandi*) and nesting habitat for threatened green sea turtles (*Chelonia mydas*). The NWRs host several plant species that include the federally listed endangered *Mariscus pennatiformis* ssp. *bryanii*, *Pritchardia remota*, *Schiedea verticillata*, *Amaranthus brownii*, and *Sesbania tomentosa*. The NWRs provide forage and shelter habitat for numerous species of migratory shorebirds and federally listed endangered Short-tailed albatrosses (*Phoebastria albatrus*), Hawksbill sea turtles (*Eretmochelys imbricata*), and Leatherback sea turtles (*Dermochelys coriacea*). The NWRs also contain rich coral-reef ecosystems that support hundreds of species of reef fishes and algae and thousands of species of invertebrates.

Executive Orders 13178 and 13196

We are concerned that the DEIS does not address the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve (Reserve), as established by executive orders 13178 and 13196 (Reserve EOs). We believe that the proposed action is not consistent with the conservation measures that apply throughout the Reserve. These measures prohibit commercial fishing activities in the

Reserve, except as specifically expressed in the Reserve EOs; cap the number of commercial fishing permits at the number of permits in effect the year preceding the Reserve EOs; limit the level of aggregate take for a fishing method so that it does not exceed the aggregate take for that type of fishing over the year preceding the Reserve EOs; and prohibit the issuance of permits for any particular type of fishing activity for which there were no permits issued in the year preceding the Reserve EO. The measures also cap recreational fishing effort at existing levels. Further restrictions on fishing effort, species targeted, or gear used, are possible should it become necessary to protect Reserve resources. Furthermore, the Reserve EO prohibits certain activities in the Reserve, including: anchoring on living or dead coral when the seabed can be seen; discharging or depositing any material or other matter into the Reserve; and removing, moving, taking, harvesting, or damaging any living or non-living Reserve resource except under certain limited circumstances.

In addition, the Reserve is managed to supplement and complement existing management of resources in the Midway Atoll NWR, Hawaiian Islands NWR, and adjacent Hawaii State waters to ensure coordinated conservation and management of the Northwestern Hawaiian Island (NWHI) consistent with the purposes and policies of the National Marine Sanctuaries Act, the National Marine Sanctuaries Amendments Act of 2000, and the Reserve EOs, and the authorities of the U.S. Fish and Wildlife Service under the National Wildlife Refuge System Administration Act (16 U.S.C.668dd-668ee) and other laws with respect to management of the NWRs. We believe that the Draft Plan may make it more difficult for the U.S. Fish and Wildlife Service, and hence the Secretary of the Interior, to administer and manage the Reserve and the NWRs in cooperation with other Federal agencies. Therefore, we recommend the revised DEIS incorporate a full discussion of the compatibility of actions proposed in the Draft Plan with the Reserve conservation measures. Furthermore, we recommend the revised DEIS discuss the coordinated management of the Reserve and the Refuge, and how the proposed action may supplement and complement stated Refuge conservation goals, strategies, management areas and boundaries.

Executive Order 13089

Executive Order 13089 (EO 13089)(Coral Reef Protection) states that "All Federal agencies whose actions may affect U.S. coral reef ecosystems shall: "(c)...ensure that any actions they authorize, fund, or carry out, will not degrade the conditions of such ecosystems." Even though the Draft Plan is supposed to be ecosystem based, each alternative, with the exception of the no action alternative, appears to be incompatible with EO 13089. Alternatives 2, 3 and 4 each propose some form of harvest of coral reef resources or activities that may adversely affect coral reef resources. However, the DEIS does not discuss the full impacts of the harvest activity upon target and non-target species in the coral reef ecosystem. Therefore, we recommend that the revised DEIS identify and discuss all non-target species and their relationship to target species (e.g., prey/predators). We also recommend the revised DEIS discuss the potential adverse effects

that may result from the removal of target species and the effects of its removal upon prey predator species (*e.g.*, marine organisms and seabirds). Furthermore, we recommend that the revised DEIS describe each distinct coral reef ecosystem that occurs in the area of the proposed action and discuss the adverse effects upon each coral reef ecosystem that may result from the potential removal of target and non-target species. We also recommend that the revised DEIS discuss mitigation for the potential unavoidable loss of target and non-target marine organisms and seabirds.

The DEIS also fails to adequately assess the past and potential future impacts of fishing vessel groundings upon Federal trust resources. For instance, since 1998, two federally permitted Hawaiian longline vessels have run aground on coral reefs located within the northwestern Hawaiian Islands (Enclosure 3-1, 3-2).

In light of Executive Orders 13178 and 13196 (Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve (NWHI)) and 13089 (Coral Reef Protection), we are very concerned about adverse impacts to coral reef resources that have resulted from federally permitted fishing vessel groundings, especially in the NWHI. We recommend the revised DEIS discuss how vessel groundings may be reduced or eliminated from occurring in the NWHI in the future. We suggest that "safe transit corridors" be designated to allow fishing vessels to transit between the NWHI in a manner that reduces or eliminates accidental groundings. If future vessel groundings are an unavoidable consequence of these activities, we recommend that the revised DEIS discuss compensatory mitigation as a possible consequence of causing significant adverse impacts to federally protected resources.

Invasive Species Assessment

The DEIS lacks a discussion of how NMFS plans to prevent introductions of terrestrial and marine alien species spread by fishery-related activities and vessel groundings, especially at remote island sites within the NWRs. Introduction of alien species is one of the greatest threats to the biological health of NWRs in the Pacific. Invasive aliens, such as rats, insects, weeds or marine organisms carried in ballast water or attached to the hulls of ships, can potentially out-compete and eliminate many native species. We recommend that the revised DEIS address these threats and discuss detailed measures for preventing the spread of alien species on refuge lands and waters, including how alien species would be eradicated in the event of accidental introductions.

We believe that actions proposed in the Draft Plan may adversely effect the federally listed endangered Micronesian megapode (*Megapodius laperouse laperouse*), the short-tailed albatross and the green sea turtle, the hawksbill sea turtle and five plants including the federally listed endangered *Mariscus pennatiformis* ssp. *bryanii*, *Pritchardia remota*, *Schiedea verticillata*, *Amaranthus brownii*, and *Sesbania tomentosa*. Micronesian megapodes, which occur at

Aguiguan, Farallon de Medinilla, Anatahan, Sarigan, Guguan, Alamagan, Pagan, Agrihan, Asuncion, Maug, and Uracus, in the CNMI, are flightless birds that may be especially vulnerable to the proposed actions if these actions result in the introduction of alien species (*e.g.*, rats, insects or plants) at these islands. Rats may prey upon bird eggs or chicks and negatively effect population production rates and the species recovery. Alien insects and plants could potentially displace native plants and disrupt megapode forage items and habitat and negatively affect the species' ability to recover (Enclosure 3-3).

We recommend the National Marine Fisheries Service initiate consultation under section 7 of the Endangered Species Act for each federally listed species.

In summary, despite the density and length of the document (three volumes), significant concerns of the U.S. Fish and Wildlife Service and the Department of the Interior have not been addressed. These deficiencies preclude the use of the DEIS as a basis for a meaningful analysis of anticipated project-related impacts to certain fish and wildlife resources. As a result, we feel the release of the DEIS was premature, and recommend it be revised with more complete information, improved analyses of alternatives and potential impacts, and a clearer commitment to avoid unnecessary impacts, minimize unavoidable impacts, and compensate for significant unavoidable impacts. We believe the DEIS should provide a thorough and complete analysis of the proposed Draft Plan on existing NWRs, and identify the Service as a cooperating agency.

Thank you for the opportunity to review and comment on the Draft Plan and the DEIS. We hope that our comments are useful. If you have any questions, please contact Ken Havran in the Office of Environmental Policy and Compliance at (202) 208-7116. We look forward to working with your agency to provide data, analyses and reports that would contribute to the revised DEIS.

Sincerely,

Willie R. Taylor

Willie R. Taylor
Director
Office of Environmental Policy
and Compliance

Enclosures (3)

SPECIFIC COMMENTS

VOLUME I: Fishery Management Plan for the Coral Reef Ecosystems of the Western Pacific Region (Including Regulations) and Regulatory Impact Review/Initial Regulatory Flexibility Analysis.

Pg. 1, Executive Summary: Paragraph 5 - We recommend that the revised DFMP include this sentence: "There is also the need to take prompt action to head off the depletion and localized extinctions of many overfished or vulnerable species (*e.g.*, giant clams, reef sharks, large groupers, pearl oysters, bumphead parrot fish, napoleon wrasse, lobsters etc.)."

Pg. 2-3, Marine Protected Areas (MPAs): We recommend that the revised DFMP include a discussion concerning the need to cooperate with other agencies to integrate and combine proposed MPAs with those that already exist and not to undermine or add confusion interpreting other established MPAs that have the same purpose of conserving coral reef resources.

Pg. 3, Permits and Monitoring: Paragraph 4 - The DFMP states that fishers may be exempt from being subject to additional permit requirements to reduce coral reef incidental catch. We recommend that harvest permits be issued to fishers on a per coral reef ecosystem basis to facilitate tracking and managing resource exploitation.

Pg. 5, Frequently Asked Questions: Paragraph 1 - We believe the plan fails in its goal to "reinforce existing resource management efforts and establish consultative procedures that would improve inter-agency coordination" and may result in a regime that would actually diminish and confuse protection of coral reefs at nine NWRs in the Pacific. Therefore, we recommend that the existing management regime established for coral reefs in these NWRs be incorporated into the revised DFMP.

Pg. 5, Were diverse stakeholders and users of coral reefs considered during FMP preparation?: Paragraph 2 - We believe the proposed regime is not "a consensual management approach." We believe the Western Pacific Regional Fishery Management Council (Council), has ignored the best advice of its Draft Plan Team and has not acknowledged the relevant management responsibilities of the Service. The Department objects to any proposed regime that would undermine the Services' existing protection of coral reefs as established in their NWRs. We are dismayed that the Service is not mentioned in any of the discussions of "consensual" management. Therefore, we recommend that the revised DEIS include all comments concerning Service management responsibility for coral reef resources located within the management area of its NWRs in the Pacific region.

Pg. 5, What fisheries resources would be managed by the proposed FMP for Coral Reef Ecosystems?: Paragraph 3 - The DFMP states that "Adverse effects on the ecosystem cannot necessarily be prevented through existing FMP and island government regulations that aim to

maintain optimum yield, while preventing overfishing of target stocks. The FMP for Coral Reef Ecosystems is needed to incorporate additional ecosystem principles into the regulatory structure already established." However, nowhere in the DFMP does it explain how the addition of these "ecosystem principles" will be accomplished to meet this aim. We are concerned that this DFMP proposes to resolve the collapse of the lobster fishery in the NWHI through the addition of "ecosystem principles" as a means to sustain the harvest of lobster resources in the future. Therefore, we recommend that the revised DFMP provide a detailed discussion that addresses specific management measures to resolve current collapse of the lobster fishery.

Pg. 6, How would the proposed FMP affect existing FMP fisheries?: Paragraph 1 - The DFMP states that fishing and harvest activities, as proposed in the DFMP, would be authorized to occur within the management area of established NWRs. Currently, the management areas of NWRs are designated as *no take areas and are off limits to commercial fishing*. Harvest activities are restricted by the Service through the issuance of special use permits. Therefore we recommend that the revised DFMP discuss the management areas, fishing and harvest restrictions that apply to the Hawaiian Islands, Midway, Johnston, Jarvis, Palmyra, Kingman, Howland, Baker, and Rose NWRs

Paragraph 3 - The boundaries for the newly established Palmyra and Kingman NWRs extend 12 nautical miles (nm) offshore, well seaward of the 50 fathom contours proposed in the Draft Plan. The proposed plan would conflict with existing Service management regimes that prohibit commercial fishing within both NWRs. Therefore, we recommend that proposed Draft Plan activities be designated to occur seaward of the 12 nm management areas of both NWRs.

Pg. 7, Does the proposed FMP addresss non-fishing impacts?: Paragraph 1 - We recommend that the revised DFMP identify French Frigate Shoals, Kure Atoll, Howland Island, and Baker Island as areas that were also used or modified by the U.S. Military or Coast Guard. Kingman Reef was an anchorage for the U.S. Navy during World War II.

Pg. 7, How does the proposed FMP demonstrate an ecosystem-based approached to coral reef management?: Paragraph 2 - We recommend that the revised DFMP include a discussion concerning information and data collection, and the need for independent verification concerning harvest data provided by fishers to insure quality control and accuracy.

Pg. 7, Which places in the U.S. Pacific islands constitute "fishing communities.": Paragraph 4 - None of the Pacific Remote Island Areas (PRIAs) have "fishing communities" that conform to the Magnuson-Stevens Act (MSA) definitions. All were uninhabited at the time of western discovery, and only a few of the NWHI and Wake Atoll possess any evidence of past visits and occupation. The present day fishers at Wake Atoll and Johnston Atoll NWR are employees of the U.S. government or their contractors, without any legal or traditional property or harvesting rights, and none have aboriginal claims. Fishing at Johnston is confined to recreational take under the control of the Service which operates the refuge under a cooperative agreement with the U.S. Department of Defense. Therefore, we believe that the DFMP should not include Wake

or any of the NWRs in this dicsussion as there is no evidence that said communities occur at these locations.

Pg. 9, What criteria were used to select the MPA locations proposed in the CRE-FMP?: Paragraph 3 - The listed criteria for selecting MPAs are deficient and do not include the existence of already established MPAs. The NWRs serving as no-take MPAs for coral reefs in the Pacific should have contributed to the selection process, and yet there is no documented evidence of any coordination or consideration of this in the analysis. We recommend that the revised DFMP include the MPA contributions made by the NWRs in this discussion.

Pg. 10, Why is 50 fathoms, rather than 100 fathoms, the depth limit of the proposed MPAs?: Paragraph 1 - Although active reef growth certainly does not extend to 100 fathoms (fm), there is literature documenting the presence of reef building corals at depths approaching 100 fm. For example, deep diving submersible observations at Johnston Atoll in 1983 revealed the presence of living hermatypic corals to depths of 565 feet (92 fm) and coralline algae to 600 feet (100 fm). Furthermore, many reef fishes are known to make diurnal migrations ranging as much as 100 fathoms or more along ocean reef slopes. From an ecosystem perspective there is adequate documentation to support the deep boundaries of reefs extending to 100 fathoms. Therefore, we recommend that the revised DFMP expand the proposed MPA boundaries from 50 fathoms to depths of 100 fathoms. Please consult the U.S. Fish and Wildlife Service Honolulu Office for this documentation.

Pg.11, Low-use Marine Protected Areas: Paragraph 3 - Other than the requirement of a special permit, the DFMP does not identify measures that would be implemented within "low-use MPAs" to improve conservation or measures that could be construed as needed for maintaining any type of true MPA. In essence, the low-use MPAs represent opportunities for fishers to exploit coral reef resources instead of protecting them. There are no stated criteria or standards that demonstrate a higher level of restricted take or protection for reefs in low use MPAs. The only distinction in the document is the increase in the amount of paperwork for the fishers themselves to fill out, to gain access to the few areas designated as "low-use". We suggest that the MPAs in the Draft Plans be rethought with the goal of including the standards and criteria to demonstrate their function as real MPAs or be labeled as something else (*e.g.* "fishery areas requiring a special permit").

Pg. 14, History of Coral Reef Resource Use and Management (also at p 20 par 1.3.4): Paragraph 2 - We recommend that the DFMP elaborate on the other Pacific Remote Islands Areas, not just Wake Atoll. Also, statements should be included to the effect that there is no physical evidence of recent or any occupation on any of the 18 reefs, atolls, or islands by aboriginal islanders except for a few of the NWHI and via legends for Wake Atoll. All were uninhabited at the time of their discovery over the past two centuries, including a) Nihoa, Necker, French Frigate Shoals, Gardner Pinnacles, Maro Reef, Laysan, Lisianski, Pearl and Hermes, Midway, Kure in the NWHI; b) Johnston, Jarvis, Palmyra, Kingman Reef in the Line Islands; c) Howland and Baker in the Phoenix Islands, d) Rose Atoll in American Samoa, and f) Wake off the northern end of

the Marshall Islands.

Pg. 15, Purpose and Need for Action: Paragraph 4 - We believe that the revised DFMP must include Department concerns regarding the potential for overfishing via existing FMPs (*e.g.* NWHI lobster fishery) and destructive fishing (*e.g.* use of nets, traps, explosives, poisons). The revised DFMP should require all commercial fishing ventures to be authorized by special permits and not just be subject to reporting requirements or a general permit. Also, in addition to record-keeping and reporting, each permitee should be bound, via a permitting procedure, to honor all restrictions that protect coral reefs or face the penalty of being denied future fishing rights and access. The Department wants all fishing, not just some in the "low-use" regime to be bound and controlled, via special permits.

Pg. 16, Ecosystem Effects of Established Fisheries: Paragraph 4 - We concur that non-selective gear (tangle nets) is destructive to precious coral habitats. We also support current proposals to amend existing FMPs and prohibit non-selective fishing gear.

Pg. 19, Live Rock Harvest: Paragraph 1 - The DEIS states that local governments prohibit live rock collection in their jurisdictional areas which has been unregulated in adjacent federal (EEZ) waters. However, the DFMP appears to authorize the harvest of live rock in these adjacent Federal waters. This statement indicates that the DFMP is not consistent with local government efforts to conserve live rock resources. Therefore, we recommend that the DFMP be revised to preclude harvest of live rock from Federal waters where such harvest in adjacent territory or state waters has been prohibited.

Pg. 21-22, 1.4, Management Plan Objectives: This section - We recommend that the revised DFMP discuss the management plan objectives and mention the role and opportunity for collaboration and cooperation with the Service that exists to meet these objectives, especially for objective 1 ("precautionary approach for ecosystem-based management"), objective 6 ("collaborate with other agencies and organizations"), and objective 7 (" to encourage and promote improved surveillance and enforcement"). To date, none of these objectives have been met by the DFMP.

Pg. 24, Assess the ecological, human, and institutional elements of the ecosystem which most significantly affect fisheries, and are outside Council/Department of Commerce authority. Included should be a strategy to address those influences in order to achieve both FMP and FEP objectives. (Also at p. 138, 1st para): Paragraph 4 - Regarding "*Management Plan Approaches*" the DFMP has failed to adequately assess and discuss the "institutional elements," such as those of the Service. The DFMP does not discuss the opinions of the Service, nor has it included the institutional elements suggested by the Draft Plan Team and other reviewers. Therefore, we recommend that the revised DFMP incorporate Service and Draft Plan Team comments concerning institutional elements.

Pg. 28, Hawaii: Paragraph 2 & 3 - Based on the results of recent expeditions to the NWHI (NOW-RAMP September to October 2000), the Service has documented that the best reef

growth and live coral cover are concentrated in sheltered and partially sheltered habitats. Also there are now about 60 true species of stony corals reported from all of Hawaii, and the Service has documented about 45 species from the NWHI and over 30 new records. We recommend that the revised DFMP reflect this new and relevant information.

Pg. 29, Island Areas: Paragraph 6 - Giant clams (*Tridacna spp*), have now been reported in abundance on the ocean reef slopes of Howland, Baker, and also in the lagoon of Kingman Reef as a result of recent expeditions to those areas (Townsend Cromwell, Spring 2000). IUCN lists all species of *Tridacna* as depleted or threatened. We recommend that the DFMP discuss the status of giant clams in a protected legal context for the above mentioned locations. We also recommend that the revised DFMP note that these species are protected under CITES .

Pg. 30, 1.6.2 Management Unit Taxa: Paragraph 1 - We recommend that the revised DFMP cite the original references with regard to coral and reef observations at Johnston Atoll NWR. The Service (Honolulu FWO) can provide the correct citations for these references upon request.

Pg 32, Potentially Harvested Coral Reef Taxa: Table - We recommend that *Tubiphora* be changed to *Tubipora* to reflect the correct spelling of this coral.

Pg. 33, Potentially Harvested Coral Reef Taxa: Table, last line - The catch-all phrase "All other coral reef ecosystem marine plants, invertebrates and fishes not listed under existing FMPs" is unreasonable. It implies that a coral reef ecosystem can be managed without specifically identifying the species targeted for fishing and management. Moreover, this catch-all allows fishers to request fishing permits for species not on the list. The wording is such that seabirds, whales, turtles, dolphins, porpoises and other marine species with any association with reefs can be added to the list without proper justification. Therefore, we recommend that the revised DFMP eliminate the catch-all phrase.

Pg. 35, Coral Reef Ecosystems: Paragraph 2 - Over 400 species of corals have been reported from the Great Barrier Reef (Veron 1986, 2000). We recommend that the revised DFMP reflect this relevant information.

Paragraph 3 - We recommend that atoll and barrier reefs be addressed in the discussion of the revised DFMP. Atolls are reported in American Samoa (Rose), the NWHI (French Frigate Shoals, Maro Reef, Pearl and Hermes Reef, Midway Atoll, and Kure Atoll), and the PRIAs (Palmyra Atoll, Kingman Reef, Johnston Atoll, and Wake Atoll). Also, according to the Atlas of Hawaii (1998), barrier reefs are found in the Main Hawaiian Islands (MHI) (Kaneohe Bay and Mana off Na Pali).

Pg. 37, Reef Productivity: Paragraph 1 - Not all the PRIAs are dry. Both Palmyra and Kingman get about 175 inches of rain per year (4,300 mm), and Rose Atoll is similar to that although Kingman lacks any permanent vegetated land. Thus, Palmyra and Rose are unique in being the only wet atolls under U.S. jurisdiction and among the few wet atolls in the world, that are not permanently inhabited. We recommend that the revised DFMP include this information.

Pg. 42, Long-term Ecosystem Variability: Paragraph 5 - We recommend that the revised DFMP include a discussion of Laysan Island and note that the reduced quotas and access to Laysan did not stem the decline of the NWHI lobster fishery in terms of catch (numbers), average size, and catch per unit effort. The NMFS closed the lobster fishery in 2000 due to a Federal court case that had the potential to close the lobster fishery as an outcome of the case.

Pg. 51, Data Available: Paragraph 3 - We recommend that the revised DFMP discuss why the DFW suspended creel surveys in 1996.

Pg. 51& 52, Data Available: Paragraph 5 - We recommend that the revised DFMP indicate whether the logbook requirements will apply to both special and general permit holders. We also recommend that the revised DFMP indicate whether the Draft Plan annual reports will include data from both special and general permit holders.

Pg. 55, Pacific Remote Island Areas: Paragraph 3 - Kingman Reef was transferred to the Service and established as a NWR via Department of Interior (DOI) Secretarial Order, which became effective on January 18, 2001, as published in the federal register. We recommend that you include this point in the revised DFMP.

Pg. 56, Pacific Remote Island Areas: Paragraph 1 - The Nature Conservancy completed the purchase of Palmyra Atoll in November 2000, and a Department Secretarial Order established the Palmyra NWR, which became effective on January 18, 2001. We recommend that you include this point in the revised DFMP.

Pg. 56, Pacific Remote Island Areas (and also at Pg. 97, 2nd Paragraph): Paragraph 3 - The description of the recent history at Johnston Atoll NWR is incomplete and misleading. In keeping with the DFMP's goal to strengthen MPAs in the region, we recommend that the revised DFMP discuss the fact that the refuge was established in 1926, well before the military interest, modification, and occupation of Johnston Atoll beginning in the late 1930s.

Pg. 56, Pacific Remote Island Areas: Paragraph 4 - Sport diving and snorkeling during daylight hours is even more popular than night diving at MidwayAtoll NWR, and refuge regulations prohibit collecting or capture of any reef life. We recommend that the revised DFMP discuss Service management activities concerning marine resources at Midway Atoll NWR.

Pg. 57, 3.3.2 Estimated value of coral reef resources: Paragraph 4 - We recommend that the revised DFMP indicate whether the present estimated level of the federal fishery is about $2 million or less per year. We also recommend that the revised DFMP include a table providing the estimated value of the Federal coral reef fishery over the past 20 years. We also recommend that the revised DFMP discuss the value of coral reef resources for purposes other than for harvest. For example, what is the value placed on coral reef resources by U.S. citizens knowing that they are protected from resource exploitation in no-take protected areas.

Pg. 58-64, Summary of Fisheries Annual Ex-vessel Value ($1,000/year): These tables are redundant and provided in three separate places in the 3 volume DFMP/EIS. These and many other sections are repeated several times in the DEIS without considering other options such as incorporating them by reference in various places within the DEIS or the DFMP, as stressed in the President's Council on Environmental Quality regulations for implementing the NEPA (40 CFR 1500-1508). The repetitive and overly excessive nature of the 3-volume document discourages public review and input, contrary to the NEPA regulations. We recommend that it would be fairly simple to condense the volumes to two by combining both the plan and the DEIS in a first volume and using a second volume for the lengthy Essential Fish Habitat descriptions, the catalogue of fishing gears, and other wordy or lengthy peripheral material that could be placed in an appendix volume and referenced in the text of the first volume.

Pg. 73, Remote US Pacific Islands: Paragraphs 5 & 6 - The earlier practices of shipping coolers full of reef fish back to Hawaii by "recreational" fishermen and workers at Johnston Atoll was stopped after the Service succeeded in obtaining concurrence from military management at the atoll. Likewise the collection of live corals by recreational divers and their shipment off island were stopped. The Service's long-standing presence and the NWR status of the atoll were instrumental in compelling the military to cooperate and enforce these conservation measures. We recommend that the revised DFMP acknowledge the benefits of cooperative management between Federal agencies to conserve coral reef resources.

Pg. 74, 3.5 Description of Fishing Gear Used and Associated Bycatch: Paragraph 4 - We suspect low survival rates for "regulatory discards of undersized or egg bearing females" of lobsters because of learned behavior by sharks and other apex predators to follow the fishing vessels and feed off the discards. In turn, low survival of discards should have prompted the fishery to reduce catch quotas. There are many potential reasons for the collapse of the NWHI lobster fishery, and we recommend that the DFMP present a neutral appraisal of what went wrong, including the summary graphs of the lobster fishery statistics presented earlier in 2000 at a multi-advisory/plan team meeting.

Pg. 77, Fish Traps: Paragraphs 1 & 2 - We recommend that the revised DFMP discuss the effectiveness of regulatory discards noted above, and any research results on the effectiveness of "small holes in the trap walls to allow undersized lobster and other small bycatch species to escape." The DFMP should also discuss the effectiveness of "seawater-degradable pins or panels built into traps and any research that may verify that such traps lose their ability to hold fish." Also, we recommend that the DFMP discuss any in-situ research involving repeated monitoring or observations of individual traps to determine the effectiveness of prey escape in relation to trapped prey that are eaten in the traps by predators before they can escape.

Pg. 79, Bycatch Reduction: Paragraph 3 - The DFMP states that "More difficult are gillnets and other seines where fish are gilled or tangled and release (sic) without serious damage is just not feasible." We believe that this statement suggests that a complete ban on such nets should be considered. Therefore, we recommend that the DFMP discuss banning "gillnets and other seine nets" from the list of proposed gear types to harvest reef fish as part of the proposed alternatives.

Pg. 80, Local Fishing Communities: Paragraph 4 - The DFMP states that "Furthermore there are no coral reef resources being harvested in the Northwest Hawaiian Islands." We believe this statement is misleading. In 1999, a federally permitted fishing vessel harvested sharks with longline gear at French Frigate Shoals, Hawaiian Islands NWR. Also, in 1999, federally permitted vessels harvested lobsters in the NWHI. Finally, for many years up to the present time, federally permitted bottomfishing vessels, on occasion, have harvested shallow reef fish in the NWHI. We recommend that this statement be removed from the DFMP.

Pg. 82-83, Major Geographic, Demographic and Economic Characteristics of American Samoa, Guam, Hawaii and the Commonwealth of the Northern Mariana Islands.: Tables - We recommend that the Pacific Remote Island Areas be added to these tables.

Pg. 91, Island of Niihau: Paragraph 7 - Although the Department of Defense uses a portion of Ka'ula Rock as a bombing range for US military aircraft, it is primarily used by seabirds for roosting and nesting purposes. Furthermore, the State of Hawaii manages Ka'ula Rock as a sanctuary for seabirds. We recommend that the revised DFMP discuss the uses of Ka'ula Rock as a sanctuary for seabirds.

Pg. 80 –104, Major Geographic, Demographic and Economic Characteristics of American Samoa, Guam, Hawaii and the Commonwealth of the Northern Mariana Islands.
Pg. 96-97, Major Geographic, Demographic and Economic Characteristics of American Samoa, Guam, Hawaii and the Commonwealth of the Northern Mariana Islands.: Palmyra, Midway, and Johnston are described, inferring that they are fishing communities. We believe that this inference is misleading. The fishers of all three are workers, mostly seasonal or temporary, with no legal rights to remain after retirement, no land ownership, no traditional rights to fish, no commercial fishing rights, and no permission to fish commercially. Although recreational fishing is allowed at all three locations, it is mostly catch and release, with a minor amount retained only for on-island consumption. The Service manages the recreational fishing program at Johnston and Midway NWRs, and both The Nature Conservancy and Service will be playing key roles in establishing a public use plan for recreational fishing at Palmyra NWR.

Pg. 123-124, The Northwestern Hawaiian Islands (& pg. 171, Paragraph 5): This section - We recommend that the revised DFMP discuss the new NWHI Coral Reef Ecosystem Reserve, and that it recognizes certain fishing rights for native Hawaiians and has garnered substantial support from native Hawaiians.

Pg. 143, 5.3.1.1.2 Low-use Marine Protected Areas: Paragraph 1 - We recommend that the revised DFMP discuss the criteria used to select and designate no-take and low-use MPAs. The discussion should identify the key differences between the two classes of MPAs and why they should be applied at a given location.

Pg 160, 5.3.2.2 General Permit & Pg. 161, 5.3.2.3 Special Permit (Paragraph 1): Paragraph 2 - We recommend that the revised DFMP discuss criteria used to classify potential applicants for general vs special permits. The discussion should include differences in reporting, licensing, and regulatory guidelines.

Pg 179, Geomorphic Table: Table - We recommend that the revised DFMP add estuaries in the CNMI and Guam, and also add Mangroves, Patch Reefs, and Reef Communities/Apron Reefs, and possibly Seagrasses in Guam.

Pg 193, 6.2 Habitat Area of Particular Concern: NWHI portion of HAPC Table - The rationale for selection of the NWHI sites in this table was not presented. We recommend that the revised DFMP discuss why the HAPC is set at a base of 10 fathoms for most reefs in the NWHI, but is lowered to 50 fathoms for French Frigate Shoals, Laysan, and Midway. We also recommend that the revised DFMP discuss, in detail, why the north and south sides of Midway Atoll NWR were differentiated in the proposed actions.

Pg 195-197, 6.2 Habitat Area of Particular Concern: Tabular listing of candidate HAPC sites - Similarly, the rationale for selection of candidate sites is not presented. We recommend that the criteria used for the candidate HAPC sites should include existing protective status, especially if the sites are already established MPAs.

Pg 195, 6.2 Habitat Area of Particular Concern: Table - The reference to "Tierna" bank is incorrect. The correct spelling is Taema.

Pg 195, 6.2 Habitat Area of Particular Concern: Table - We recommend that the revised DFMP include the criteria "susceptibility for human impacts" and "likelihood of developmental impacts" for Laysan, Pearl and Hermes, Maro Reef, and Midway Atoll. We also recommend that the susceptibility criterion should also apply to Jarvis, Howland, and Baker islands.

Pg 199, Human Threats to Coral Reefs in the US Pacific Islands: Table- We recommend that the revised DFMP add "destructive fishing" as a threat to the NWHI and PRIAs.

Pg. 212, Ongoing Coral Reef Initiatives: Table "Ongoing coral reef initiatives" - We recommend that the revised DFMP discuss the considerable ongoing initiatives undertaken by the Service, as noted below.

(1) Monitoring – established in 2000-2001 monitoring at all NWRs in the region except Guam.

(2) Fishing impacts – estimated in cooperation with NMFS at all NWRs except Guam, Johnston, & Rose.

(3) MPAs – Management plans for Palmyra & Kingman NWRs are in progress.

(4) Education – Status reports, Websites, habitat & jurisdictional maps, brochures and Scientific publications have or are being prepared for the Hawaiian Islands, Howland, Baker, Jarvis, Palmyra and Kingman Reef NWRs.

(5) Mapping – In cooperation with the National Ocean Service and the NMFS, mapping of NWHI, Guam, Howland, Jarvis, Baker, Palmyra, and Kingman Reef NWRs is in progress.

(6) Land pollution – Initiatives to control pollution at Tern, Pearl and Hermes, Midway, Johnston, Palmyra, Baker, Laysan, Guam, and Rose NWRs are on-going.

We also recommend that the revised DFMP discuss another category in the table concerning reef restoration in response to removal of wrecked fishing vessels at Rose Atoll NWR and Pearl and Hermes Reef, HI NWR; removal of marine debris from the NWHI, and mooring buoy installation for recreational boats at Johnston Atoll NWR.

Pg. 215, Summary of Council - Proposed Research: Tabular summary - We recommend that the revised DFMP discuss a cooperative, multi-agency and institutional partners effort, that includes the Service.

Pg. 218, No-take Marine Protected Areas: Paragraph 4 - We recommend that the revised DFMP discuss how a cooperative, multi-agency effort, which includes the Service, should be convened to identify and designate MPAs to ensure the full weight of the Federal government is brought to bear on the establishment and management of MPAs.

Pg. 221, 7.2 Other Research Addressing Ecosystem Management: Paragraph 4 - When referencing the Service, it should read "U.S. Fish and Wildlife Service."

Pg. 222, 7.2 Other Research Addressing Ecosystem Management: Paragraph 1 - The proposed "Omnibus Research Proposal" has not been reviewed by the Service. We recommend that the revised DFMP discuss how future research proposals and planning efforts will include the Service as a cooperator.

Pg. 224, 7.2 Other Research Addressing Ecosystem Management: Last Paragraph - The paragraph for the HCRI Research Program lacks information for FY2000-2001. During that period, an expedition to the NWHI completed fifty seven ship days of research, involving 170 assessment sites, 200 km of tow board surveys, 40 scientists, 90 remote sensing ground-truth surveys, oceanographic surveys, and collection of 50 contaminant samples. Analyses include precise habitat mapping of the NWHI and a publication on the status and importance of the reefs and key organisms, web sites and several publications, and numerous findings that update and correct earlier impressions and studies. Nine organizations are participating in the effort with the Service, NMFS, and the State of Hawaii as co-leads. Substantial matching support from NOS (Wash. D.C.), UC Santa Cruz, Oceanic Institute, University of Hawaii, Bishop Museum, and others was secured. We recommend that this information be incorporated into a revised DFMP.

Pg. 231, 8.0 References: Citations for Maragos 1993 and Maragos and Payri 1997 are listed twice while citations for Maragos 1977 and 1995 are cited in the text (volume & 3) but missing from the references.

Pg. 255-257, Executive Order No. 13178 - Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve: Last Paragraph - We believe the entire summary for the Northwest Hawaiian Islands Coral Reef Ecosystem Reserve is outdated and now inaccurate. We recommend that the revised DFMP discuss Reserve EOs in their final form.

Pg. 258, State, Local and Other Applicable Laws and Policies: Paragraph 4 - The citation for "Green (1977)" should instead be "Green (1997)".

Pg. 261, US Fish and Wildlife Service Refuges and Units: We recommend that the revised DFMP discuss the summary for Executive Order 1019 (Hawaiian Islands NWR) in terms of its important reference to "reefs."

Pg. 262, US Fish and Wildlife Service Refuges and Units: We recommend that the revised DFMP include a discussion of Howland, Baker, Jarvis, Rose, Guam, Palmyra and Kingman Reef NWRs

Pg. 263, State of Hawaii: Paragraph 1 - We believe that this discussion does not accurately reflect the current cooperative relationship that exists between the State of Hawaii and the Service. We recommend that the views of the State of Hawaii and the Service be accurately articulated. Also, note that the reference to "reefs and islets" is misquoted as "reefs and inlets."

Pg. 264, PRIAs: Paragraph 3 - We believe the statement in the DFMP: "Management authority is currently unresolved because no clear baseline boundary has been designated for which the seaward boundary of the PRIAs are measured", is incorrect. The Department believes that the seaward boundaries for the PRIAs have been established and that administration of NWRs in the PRIAs is the responsibility of the Service. We recommend that the revised DFMP incorporate these points.

Pg. 268, General Permit Form and Pg. 270 - 273, Special Permit Form: Information on vessel removal insurance is not included in the permit form. Insurance is now required and should be included on the forms. For example, the name of the insurance company, policy number, amount and period of coverage should be included. We recommend that a copy of the policy be attached to the permit form. In addition, specific references to allowable by-catch, vessel monitoring system, owner identification markings on traps etc. should be included on the form. We recommend that these points be included in the revised DFMP.

General and Special Permit Forms & General and Special Coral Reef Taxa Daily Catch Reports - We recommend that a specific reference to by-catch, VMS, owner identification markings on traps, and wreck or vessel removal insurance are needed in these permits. In particular the insurance is now required, and must be somehow included in the application forms, e.g. "do you

have hull removal insurance? Policy number? Company? Amount ? Dates or period of coverage? Copy of the policy attached?," etc. We recommend that these points be included into the revised DFMP.

Pg. 305, Gear Table: Table - We recommend the DFMP indicate that the by-catch for a lobster trap is likely to be high, not low.

Pg. 340, Habitat Impacts: Paragraph 3 - It is stated in the DFMP that "pelagic longline gear does not adversely affect essential fish habitat." We disagree since gears can break free or be lost at sea and eventually drift and join up with the thousands of tons of derelict fishing gear that has accumulated on many reefs. In turn the gear could snag on or smother coral; hook seals, turtles, and seabirds; and impede circulation and sunlight on the reefs themselves. We recommend that the revised DFMP clearly discuss the above referenced points of adverse effects to coral reefs.

Pg. 341, Habitat Impacts: This section omits some relevant and important information. We recommend that the revised DFMP discuss the by-catch of sharks, including a ratio per 1,000 hooks for the Pelagic fishery. Also the revised DFMP should include estimated rates at which the pelagic fishery (e.g. the Hawaiian longline fishery) kills turtles, seals, seabirds. Finally, we recommend that the revised DFMP discuss the Service's 2000 Biological Opinion for the Effects of the Hawaiian Longline Fishery on the Short-tailed albatross (*Phoebastria albatrus*).

Pg. 1, RIR/IRFA: Introduction: Economic Analysis of Regulatory Alternatives: Pg.1 of the Appendix - The DFMP states that requirements to "assess all costs and benefits of available regulatory measures, including the alternatives of not regulating (EO 12866, Section 1 were not met nor adequately assessed. The DFMP does not discuss less costly alternatives recommended by the Draft Plan Team nor does it consider adjusting the fishery regime and MPA boundaries to conform to those of the existing National Wildlife Refuges and the NWHI Reserve. We recommend that more effort be made to collaborate with the Service and others to pool resources and reach consensus on the scope, schedules, and partners for a long-range assessment, monitoring, and research program.

Pg. 66, RIR/IRFA: 2.5 Identification of Duplicating, Overlapping, and Conflicting Federal Rules: Item 1 - No mention is made of the obvious conflicts between the proposed action and established National Wildlife Refuge and NWHI Reserve rules and boundaries. These conflicts account for 10 separate MPAs for reefs and 25 percent of all the reef areas in the U.S. Western Pacific. We recommend that the revised DFMP discuss, in detail, management goals and areas for both the Hawaiian Islands NWR and the NWHI Reserve.

VOLUME 2: DRAFT EIS FOR Draft Plan

Pg. 1, Executive Summary: The lead and cooperating agencies have not been identified in the DEIS. Because the proposed plan would have a major effect on how the Service manages nine of its NWRs in the tropical Pacific, the Service has requested to be cooperating agency in the

development of this DEIS. Therefore, we recommend that the Service be a cooperating agency for all subsequent phases of the DEIS.

Pg. 1, Executive Summary: The DEIS is deficient by not considering additional alternatives, including the alternative recommended by the Draft Plan Team and the alternative of cooperative management with the lead Federal agencies in the NWHI and the PRIAs. The No Action Alternative is inadequately described, and it should include a prediction of what will happen in the affected coral reef area without a Draft Plan. Another variation of this alternative is that coral reef fisheries would be managed by the lead management agencies using authorities other than the Draft Plan. We do not support the preferred alternative in its current form, and we recommend that NMFS work together with the Service to develop alternatives that would satisfy our goals for the conservation of coral reef resources in the Pacific.

Pg. 3, Summary of Impacts of the Alternatives and Options: Environmental Impacts Section - By focusing on "immediate" impacts, the DEIS violates NEPA by not considering the short-term and long-term (cumulative) effects of each feasible alternative. There are numerous considerations in the proposed action that may lead to adverse impacts that have not been addressed in the DEIS. Also, the DEIS compromises the Service's responsibilities in managing NWRs for the protection and conservation of coral reefs in the Pacific and may result in significant adverse impacts to these resources. For example, the proposed action may authorize commercial fishing within NWRs, that are currently closed to fishing and may result in the depletion of refuge resources and may adversely effect federally listed species. We are concerned that the DEIS does not assess a worst case scenario for potential unrestricted and unpermitted harvest of coral reef resources beyond 50 fathoms, especially areas that are part of our NWRs in the Pacific. We recommend that you clearly discuss these concerns in the revised DEIS.

We are concerned that the proposed permitting system does not discuss coverage for most of the commercial fishing activities that may occur under the proposed actions. We are also concerned that the DEIS does not clearly detail the insurance requirement for removing grounded and wrecked fishing vessels from reefs. Lacking clearly stated commitment to remove federally permitted vessels that have grounded upon federally protected coral reefs may result in confusion and negative impacts to coral-reef resources. We believe the gear restrictions are inadequate to prevent damage to coral reef habitat. We are concerned that the DEIS does not require anchoring restrictions (except for one small area off Guam). We are also concerned that the vessel monitoring systems (VMS) to help managers enforce fishery and NWR regulations and to keep track of fishing vessel locations is not required throughout the proposed action area. We believe that reporting requirements are also deficient and that independent verification of the information is not proposed as mitigation. We are also concerned that the DEIS does not discuss mitigation relative to the proposed actions that may result in potential adverse impacts to coral-reef resources. Therefore, we recommend that the revised DEIS discuss each of these concerns in detail. We strongly recommend that you coordinate your revised response to each of these points with the Service.

Pg. 4, Summary of Impacts of the Alternatives and Options: Social and Economic Impacts Section - The DEIS does not discuss the details of the proposed action in terms of the number and size of boats, the number of full time and part time fishers, where they fish, and what they fish for, and how these will change with and without the proposed action. Also, the DEIS does not clarify the extent that coral reef fisheries would be supported by the Council budget. We recommend that the revised DEIS discuss these details.

We believe that the revised DEIS should provide a more comprehensive economic analysis of the lobster fishery in the NWHI. We believe the revised DEIS should analyze the economic consequences of keeping this fishery closed versus a resumption of the fishery. We recommend that the revised DEIS include discussion of the option of voluntary buyouts for the lobster and bottom fish fisheries and that this should be considered as another alternative.

Paragraphs 4 to 6 - The DEIS does not clearly state what the bottomfish fishery adverse impacts may be for the various proposed alternatives, and more precise information for the fishery is needed (e.g., more precise information on targeted depth ranges). It is our understanding that the fishery generally targets fish from 50 fathoms to 150 fathoms, although sometimes taking fish as shallow as 30 fathoms or as deep as 200 fathoms. We recommend that the revised DEIS discuss the depth range and other characteristics of the bottomfish fishery to help decision makers understand the consequences of the various alternatives.

Pg. 5, Summary of Impacts of the Alternatives and Options: Social and Economic Impacts Section, Bullets in Paragraph 1 - The DEIS presents an unbalanced assessment of impacts of closing some or all of the fishing grounds in the NWHI. We recommend that the revised DEIS discuss the positive impacts of closure including : 1) fewer ship groundings and associated injury to corals and damage to reefs, 2) more lives saved given the dangerous and hazardous environments where the fishers now operate, and 3) less impacts to fish stocks.

Pg. 6, Permits and Reporting: Paragraph 2 to 3 - The DEIS states that special or general permits would only be required for coral reef fishing in the few low-use MPAs. Also, only general permits would be needed for taxa already being harvested. The implication is that all commercial fishing beyond 50 fathoms would not be subject to any permitting requirements. We recommend that the revised DEIS discuss activities relative to the proposed action that may occur beyond the 50 fathom contour, especially those areas within NWRs.

Pg 7, Executive Summary Tables (alternatives): Table - This table is very confusing and it is not clear which measures apply to which alternatives. We highly recommend that in the revised DEIS a number be assigned to each alternative corresponding to the enumeration elsewhere. Also, we recommend that the revised DEIS clarify the statement "describe areas which will total 100% of the region's EEZ coral reefs" (quoted in the third box from the top on the left) as this statement is unclear.

Pg. 8, Allowable Gear Types: Table - The DEIS falls short of clearly describing the allowable and prohibited gear types, which may result in hampering adequate enforcement of the proposed

measures. We recommend that the revised DEIS provide clearer descriptions of proposed measures, and exclude "surround, barrier nets, purse seine, and other long nets" from the list of authorized gear types. These types of nets are indiscriminate in capturing and killing non-targeted species, as well as trapping turtles, sea birds, and perhaps marine mammals.

Pg. 9. Purpose and Need For Action: In general, the DEIS does not address the need for cooperation with other agencies, such as the Service, who are responsible for the management of fish and wildlife resources in areas identified in the proposed action. Most of these reefs are in remote locations where assessment, monitoring, surveillance, enforcement, restoration, and other management actions are logistically difficult and expensive to accomplish. There is a strong need to cooperate and pool resources with your agency, the Service, local governments, and research institutions, and reach agreement on a common regime and the specific roles that each of the team members will be responsible for. We recommend that the revised DEIS discuss this important issue.

Pg. 10, Paragraph 3: This paragraph discusses habitat impacts from certain gear types. We also recommend that the revised DEIS include a discussion on the restrictions to use these gear types as part of the proposed action. We recommend that the description of fishing gear impacts in the Purpose and Need section of the revised DEIS should form the basis for presenting options for corrective actions and potential mitigation.

Pg.11, Paragraph 1: The tenets of an ecosystem-based fishery management plan are not discussed. Such a discussion should differentiate the proposed plan from other FMPs, which are based upon the harvest of individual species. We strongly recommend that the revised DEIS discuss the adequacy of the Magnuson-Stevens Fishery Conservation Management Act to provide your agency with the ability to plan for fisheries management on an ecosystem basis.

Pg.13, 2.0 Description of the Alternatives, Paragraph 1: The DEIS does not discuss whether vessels permitted under other FMPs are required to carry wreck or vessel removal insurance. We recommend that the revised DEIS provide this information. Also, we recommend Jarvis Island and Rose Atoll be added to the list of PRIAs in this section of the revised DEIS.

Pg. 14, Coral Reef Ecosystem Special Permit (CRE Special permit or special permit): Item 7- The DEIS states that "with some exceptions" fishers would be exempt from the need for a special permit to fish in low-use MPAs. We recommend that the revised DEIS clearly discuss the circumstances under which fishers would be authorized to fish in low use MPAs, without a special use permit.

Pg. 15-17, Currently Harvested Coral Reef Taxa: Table - This list or variations thereof have been presented 4 times in the DEIS with supporting documents. We recommend that the revised DEIS present a thorough list once in a combined FMP/DEIS volume. Perhaps, it could be included again in the appendix. Otherwise, simply make reference to where the list can be found. The listing itself appears to serve as a catalogue of the resources that can be exploited, rather than protected on coral reefs. None of these resources are identified as potentially rare or

vulnerable species, as would be expected if the list were to serve the purpose of conservation. Therefore, we recommend that the revised DEIS indicate the status, as prescribed by the International Union for the Conservation of Nature (IUCN) or by Federal statutes, for each species in a separate column.

The last entry in the table, is for "All other coral reef ecosystem marine plants, invertebrates and fishes not listed under existing FMPs." Because many rare and vulnerable and protected species are included within this general category, we strongly recommend that it be removed from the table.

Pg. 18-19, Tabular Summary of Alternatives: Summary Table - The DEIS presents this summary at least 4 or 5 times in the three-volume FMP/DEIS, underscoring our concern that the document is unnecessarily long and complex, making it difficult for use by decision-makers. We recommend that unnecessary complexity and redundancy be replaced in the revised DEIS with discussion on more significant topics including other alternatives. For example, the revised DEIS should discuss: 1) the no-action alternative in terms of the future environment without the FMP, but including the NWRs and the new NWHI Coral Reef ecosystem Reserve, 2) the Draft Plan Team alternative, and 3) enhanced cooperation among the several existing management agencies (NOAA, FWS, State or territorial fishery management agency) to manage commercial and recreational fishing without a Draft Plan.

Pg. 39, Management Measure 2, Permits and Reporting Requirements: Paragraphs 1 & 2 - The DEIS overlooks details in the discussion of management measures. For example, we recommend the revised DEIS discuss the threshold criteria for elevating a proposed fishing permit from general to special; the differences in reporting requirements, conservation implications and gear restrictions; the reporting differences between fishers who need a permit and those who do not; and whether vessel hull removal insurance will be required for non-permitted fishers crossing the NWHI. We are concerned that non-permitted fishers may not report their catch, if they are not bound by a federally issued permit. We recommend that the revised DEIS discuss the proposed permit process to address this concern.

Pg 40, Management Measure 3, Allowable Gear Types and Methods: Paragraph 2 – The DEIS does not indicate whether there will be exemptions for the cultural use of natural poisons (*e.g.* awa or arrow-root poisons) to harvest coral reef resources. We recommend that this be addressed in the revised DEIS.

Pg 42, Discussion of Potential Framework Measures: Framework Action 1 – We recommend that the revised DEIS prohibit anchoring in any established MPA (including NWRs, NOAA Reserves and Sanctuaries, State and territorial MPAs) unless anchoring zones are explicitly delineated by the responsible management authorities and eligible for use by the fishers. Also, we recommend that the revised DEIS incorporate permit requirements that include using these anchoring zones.

Pg. 48, 2.8 Management Measures Considered But Not Analyzed Further: Paragraphs 1 & 2 - The DEIS states: ". . . quotas based on equilibrium yield models of particular resources would not necessarily prevent ecosystem over-fishing." This does not discuss the collapse and closure of the NWHI lobster fishery. We recommend that the revised DEIS discuss the failure and closure of the NWHI lobster fishery in this context and instead require "a rest period when fishing for particular species is temporarily suspended."

Pg. 50, 2.9 Discussion of the Preferred Alternative: Management Objectives 1-8 – We believe the plan fails to comply with these objectives. We recommend that future efforts to revise the DEIS include the Service as a cooperating agency under NEPA. The following is a summary of our concerns:

We believe the plan fails to comply with Objective No. 3 by not integrating its ". . . integrated resource data collection and permitting systems, research and monitoring program. . . "with those of the Service.

We believe the plan also fails to meet Objective 4 because ". . . establishing new and improving existing marine protected areas. . . " was not pursued. Instead new MPAs were developed without a clear understanding of the selection criteria. We are very concerned that establishing low-use MPAs would compromise and conflict with existing NWR MPAs and the NWHI Reserve MPAs.

We believe that Objective 6, "To collaborate with other agencies and organizations concerned with the conservation of coral reefs in order to share in decision-making and to obtain and share data and resources..." was not met. We believe the FMP does not recognize recommendations provided by the Draft Plan team, including the Service, in favor of the Council's own research agenda and fails to identify the Service and others as a cooperating agencies.

We believe Objective 7, "To encourage and promote improved surveillance and enforcement of the plan.", was not met. Instead a conflicting set of MPA and fishing regimes is proposed with no relationship to established NWR and NWHI Reserve regimes. Cooperative enforcement or surveillance is never mentioned anywhere in this document.

Pg 51, Marine Protected Areas: Paragraph 6 – The DEIS indicates that the NWHI lobster fishery is a "carefully controlled" fishery. We recommend that the revised DEIS clarify that this lobster fishery is now closed indefinitely, due to a Federal court action and establishment of the new NWHI Reserve.

Pg. 55, Precious Corals Management Unit Species List: Table - The DEIS does not discuss the Precious Coral Fishery and its compatibility with conservation measures established in the NWHI Reserve. We recommend that the revised DEIS provide this discussion and clearly indicate that the two precious coral beds, located in the northwestern Hawaiian islands, and previously considered for exploitation are now protected by the Reserve and are off limits to

harvest.

Pg. 55, Low Use Marine Protected Areas: Paragraph 3 - The DEIS indicates that commercial fishing may be authorized within the boundaries of NWRs and the NWHI Reserve. Implementation of the proposed provisions would violate established management regimes of the Hawaiian Islands, Johnston Atoll, and Midway Atoll NWRs. We are unequivocally opposed to the authorization of such fishing, particularly in the absence of dialogue or coordination of this proposal with the Service. We recommend that the proposal to authorize commercial fishing within the NWR and NWHI Reserve boundaries be removed from the revised DEIS.

In addition, coral reef areas beyond the boundaries of no-take MPAs and low-use MPAs would be open to commercial fishing without any permit requirements. Depending on the unstated offshore limits of the proposed Draft Plan, commercial fishing within nine NWRs would be authorized by the FMP. We believe that the geographic extent of this conflict is significant. We recommend that the revised DEIS remove any and all proposed actions that authorize commercial fishing to occur within the following NWRs: Midway Atoll, Hawaiian Islands, Johnston Atoll, Jarvis Island, Palmyra Atoll, Kingman Reef, Howland Island, Baker Island, and Rose Atoll.

Pg. 74, Pacific Remote Island Areas: Paragraph 4 - We recommend that the revised DEIS indicate that jurisdiction over Kingman Reef was transferred to the Department in January 2001, and that the atoll is now a designated NWR under the administration of the Service.

Pg. 75, Pacific Remote Island Areas: Paragraph 3 - We recommend that the revised DEIS indicate that Johnston Atoll was initially established as a Federal bird reserve in 1926 by the Department, long before military presence at the atoll. Later the Service was directed to manage Johnston Atoll as a NWR.

Pg 77-84, Summary of Fisheries Annual Ex-Vessel Value: Tables - The DEIS presents these tables, without change, for the third time. This repetition is an unnecessary lengthening of the document by 16 pages. We recommend that these tables be presented once and then incorporated by reference elsewhere.

Pg. 93, Remote US Pacific Islands: Paragraph 3 - The DEIS does not recognize the collaborative spirit and cooperation that exists between NMFS and the U.S. Fish and Wildlife Service for undertaking the first comprehensive studies of Howland, Baker, Jarvis, Palmyra, and Kingman, initiated in 2000 and continued in 2001. These investigations include tow-board surveys, oceanography, corals, invertebrates, marine algae reef fish assessments, and contaminant surveys. Permanent coral reef transects for long term monitoring have also been established and are being expanded (see Brainard et al, in press). Additionally in 2000, permanent monitoring transects were established at 1) Midway by the Service, 2) at Pearl and Hermes by DLNR and the Service, in response to a federally licensed fishing vessel running aground on the reef, and 3) by the Service at Johnston Atoll during the installation of mooring buoys for recreational boats. Also in

2000, the Service established permanent coral reef monitoring transects and removed over 100 tons of metallic debris from an earlier grounding of a Taiwanese longliner. We recommend that the revised DEIS include this information.

Pg. 94, Remote US Pacific Islands: Paragraph 2 - The DEIS states that ". . . collection of selective organisms and shells is permitted in restricted areas by recreational divers.", at Johnston Atoll. This statement is not correct, nor is it consistent with Service policy for managing Johnston Atoll NWR. We recommend that this statement be removed from the revised DEIS.

Pg. 97, 3.4.2 Northwestern Hawaiian Islands Lobster Fishery: This section - We recommend that the revised DEIS discuss the recent events surrounding the Federal court case and ultimate closure of the NWHI fishery due to overfishing and possible negative impacts on the endangered Hawaiian Monk Seal. We believe this is important information that should be included in the revised DEIS to facilitate a comprehensive understanding of the proposed actions.

Pg.105, Human Disturbance: Paragraph 3 - The DEIS includes a quote by Lavigne (1999:260). We recommend that the revised DEIS include a statement immediately after the Lavigne quote:

> *Midway Atoll is host to a wide variety of seabirds, migratory shorebirds, reef fish, corals, non-coral invertebrates and algae. It also is a very important home for the federally listed endangered Hawaiian monk seal, the threatened green sea turtle, the endangered short-tailed albatross, and on occasion, the endangered hawksbill sea turtle, and the endangered leatherback sea turtle. Federal recovery plans have been developed for the Hawaiian monk seal and the sea turtles. Because of the especially low numbers of Hawaiian monk seals, we believe that this species can no longer persist in the wild without humans playing a positive and active role in their recovery. The Service provides valuable support to the NMFS at Midway Atoll NWR to conduct research and management to recover this species throughout the northwest Hawaiian Islands. To simply vacate Midway Atoll NWR, would be tantamount to "throwing in the towel" on the recovery of this species, as well as populations of other species that find refuge there.*

Pg. 114, US Fish and Wildlife Refuges and Units: This section - The DEIS attempts to identify authorities and programs of the Service in the region. We recommend that the revised DEIS include discussion of Department jurisdiction over Kingman Reef and Palmyra Atoll NWRs. We also recommend that the Service be a cooperating agency for all revisions of the DEIS (also see Enclosure 2, pg. 22 of this comment).

Paragraph 2 - We believe the selected reference to Moss (2000) on the application of *U.S. v. Midwest Oil* for establishing new refuges, as opined by the U.S. Department of Justice, is completely out of context and is not relevant to the discussion of this section. We recommend this selected footnote be omitted. In its place, as more apropos to this section, we recommend the addition of the Department of Justice's opinion that ". . . the NWRSAA requires that the FWS maintain sole and exclusive management authority over all national wildlife refuge areas." (Moss, 2000)

Pg.116, State of Hawaii: This section - We believe that this discussion does not accurately reflect the current cooperative relationship that exists between the State of Hawaii and the Service. We recommend that the views of the State of Hawaii and the Service be accurately articulated in the revised DEIS.

Pg.118, Direct Effects on Target Stocks: Paragraph 4 - The DEIS states that, "Coral reefs in remote areas of the EEZ are not in danger of being overfished by existing fisheries for current-harvested resources (Green 1997)." We disagree with this statement. Recent surveys at Howland, Baker, Palmyra, and Kingman Reef NWRs suggest recent episodes of shark fishing and the depletion of most large edible fish at Kingman. Overfishing is not evident elsewhere except that lobsters were rarely seen during recent expeditions, in the NWHI, except at Kure, where lobster fishing is not authorized by the current FMP. We recommend that the revised DEIS incorporate our concerns in a discussion about the potential depletion of coral reef resources at remote areas.

Pg.149, 5.5 Environmental Consequences for National Wildlife Refuge Wilderness Resources: Paragraph 2 - Proposed actions stated within the DEIS will encroach within existing NWR by allowing commercial fishing where such fishing is prohibited. We oppose the proposed actions that would authorize commercial fishing to occur within any of the NWRs without Service authorization. Therefore, we reiterate our desire for the Service to be a cooperating agency in the development of the DEIS so that the next revision is consistent with Service policy and management strategies.

Pg.188, Significant Cumulative Effects on National Wildlife Refuge Wilderness Resources: We recommend that the revised DEIS discuss the cumulative effects of the proposed action that would compromise the responsibility of the Service to manage NWRs.

VOLUME 3: ESSENTIAL FISH HABITAT FOR THE Draft Plan

Pg. 9 & 149-151, EFH & MUS for Napoleon Wrasse: The Napoleon Wrasse is one of several species that is now depleted throughout its range. We recommend that this species, and other species (e.g. Bumphead Parrotfish and certain species of sharks and rays) that are similarly depleted, be placed in a special protective category (vulnerable, depleted) and not be targeted for harvesting authorized by the Draft Plan.

Pg. 99, MUS for Jacks: All Jacks should not be included within the bottomfish FMP. We recommend that all shallow water Jacks be managed separately from bottomfish in another category for coastal reef fishes.

Pg.193, MUS for dogtooth tuna: The dogtooth tuna is not a true pelagic species and we recommend that it be managed under the Draft Plan, not the Pelagic FMP.

Pg. 261, The Management Unit Species (MUS): an ecosystem approach: Paragraph 2 - The

generalization about ". . . *Porites/Faviid* assemblages are characteristic of areas of periodic flooding. . . ." is not relevant to Hawaii where faviids are very rare or to the PRIAs where flooding is limited. The entire paragraph seems to apply to corals from a region outside the U.S. Western Pacific. We recommend that this section be rewritten.

Pg. 262, Habitat Areas of Particular Concern (HAPC): Paragraph 2: We concur that: "Reserves, national parks, wildlife refuges and other protected areas are existing operational areas of particular concern." Therefore, we recommend that the revised DEIS identify and discuss each Reserve, Park and Refuge and other protected areas in the HAPConcern section, as well as under section IV of the appendix (p. 445-451).

Pg. 335, MU for *Millepora* (Fire coral): Regarding distribution, Fire coral is not found in the Hawaiian islands although reported at nearby Johnston Atoll and the other reefs in the Western Pacific. We recommend that this correction be made.

Pg. 337, MU for Lace Corals: *Distichopora* and *Stylaster* (lace corals) are not reported from Hawaii, although they are present at nearby Johnston and the other reefs in the Western Pacific

Pg. 341, MU for Scleractinia (stony corals): Taxonomic issues - We recommend that the revised DEIS correct the citation for Palmyra to read: "Palmyra Atoll- Maragos (1979, 1988, in prep.)" Add a citation for: "Howland, Baker, Jarvis, and Kingman- Maragos (in prep.)". Correct another citation to read: "Midway Atoll, Northwest Hawaiian Islands- DeFelice, Coles, Muir, and Eldredge (1998); Maragos, Gulko, Van Ravenswaay, and Dunlap (in prep.)". Amend the citation: "Johnston Atoll- Maragos and Jokiel (1986); Jokiel and Tyler (1992); Maragos (in prep.)"

Pg. 341, Management Unit: Scleractinia (stony corals): Paragraph 4 - We recommend that the revised DEIS incorporate the following correction: " The genera *Porites, Pocillopora, Montipora,* and *Pavona* in that order dominate the reef scleractinians in Hawaii. Elsewhere in the region *Acropora,* faviids, and *Millepora* are dominant or very common along with the other genera mentioned above." Clarify the second to last sentence to read: "In Hawaii, the predominantly branching coral genus *Acropora* is rare and generally confined to several of the NW Hawaiian Islands. In the main Hawaiian islands, massive and finger coral forms of *Porites* dominate along with branching *Pocillopora,* and encrusting and massive *Montipora,* and to a lesser extent *Pavona,* are common and in some places locally abundant."

Pg. 357-377, Distribution of Scleractinia (hard coral) within the American Flag Pacific Islands (AFPI): Table - We recommend that this table needs to be updated to account for many new records for the listed areas of PA, and NWHI, plus initial lists for Howland, Baker, Jarvis, and Kingman Reef NWRs. Please note the misspelled *Montipora tubercubsa*, the records of which should be combined with those of *M. tuberculosa.*

We recommend adding to the NWHI the following 29 species: ***Psammocora nierstraszi, P. verrilli, Pocillopora sp., P. ligulata, P. molokensis, Acropora cerealis, A. cytherea, A. gemmifera, A. humilis, A. nasuta, A. valida, Montipora flabellata, M. incrassata(=M. studeri), M. tuberculosa, Leptoseris incrustans, L. scabra, P. maldivensis, P. varians, Balanophyllia hawaiiensis, Cycloseris tenuis, C. vaughani, F. granulosa, Porites compressa, P. duerdeni, P. evermanni, Sinularia abrupta, S. sp, Palythoa sp, and Zoanthus sp.***

We recommend deleting the following 3 species from the NWHI: *Pocillopora verrucosa, Montipora monasteriata, M. sp 1 (green spine), Cyphastrea chalcidicum.*

We recommend adding to the MHI the following 3 species: *Fungia granulosa, Palythoa sp.* and *Zoanthus sp.*

We recommend deleting the following 8 species from the MHI: *Acropora humilis, A. valida, M. verrucosa, M. monasteriata, M peltiformis, Porites lichen, P. murrayensis, C. chalcidicum.*

We recommend deleting the following species from the JA list: *Montipora hispida.*

We recommend adding the following species to both the PA and JA lists: *Palythoa* sp

Pg. 380, Comment: *Oulangia bradleyi*: We recommend that this statement be reworded as follows: "*Oulangia bradleyi* Verrill 1866 is a deep water ahermatypic coral species not found on shallow reefs."

Pg. 381, Table 9: Zooxanthellate Corals Likely to be Found in the American Flag Pacific Islands:
Table - "Acroporidae"- We recommend that the revised DEIS delete it as it is incomplete and subsumed by the next entry.

Table - "*Fungin*" to read "*Fungia*"

Table - "*Gajaxea*" to read "*Galaxea*"

Table - clarify that the corals listed were taken from Vaughani (1907) without any updating of the taxonomic nomenclature and systematics of these species.

Pg. 394, Table 11: ACTINIARIA FROM HAWAII: The list of Actiniaria and other soft corals on this list is probably incomplete. Entries are needed for the actiniarian *Heteractis malu* and the octocoral *Anthelia edmundsoni*, both of which have been reported from Hawaii.

NATIONAL WILDFIFE REFUGES OF THE PACIFIC SUMMARIES

This enclosure is a refuge-by-refuge summary of the eight national wildlife refuges that have marine boundaries in the Pacific. It reviews the authorities by which the refuges were established, and describes submerged lands and coral reef habitats within national wildlife refuges in the North, Central, and South Pacific Ocean:

(1) *Guam National Wildlife Refuge, Territory of Guam*

The U.S. Fish and Wildlife Service (Service) has fee title to the Ritidian Unit of the Guam National Wildlife Refuge, which includes approximately 371 acres of emergent lands, and 401.5 acres of submerged lands adjacent to Ritidian down to 100 foot bottom contour. These submerged lands were never transferred to the Territory of Guam pursuant to the Territorial Submerged Lands Act and were specifically withheld by the Federal government. The Service acquired the emergent lands from GSA in 1993 and submerged lands in 1996. These lands had been reported to GSA as excess lands by the U.S. Navy, and were transferred to Service pursuant to Public Law 8537, which allows for such no cost transfer of Federal properties that have value to migratory birds. At the Guam NWR as well as many other coastal refuges in the Pacific, managing an intact ecosystem for migratory birds means the protection of both land and ocean resources upon which these species depend. In addition to the protection of these ocean resources for wildlife, the Ritidian Unit of the Guam NWR also offers a recreational fishery within these waters, pursuant to 50 CFR§32.71. The amount of coral reef managed by the Service is approximately 401.5 acres.

(2) *Rose Atoll National Wildlife Refuge, American Samoa*

Rose Atoll NWR is similar to Guam NWR, in that the lands, and waters of Rose Atoll were specifically withheld from transfer to the Territory of American Samoa. Rose Atoll is the only national wildlife refuge that is truly located in the South Pacific. The Refuge was originally established by a cooperative agreement between the territorial government of American Samoa and the Service dated July 5, 1973. Announcement of the new Refuge was through a Public Notice in the *Federal Register* that was published on April 11, 1974. On February 1, 1975, President Gerald Ford, by Proclamation No. 4347, exempted Rose Atoll from a general conveyance of submerged lands around American Samoa to the American Samoan government. He stated the submerged lands out to 3 miles around Rose Atoll would be under the joint jurisdiction of the Department of Commerce and the Department of the Interior. Pursuant to this joint jurisdiction and in cooperation with the government of American Samoa, fishing is not permitted within the 3-nautical mile Refuge boundary. Rose Atoll NWR is surrounded by the 200-nautical mile U.S. Fishery Conservation Zone, within which fishery resources are managed and regulated by the National Marine Fisheries Service (NMFS) and the Western Pacific

Regional Fishery Management Council. The total amount of coral reef area within the boundary of Rose Atoll NWR is approximately 2,564 acres and the total amount of submerged lands within the refuge boundary is 39,236 acres; emergent land consists of only about 15 acres.

(3) *Howland Island, Baker Island, and Jarvis Island National Wildlife Refuges*

All three of these refuges are located in the Central Pacific Ocean, near the equator, and are unincorporated territories of the United States. Howland Island is located at 0° 48' North, 176° 38' West, and is 36 nautical miles north of Baker Island, 48 miles north of the equator, and 378 miles north of Canton Island in the Phoenix Islands.

Baker Island is located at 0° 13' North latitude and 176° 28' West longitude and sits just 13 miles north of the equator, approximately 1,600 nautical miles southwest of Honolulu and 1,000 miles west of Jarvis Island.

Jarvis Island is located at 0° 23' South latitude and 160° 01' West longitude, just 25 miles south of the equator and about 202 miles southwest of Kiritimati Island in the Republic of Kiribati. It is 1,300 miles south of Honolulu and is considered to be part of the Line Islands.

All three islands have been under the jurisdiction of the Department of the Interior since 1936. A public notice published in the *Federal Register* on August 2, 1974, transferred the administrative responsibility for the islands from the Office of Territorial Affairs to the Service to be managed as individual National Wildlife Refuges. These possessions do not fall within the jurisdiction of any state or other U.S. territory, and Refuge boundaries for all the islands extend 3 nautical miles out from land in all directions, which was the limit of the territorial seas at the time the refuges were established. Fishing is prohibited within Refuge boundaries, in addition to any type of unauthorized entry. Each island is surrounded by a 200-nautical mile U.S. Fishery Conservation Zone, within which fishery resources are managed and regulated by the Western Pacific Regional Fishery Management Council in coordination with the National Marine Fisheries Service.

Howland Island National Wildlife Refuge has a total of 32,529 acres within the Refuge boundary, which include 455 acres of emergent lands and 2,083 acres of coral reef. Baker Island National Wildlife Refuge contains 30,909 acres, including 405 acres of emergent lands and approximately 2,859 acres of coral reef. Jarvis Island National Wildlife Refuge includes 36,483 total acres with the island of 1,086 acres and about 1,823 acres of submerged coral reefs.

In 1995, a routine visit to Howland Island NWR by the Coast Guard revealed a commercial fishing vessel, the F/V Hornet III, fishing within the boundaries of Howland Island NWR. The parent company of the F/V Hornet III, the Hornet's Nest Corporation,

was issued a notice of violation pursuant to wildlife refuge laws found at 50 CFR §27.32 (a) and 16 USC 460 (k).

(4) *Johnston Atoll National Wildlife Refuge, Central Pacific Ocean*

Johnston Atoll National Wildlife Refuge is an unincorporated U.S. Territory located approximately 700 nautical miles southwest of Honolulu. Johnston Atoll was declared a "refuge and breeding ground for native birds" in Executive Order 4467, signed by President Calvin Coolidge in July 1926. Recognizing its strategic value, President Franklin Roosevelt signed Executive Order 6935 in 1934 assigning the Navy administrative jurisdiction over the atoll. Most importantly, the 1934 Executive Order noted that the Navy's jurisdiction was "subject, however, to the use of said islands . . . as a refuge and breeding ground for native birds . . ." as provided by the 1926 Executive Order. A third Executive Order designated naval defensive seas around Johnston Atoll and other Pacific atolls in 1941.

Today the Refuge boundary at Johnston Atoll NWR extends to the limits of the naval defensive seas, which are measured from monuments placed in the lagoon at Johnston Atoll to a boundary 3nm seaward. About half (59,102 acres) of the 118,656 acres of marine habitat at Johnston Atoll are coral reefs managed by the Service. A recreational fishing program is managed by the Service at Johnston Atoll NWR, pursuant to 50 CFR §32 71.

5. *Hawaiian Islands National Wildlife Refuge*

The Hawaiian Islands National Wildlife Refuge covers the Northwestern Hawaiian Islands, with the exception of Midway and Kure atolls, and is located between 23° N and 29° N latitude and between 161° W and 177° W longitude. It consists of a chain of islands, reefs, and atolls extending about 800 miles northwest of the main Hawaiian Islands, encompassing most of the Hawaiian archipelago. The Refuge includes eight main islands and atolls and their surrounding waters: Nihoa (23° 04'N, 166° 53'W) Necker, French Frigate Shoals, Gardner Pinnacles (25° 00'N, 168° 55'W), Maro Reef, Laysan, Lisianski, and Pearl and Hermes Reef (27° 50'W).

These tiny islets are all part of the State of Hawaii but are federally owned lands that are administered as a National Wildlife Refuge by the Service. The Refuge was established in 1909 through Executive Order 1019 by President Theodore Roosevelt to protect seabirds from slaughter for the millinery trade. While this early 20th Century Executive Order did not give exact Refuge boundaries, it is clear from the archival records that Teddy Roosevelt intended for marine areas to be protected and included in the bird sanctuary along with emergent lands. The Refuge management area now administered by the Service, includes the land area of the eight islands and atolls and reefs that extend seaward to 10 fathoms, except for Necker, where the management area extends to

20 fathoms. These islands and atoll have no permanent residents, although two of the eight areas have field camps staffed with government employees and researchers devoted to wildlife management and research. The Department of Commerce, National Marine Fisheries Service (NMFS) are frequent visitors to the refuge.

Fishing is prohibited within Refuge boundaries. The State of Hawaii Department of Land and Natural Resources, Division of Aquatic Resources, has proposed establishment of a Fishery Management Area within 3 nautical miles of land. Fisheries in Federal waters, from 3 to 200 nautical miles, are controlled by the NMFS and the Western Pacific Regional Fishery Management Council, and regulations are enforced by the U.S. Coast Guard and NMFS.

The Western Pacific Regional Fishery Management Council has established a Protected Species Zone to protect endangered Hawaiian monk seals that extends for 50 nautical miles around each Refuge island and includes a 100 nautical mile-wide corridor connecting the Refuge islands. Pelagic longline fishing is prohibited within this zone, but other fisheries are allowed.

Under the Endangered Species Act, NMFS established Hawaiian monk seal critical habitat around each of the eight Refuge islands. Critical habitat includes all waters, beaches, sand spits, and islets from the beach crest vegetation out to a depth of 20 fathoms. However, fishing boats targeting lobsters and bottomfish are currently fishing within the existing Refuge management area (the 10- or 20-fathom isobath). Marine mammals, including seals, dolphins, and whales are also protected under the Marine Mammal Protection Act.

The Service and the State of Hawaii are in general agreement that the nearshore marine environment of the Hawaiian Islands NWR needs to be managed in a sensitive manner, mindful that these areas are all within critical habitat zones for the endangered Hawaiian monk seal. In addition to being critical for Hawaiian monk seals, most of the green sea turtle nesting in the Hawaiian Islands (99 percent) occurs within the Hawaiian Islands NWR. The Service supports the State effort to establish a Fishery Management Area designation for the Northwestern Hawaiian Islands.

The Western Pacific Regional Fishery Management Council has not recognized any marine boundaries in the Hawaiian Islands NWR. As a result, in past years commercial fishing has occurred in nearshore waters within the Refuge. In order to clarify the boundary issues, the Service is currently engaged in a search of archival information surrounding the Roosevelt Executive Order of 1909.

A total of about 610,140 acres of coral reef are within the administrative management area of the Hawaiian Islands NWR, as described above, plus about 1,766 acres of emergent land.

6. *Midway Atoll National Wildlife Refuge*

Midway Atoll is an unincorporated U.S. territory located near the northwestern end of the Hawaiian archipelago. Midway is not now, nor has ever been a part of the State of Hawaii. Discovered in 1859, Midway was an important military outpost for most of the 20th century. In 1993, Midway Naval Air Facility became subject to a Base Realignment and Closure (BRAC) action. At the end of the BRAC process, the Service was chosen to have custody, accountability, jurisdiction, and control of Midway Atoll, including its inner lagoon out to the extent of the former naval defensive seas.

Midway Atoll was designated as a National Wildlife Refuge by President Clinton's Executive Order 13022, dated October 31, 1996. The marine boundaries of the refuge are clearly stated within this Executive Order. There is an active public use program occurring at Midway, and recreational fishing is allowed pursuant to 50 CFR §32.71.

The total number of acres of emergent lands at Midway are 1,549 acres, and submerged lands within the refuge boundary total 296,820 acres. Within the submerged lands total acreage, there are 55,081 acres of coral reef habitat.

7. *Kingman Reef National Wildlife Refuge*

On September 1, 2000, the Department of the Interior accepted restoration of its administrative jurisdiction over Kingman Reef from the Department of the Navy. A Secretarial Order dated 01/18/01 established Kingman Reef National Wildlife Refuge (Refuge) to be administered by the Director, U.S. Fish and Wildlife Service (Director). This action was taken to protect the natural character, including the fish, wildlife, plants, coral reef communities, and other resources of Kingman Reef and all reefs surrounding Kingman Reef.

The authority for this Order is derived from 1) 43 U.S.C. §1458; 2) the National Wildlife Refuge System Administration Act of 1966, as amended, 16 U.S.C.§§ 66dd; 3) Reorganization Plan No. 3 of 1950; 4) the Fish and Wildlife Act of 1956, 16 U.S.C. §742f; 5) Executive Order 13089 dated June 11, 1998; and 6) Presidential Proclamation 5928 of December 27, 1988, 54 Fed. Reg. 777.

The refuge consists of the emergent areas of Kingman Reef and also its surrounding submerged lands and waters out to the twelve (12) nautical mile Territorial Sea Boundary. The Director manages the Refuge under all applicable laws, policies and regulations that govern the National Wildlife Refuge System. Refuge management is undertaken consistent with the administrative control and jurisdiction exercised by the Secretary of the Navy pursuant to Executive Order 6935 of December 29, 1934, and Executive Orders 8682 and 8729 of February 14, 1941, and April 2, 1941, until and unless such administrative control and jurisdiction is extinguished.

8. *Palmyra Atoll National Wildlife Refuge*

Secretary's Order 3224, dated January 18, 2001, transferred administration of Palmyra Atoll (Palmyra) from the Office of Insular Affairs to the U.S. Fish and Wildlife Service and established Palmyra Atoll National Wildlife Refuge (Refuge). The Refuge was established to protect and preserve the natural character of fish, wildlife, plants, coral reef communities and other resources associated with the tidal lands, submerged lands, and waters of Palmyra.

The authority for this Order was derived from 1) Section 48 of the Hawaii Omnibus Act of July 12, 1960, 74 Stat. 411; 2) Executive Order 10967 of October 11, 1961; 3) 43 U.S.C. §1458; 4) Presidential Proclamation No. 5928 of December 27, 1988, 54 Fed Reg. 777; 5) the National Wildlife Refuge System Administration Act of 1966, as amended, 16 U.S.C. §§668dd; 6) Reorganization Plan No.3 of 1950; 7) the Fish and Wildlife Act of 1956, 16 U.S.C. §742f; and 8) Executive Order 13089 of June 11, 1998.

Palmyra Atoll National Wildlife Refuge was established on the tidal lands and submerged lands and waters within the lagoon and out to the twelve (12) nautical mile Territorial Sea Boundary surrounding Palmyra. Emergent lands at Palmyra Atoll are currently owned by The Nature Conservancy.

DETAILS FROM IDENTIFIED SECTIONS OF THE MAIN LETTER

Enclosure 3-1: The F/V Paradise Queen No. 2 ran aground on the coral reefs at Kure Atoll, State of Hawaii (October 1998), and the F/V Swordman 1 ran aground on the coral reefs at Pearl and Hermes Atoll, Hawaiian Islands NWR (May 2000). The F/V Swordman 1 was removed from the reef and scuttled in deep water before the vessel deteriorated, resulting in only minor physical impacts to the reef and moderate risks of exposure of petroleum products to wildlife. The removal of this wreck was expedited because of the immediate risk it posed to endangered Hawaiian monk seals observed swimming in the vicinity of the wreck, migratory seabirds, and coral reef resources that occur within the refuge. The cost to the Federal government in terms of financial resources to remove and scuttle the wreck was an expenditure of $1,688,591 (U.S. Coast Guard - Marine Safety Office - Honolulu, Hawaii).

The F/V Paradise Queen No. 2 broke apart on the reef margin at Kure Atoll (a designated State of Hawaii Wildlife Sanctuary), risking exposure of released petroleum products and fishing gear to monk seals, sea turtles, migratory seabirds, and marine organisms. Substantial physical damage to the reefs resulted from the initial impact, as well as from subsequent vessel movement on the exposed windward side of the atoll. Today, the wreck is scattered on the reef, and the continued risks to coral reefs in the immediate vicinity are not well understood. However, it has been documented that elevated iron in the water column resulting from the decay of a vessel's hull (e.g. F/V Jin Shiang Fa grounding at Rose Atoll NWR) contributes to an artificial increase in the development of blue-green algal mats. Large concentrations of blue-green algae are capable of degrading corals and disrupting the entire benthic community equilibrium within the affected area.

Enclosure 3-2: Petroleum products were released into the marine environment as a result of the fishing vessel grounding at Kure Atoll (1998) and Pearl and Hermes Atoll (2000). In both groundings, seabirds were exposed to petroleum products. We believe that the likelihood of oil spills occurring in the NWHI may grow due to increased vessel traffic associated with the proposed actions. We believe that future oil spills may negatively affect short-tailed albatross pioneers that may attempt to colonize the islets within Midway Atoll NWR or the Hawaiian Islands NWR.

Enclosure 3-3: The short-tailed albatross that occur at Midway Atoll NWR and the Hawaiian Islands NWR may be adversely effected by oil spill (e.g. petroleum products may be released into the marine environment as a result of vessel groundings on coral reefs and may negatively affect short-tailed albatross).

Green sea turtles are known to nest at the Hawaiian Islands NWR, Palmyra Atoll NWR, Kingman Reef NWR, and Rose Atoll NWR and haulout or nest at Baker Island NWR and Howland Island NWR and occur in the shallow waters at Johnston Atoll NWR or Wake Atoll. Hawksbill sea turtles are known to occur in the nearshore marine environment of the Hawaiian Islands NWR, Johnston Atoll NWR, and Palmyra Atoll NWR. These species may be adversely

effected by the proposed actions that may result in the introduction of oil spills, unauthorized harvest by humans, or fishing/collection nets. We believe that the introduction of marine alien species to the marine environment at these locations could displace food items important to sustain the local populations of green sea turtles. Oil spills may occur, due to the potential increase in vessel traffic and may negatively impact the sea turtles that occur in nearshore waters or haulout to rest or nest on land at these remote locations. Furthermore, oil spill response, cleanup and sea turtle rescue operations would be significantly complicated due to the great distances oil spill responders would need to travel in a timely manner to rescue and rehabilitate the sea turtles. We are also concerned that increased human presence at these locations may result in the unauthorized harvest of green and hawksbill sea turtles. Sea turtle carapaces are prized as potential products for the handicraft trade. Sea turtle meat is consumed for subsistence purposes by Pacific islanders and may be sold to Asian markets and restaurants. Finally, we are concerned that the use of fishing/collection nets may negatively affect sea turtles. We believe that harvestors may loose their fishing/collection nets, which in turn, may accidentally entangle green sea turtles. We believe that local populations of sea turtles may be adversely affected, thus, reducing the rate at which the species recovers.

Five federally listed endangered plants occur within the Hawaiian Islands NWR and these include *M. pennatiformis* ssp. *bryanii* (Laysan Island), *P. remota*, S. verticillata, *A. brownii* (Nihoa Island), and *S. tomentosa* (Nihoa Island and Necker Island). We are concerned that these plants may be adversely effected by the proposed actions as a result of the introduction of alien species at these locations. Introduced rats may consume these plants or their seeds and negatively effect the recovery of these species. Introduced alien insects may displace native insects that serve as pollinators, thus negatively affecting the recovery of the species. We are also concerned that alien plants may be introduced to these locations that may outcompete and displace the endangered plants from their natural niches.

Received at Public Hearing

Comments on Coral Reef Ecosystem FMP and DEIS:

William G. Gilmartin
P.O. Box 540
Volcano, HI 96785-0540

Specific Comments:

1. Selection of MPA's: "Consideration of proximity to important monk seal colonies"! 0-50f no take MPA at FFS, Laysan, north Midway and 0-10 at all other NWHI.

This proposed designation does NOT, in fact, take "important monk seal colonies" into account. Rather, the rationale here is that both FFS and Laysan have historically been poor lobster fishing areas, seldom fished for that reason, so they can be offered up as no-take MPA's to "protect" monk seals. But, why not similarly protect the coral reef resources at the other major monk seal breeding islands? All major colonies of monk seals are below peak historical levels, some are slowly recovering and some are not. Allowing fishing to continue in areas where monk seals are known to feed and fishing for the same prey resource these endangered seals need is NOT managing the ecosystem in a "precautionary" manner, as is claimed in the DEIS. The entire 0-50f area around the NWHI's should be no-take MPA's for all fisheries until research on the targeted resource can demonstrate that the prey needs of endangered and other protected species in the NWHI can be fully met while also supporting a commercial fishery. The DEIS suggests this as a precondition for "new" fisheries proposed for the area, but essentially grandfathers in existing fisheries for which these data are not known.

2. The restriction on anchoring at Guam's southern banks by vessels >50ft to protect the reef is a good idea.

But why is this limited to large vessels and why only at this one location? This is a measure to protect a small local fishery for local fishers....vessels coming any distance are likely to be larger than 50ft. Can't many small anchors be as damaging to the reef, or perhaps more so, than a few large anchors. The "no anchoring" restriction ~~must~~ to all vessels apply to all no-take MPA, regardless of vessel size, because anchoring in these areas will often result in damage or "takes" in the no-take MPAs. If, in fact, a goal of this FMP is "controlled utilization of these vital resources in an ecologically sensitive manner", then anchoring should be prohibited in all MPAs.

2

3. Traps are allowed under the preferred alternative "with conditions".

Do these conditions cover trap lines? How will trap lines (e.g. between lobster traps) be managed so these lines do not entangle and break coral on retrieval. This is a very destructive fishing method in coral reef habitat, it destroys the reef and essential fish habitat, use of these trap lines is clearly NOT "utilization of ....resources in an ecologically sensitive manner".

4. Insurance for all vessels to cover cost of removal and pollution liability.

Minimum insurance needs for vessels of various sizes must be stated in the FMP, this determination cannot be left to the vessel owner or insurance carrier. Vessel groundings at remote locations can result in much higher costs of removal than can be easily extrapolated from a vessel grounding at more easily accessible locations. The lobster vessel that ran onto the reef at Kure a few years ago is still there; all gear was not removed from it before it broke up and fuel leaked before it could be removed -- and to my understanding, insurance coverage of $500,000 was spent in the futile effort to remove the wreckage and gear. Insurance coverage amounts must be calculated from realistic cost estimates to conduct these recoveries in remote locations and these amounts must be a minimum and mandated in the FMP.

General Comment:

The FMP generally admits to "a poor understanding of the basics, much less the intricacies, of coral reef ecosystems." Depletion of the NWHI lobster resource, and specifically the near-commercial extinction of the spiny lobster under Wes. Pac. Fishery Management Council control, clearly demonstrates the need to know a lot more than we do now about how these ecosystems function BEFORE we continue to exploit them. This FMP implies it is a "precautionary" approach to managing these coral reef ecosystems, however the preferred management alternative selected demonstrates rather clearly that the exploitation of the recent past will continue in spite of no or only poor knowledge of the reef resources, little information on the interactions among species, and unknown harvest quotas that are truly sustainable.

January 24, 2001

Western Pacific Regional Fishery Management Council
Attn: Kitty Simonds, Executive Director
1164 Bishop Street, Suite 1400
Honolulu, Hawaii 96813

RECEIVED
'01 JAN 25 P1:05
WESPAC

Dear Ms. Simonds:

After attending the Kona Meeting last evening regarding the DEIS and FMP for coral reef ecosystems of the Western Pacific Region, I would like to add my comments as follows:

The Northwest Hawaiian Islands are our last opportunity to save an ecosystem that needs strict and enforceable restrictions. I would like to see that whole area from north of Kauai to Kure atoll protected from any fishing and coral harvesting (except for scientific research and native subsistence). Allowing, of course, the continued tag and release program off Midway. In that way, it would be enforceable. With too many options, it becomes unenforceable. In other words, "Keep It Simple, Silly"!

The way it is worded in the Environmental Impact Statement, there are too many loopholes to make it easily enforceable, therefore worthless. Make the entire Northwest Hawaiian Islands a "No Take" zone, at any depth, surrounding the islands by at least 200 miles. Then ENFORCE those rules explicitly. That would be a whole lot easier than as suggested in the rules you have placed before the public.

The fishermen complain that this would remove their livelihood. Strange, but when the whalers were banned from taking whales, there were no reports of starvation by whaling families... they simply found something else to do.

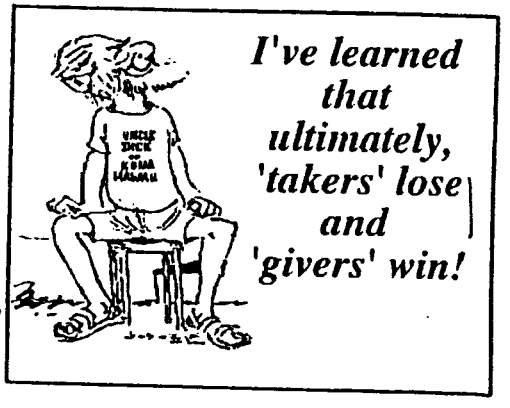
Thank you for this opportunity to express my feelings.

Aloha,

Dick Dresie

Dick Dresie
75-5822 Neke Place
Kailua-Kona, Hawaii 96740
Ph: (808) 329-5801
Fax: (808) 329-9627
E-Mail: dickdresie@kona.net

cc: Susan B. Fruchter, NEPA Coordinator, Dept. of Com



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4

National Aeronautics and
Space Administration
Headquarters
Washington, DC 20546-0001

Reply to Attn of

RECEIVED
'01 FEB 13 A9:09
WESPAC

FEB 9 2001

JE

Kitty Simonds
Executive Director
Western Pacific Regional Fishery Management Council
1164 Bishop Street, Suite 1400
Honolulu, HI 96813

Dear Ms. Simonds:

Thank you for the opportunity to review and comment on the Draft Fishery Management Plan and Draft Environmental Impact Statement for Coral Reef Ecosystems of the Western Pacific Region. NASA's comment is that the Draft Fishery Management Plan will provide useful baseline information for considering the potential impacts of proposed NASA actions on the fishery and coral reef ecosystems. We look forward to working with you in this endeavor.

Please feel free to contact Dr. Ann M. Hooker at (202) 358-0007 (NEPA), or Ms. Odean Serrano (Biodiversity and GIS) at (202) 358-1308 if you have any questions.

Sincerely,

Olga Dominguez
Director

cc:
Susan B. Fruchter
NEPA Coordinator
OPSP, Room 5805
US Department of Commerce
Washington, DC 20230

United States Department of the Interior

NATIONAL PARK SERVICE
National Park of American Samoa
Pago Pago, American Samoa 96799

IN REPLY REFER TO:

February 12, 2001

TO: Kitty Simonds, Executive Director
Western Pacific Fishery Management Council
1164 Bishop Street, Suite 1400, Honolulu, HI 96814

CC: Susan Fruchter, NEPA Coordinator
OPSP, Room 5805
Dept. Commerce, Washington, DC 20230

From: Peter Craig, PhD, Ecologist
National Park of American Samoa
Pago Pago, American Samoa 96799

Re: Comments on Draft Fishery Management Plan for Coral Reef Ecosystems and EIS

I would like to make three comments about Rose Atoll in American Samoa, but the second comment applies to the other proposed Marine Protected Areas (MPAs) as well:

1. Trojan horse conservation proposed for Rose Atoll. While the Council presents its preferred alternative for management as being "substantial additional protection to coral reef resources" by establishing, among other things, a no-take MPA around Rose Atoll to the 50 fm depth, the draft FMP fails to mention that this action will reduce by over 90% the size of the existing no-take area already in place there (Rose Atoll National Wildlife Refuge). This calculation is based on the size of the refuge (158 km², USFWS) and the estimated portion of coral reef habitat from 0-50 fm (7 km², Hunter 1999). It would be an unfortunate step backwards if Council dismantled the existing protected area at Rose Atoll, which is the only no-take MPA in the territory.

While it can be argued that there are no coral reefs in deeper portions of the existing refuge at Rose Atoll, that area is needed as a no-take buffer zone for enforcement purposes, as discussed below.

2. Proposed MPA boundaries facilitate poaching. Rose Atoll and most other islands listed in the draft FMP slope steeply, so the 10 fm and 50 fm depths occur relatively close to shore. To illustrate, the maps in the draft FMP (pages 146-157) show that the shortest distance from the shoreline to the 50 fm contour line is only about 500 meters for many of these islands. The 10 fm line would occur even closer to the shoreline. This will make enforcement difficult, because it means that a vessel can legally fish only 500 m away from the shoreline in some areas and/or scuba divers from that boat could easily swim a short distance shoreward into the no-take area to collect aquarium fish. Given this situation, standard enforcement tools such as overflights or vessel locator systems would be useful only in the most blatant infractions.

It is clear, then, that a buffer zone is needed to separate the 0-50 fm coral reef zone from the fishing grounds around all FMP islands. This buffer zone should also be a no-take area and not be euphemistically labeled "low use" because that simply opens the door for the enforcement problems mentioned above. I request that the Council revisit this boundary issue and establish common-sense boundaries that are enforceable and truly protect the coral reef ecosystems. A no-take buffer zone at least 1 mile wide (located seaward of the 50 fm line) would greatly improve the protection of the coral reef ecosystem from poaching, while limiting the area closed to fishing. Barring that, I would have to strongly recommend Alternative 4, because it would provide a larger no-take area (0-100 fm) that would better protect coral reef ecosystems and reduce the vulnerability of these ecosystems to poaching.

For Rose Atoll specifically, no pressing reason has been presented to justify dismantling the existing 3-mile boundary of the refuge. To the contrary, because enforcement and surveillance at Rose are so infrequent and costly, it remains likely that the only way poachers will be caught there is when overflights spot their presence in a zone that is unambiguously within the 3-mile limit. In contrast, the Council's preferred alternative would allow fishing as close as approximately 500 m around the whole atoll*, which is wholly inadequate to protect the important coral reef ecosystem there.

3. Proposed boundaries may impact Threatened species. Sea turtle populations in American Samoa are not doing well. The recent NMFS/USFWS Recovery Plan (1998) for them states that "outside of Hawaii, the green turtle populations have seriously declined and should probably be classified as Endangered". Rose Atoll is probably the last remaining place in American Samoa where a small but significant number of green turtles nest (Tuato'o et al. 1993). These turtles remain around Rose Atoll for weeks or months between bouts of egg laying before they migrate away to feeding grounds in Fiji (Balazs, unpublished). Council's proposed reduction of the no-take area around Rose Atoll Refuge by 90% would increase the potential for adverse interactions between fishing activities and this threatened species.

*The map of Rose Atoll in the draft FMP is a somewhat misleading because it shows only the two small islands there but neglects to show the rest of the atoll even though the whole atoll is exposed at low tide. By sketching in the missing parts, it becomes apparent that fishing vessels could fish as close as about 500 m around the whole atoll under the preferred alternative.

Ms. Kitty M. Simonds, Executive Director
Western Pacific Regional Fishery Management Council
1164 Bishop Street, Suite 1400
Honolulu, HI 96813

February 16, 2001

RECEIVED

'01 FEB 20 A10:41

WESPAC

Dear Ms. Simonds:

RE: The DEIS/FMP for the Western Pacific Region Coral Reef Ecosystems.

Thank you for the opportunity to review and comment on your office's three-volume draft DEIS/FMP for the Western Pacific Region Coral Reef Ecosystems. I urge you to implement Alternative Number 4, Maximum Additional Protection to Coral Reef Resources, at this time for the following reasons.

* There are numerous statements in all three draft volumes that accurate, reliable, scientific-quality data are not available for assessment of the coral reef fishery resources and their supporting ecosystems. It is vital to the long-term health and sustainability of any fishery resource to have accurate, hard data about the standing crop of the resource before allowing exploitation to proceed. None of the Federal or State fisheries agencies can provide accurate and reliable field data on the standing crops per area of each of the targeted species that currently have fishery management plans and/or permit requirements. Since the maximum sustainable yield (MSY) per area of a targeted species depends on an accurate assessment of that species' standing crop, the MSY values being used to determine the allowable annual fish harvest per species in permit-controlled areas are based on hope and a prayer.

* The draft FMP indicates that management decisions about maximum sustainable yields of coral reef fishery resources will depend on the current protocol of fishermen catch reporting. However, no details are provided on how the National Marine Fisheries Service [or any other permitting authority] verifies the information obtained on these reports as to accuracy and reliability. Without an independent means of verification for the information provided by fishermen, the numbers caught and areas fished are anecdotal and cannot be classified as valid scientific data. A different approach is needed for managing agencies to obtain accurate and reliable marine resource information on which to base management decisions.

* The economic analysis components of the draft FMP/EIS focus on the immediate or short-term benefits. There is mention of potential long-term benefits that cannot be assessed, so these are not given any value. Premature resource exploitation will benefit a few fishermen now, at the expense of future generations. There would not be so much pressure to immediately exploit the fishery resources in these remote areas if fishermen had not reduced the standing crops of marine resources in more accessible areas to very low levels. These remaining unexploited habitats should be left alone until we have accurate and verifiable assessments of the available marine resources. A better use of these unexploited marine stocks would be to provide a source of marine life to replenish depleted areas in more accessible fishing locations near human habitats, and to provide genetic re-invigoration for aquaculture species.

Once again, I urge you to implement Alternative #4 --Maximum Additional Protection to Coral Reef Resources--at this time. Thank you for your consideration of these comments.

Sincerely yours,

Laurel Kasaoka

Laurel Kasaoka
1658 Liholiho Street, #603, Honolulu, HI 96822-2971

LIVING OCEANS
National Audubon Society

RECEIVED
'01 FEB 22 P12:24
WESPAC

Eric Gilman, Pacific Representative
Living Oceans Program
National Audubon Society
2718 Napuaa Place
Honolulu, HI 96822 USA

Phone: 808.988.1976
Fax: 808.988.1440
E-mail: egilman@lava.net

21 February 2001

Kitty Simonds, Executive Director
Western Pacific Fishery Management Council
1164 Bishop Street, Suite 1400
Honolulu, HI 96814

Dear Ms. Simonds:

The National Audubon Society's Living Oceans Program offers the following comments on the Draft Coral Reef Ecosystem Fishery Management Plan of the Western Pacific Region (Draft FMP) and Draft Environmental Impact Statement (DEIS). Overall, we strongly support the idea of moving from a management focus on single fish stocks to an ecosystem-based approach and believe that, given existing constraints, the draft plan takes significant steps in this direction. We especially support the proposed employment of marine zoning, including no-take and low-use zones. However, we believe that the plan falls short of employing an integrated and ecosystem-based management approach, that the plan reduces conservation efforts and precautionary management by challenging the boundaries and management authority of Hawaiian and Pacific Islands National Wildlife Refuges, and that the plan conflicts with measures of the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve.

1. Management Tools: The Draft FMP and DEIS propose to use marine zoning and establish no-take and low-use zones in the Northwestern Hawaiian Islands (NWHI). These are internationally supported management tools with proven effectiveness at being capable of achieving conservation and sustainable use of coastal and marine resources. It demonstrates a precautionary and proactive approach, and as such, we fully support the proposed employment of these tools. We further support the permitting system proposed in the preferred alternative in the DEIS and Draft FMP, as this system would provide only limited opportunities to fish for poorly understood fish and to fish in proposed low-use areas using individually-reviewed special permits, while allowing general permits for better understood stocks that can sustain fishing pressure. Regarding the protocol to issue scientific permits, we recommend that scientific research only be permitted to occur in no-take and low-use areas if the applicant demonstrates that it is not practicable to conduct the proposed research outside of these areas, the research will not result in significant adverse environmental impacts individually or from cumulative impacts, and the research promises to support the conservation and sustainable management of coral reefs. We support the proposed prohibition of cruise ships and uninsured fishing vessels from operating in protected areas.

2. Conflicts with Existing Refuges and NWHI Reserve: (Section 9.2 Draft FMP, and Sections 3.6, 4.0, and 5.0 DEIS). The Draft FMP and DEIS are inconsistent with the measures established by Executive Orders 13178 and 13196, which establish the NWHI Coral Reef Ecosystem Reserve, and the Draft FMP and DEIS neglect to provide a justification for this inconsistency. The Reserve Preservation Areas and conservation measures established by these Executive Orders are more protective and precautionary than the "Marine Protected Areas" and management measures proposed in the Draft FMP and DEIS. We believe that the Draft FMP and DEIS must be revised to be consistent with these Executive Orders.

The Draft FMP and DEIS also assert marine boundaries of the Hawaiian and Pacific Islands National Wildlife Refuges that are different than those asserted to exist by the U.S. Fish and Wildlife Service. Also, the U.S. Fish and Wildlife Service asserts authority to manage all activities within refuge boundaries, including commercial and recreational fishery activities, while the Draft FMP and DEIS assert

that the Fishery Council has authority over fishery resources within these refuges. I refer you to the background paper, *Existing Marine Resources Management Framework and Recent Initiatives to Change the Governance of Marine Resources of the Northwestern Hawaiian Islands*, provided to your office in August 2000, for an overview of these unresolved jurisdictional disputes. To enable effective ecosystem-based management, the refuges need to be able to regulate all activities that could potentially adversely affect protected resources, as explained in detail in comment 3 below. Therefore, we recommend that the Draft FMP and DEIS be revised to accept the seaward boundaries, as asserted by the U.S. Fish and Wildlife Service, of all National Wildlife Refuge units in the Hawaiian Islands and U.S. Pacific Remote Island Areas, including the recently established refuges at Kingman Reef and Palmyra Atoll where the U.S. Fish and Wildlife Service prohibits commercial fishing within 12 nautical miles of emergent land, and acknowledge that the Refuges have the authority to manage all activities within these refuge boundaries, including fishery activities. Section 4.0 of the DEIS does not identify the inconsistency with the NWHI Coral Reef Ecosystem Reserve and jurisdictional dispute over refuge boundaries and management authority as significant issues. These are very significant and controversial issues and should be addressed in the DEIS and Draft FMP.

3. Integrated Ecosystem Management:

(a) Integrated Ecosystem Management Defined: An integrated management approach is appropriate for the NWHI. An integrated management approach manages all interrelated elements (natural resources, environmental processes, human activities, socioeconomic factors, and political factors) that affect a region or specific natural resource of a region under a single unifying approach to maintain ecosystem processes in a least disturbed state and sustain the provision of valued services and products indefinitely. Integrated management is implemented through the collaboration of all management authorities and stakeholders to achieve sustainable use and ecological integrity. Integrated management can be described as including three elements, an ecological element and two social elements. (1) The ecological element calls for the protection of biodiversity, functional processes, and ecological integrity, where the functioning of a particular region is influenced heavily by surrounding systems. (2) The first social element calls for the sustainable use of natural resources to allow future generations of people to derive valued services from the environment. This element acknowledges the importance of human needs and the reality that the capacity of the world to meet these needs in perpetuity has limits based on the functional performance of ecosystems. (3) The second social element calls for the collaboration and support of all management authorities and interest groups to adopt restrictions on uses of natural resources and on development to protect the region's natural resources. Integrated management acknowledges that humans are the cause of the most adverse impacts to ecosystem functioning and sustainability, and that humans are an integral ecosystem component that must be directly involved to achieve sustainable management goals. To encapsulate, an underlying principle of integrated management is that ecosystem functioning, anthropogenic forces, and the sustainability of human societies are interconnected and should be holistically managed through a collaborative approach.

(b) Why the Draft Coral Reef FMP is not an Integrated Ecosystem Approach: The Draft Coral Reef FMP and DEIS do not comprehensively address all activities that could impact the NWHI coral reef ecosystem, and do not cover all habitats that comprise the NWHI ecosystem. The executive summary of the Draft FMP refers to the plan as a, "fishery ecosystem plan," and I offer that this description is accurate, that the plan only addresses fishery activities, and as such, is short of a true ecosystem-based management approach. Regional Fishery Management Councils, which lack the authority to regulate fisheries not covered under a Council FMP and to regulate nonfishing activities, do not have the authority to implement an integrated, holistic management approach.

(c) What a true Integrated Ecosystem-Based Approach Entails for the NWHI: To effectively implement an integrated management approach, the NWHI protected area needs to include and coordinate management of both terrestrial and marine ecosystems, as marine, coastal, and terrestrial functional processes are interconnected and need to be comprehensively managed as a single system in a coordinated manner. For instance, the estimated fourteen million seabirds of 19 species nesting in the NWHI are primarily pelagic feeders that obtain fish and squid associated with schools of large predatory fish such as tuna and billfish. These seabirds are most successful at feeding their young when they can find schools of predatory fish within close range of their breeding colonies, and recently fledged birds rely on abundant and local sources of food. At least six of the 19 seabird species breeding in the NWHI

(brown noddies, black noddies, white terns, blue-gray noddies, gray-backed terns, and brown boobies) have significant proportions (33% - 56%) of their diet identified as originating from the coral reef ecosystem or are considered primarily inshore foragers. Also, for instance, green sea turtles require undisturbed beaches for nesting and coastal areas to graze on algae. And, for instance, beach habitat, lagoons, coral reefs, and pelagic waters as deep as 500 meters are used by the Hawaiian monk seal. Also, degradation of coral reef structure can cause reduced protection of upland areas from natural coastal hazards (storms and wave energy), and unwise land uses can cause erosion and smothering of coral reefs.

Because no single U.S. agency has unified authority over an entire ecosystem, and there is no current basis for multi-agency partnerships to allow for a unified and integrated management approach of the NWHI, we suggest that significant legislative changes need to be made to the governance framework of the NWHI before true integrated and ecosystem-based management can exist. A management body with representation of all government agencies with jurisdiction over the NWHI and all non-governmental stakeholders needs to be established and empowered in order to enable true integrated ecosystem-based management.

4. State versus Federal Jurisdictional Disputes: (Sections 9.2 and 9.3, Draft FMP, and section 3.6, DEIS). The Draft FMP and DEIS do not adequately address jurisdictional disputes regarding the management of the NWHI and its natural resources. In addition to the jurisdictional dispute over refuge boundaries described earlier, there is also a longstanding dispute between the State of Hawaii and the federal government that should be addressed in these draft documents. I again refer you to the background paper, *Existing Marine Resources Management Framework and Recent Initiatives to Change the Governance of Marine Resources of the Northwestern Hawaiian Islands*, provided to your office in August 2000, for an overview of these unresolved jurisdictional disputes. An integrated ecosystem approach requires unified collaboration of all management bodies. The need to resolve these disputes to the satisfaction of all parties is one additional justification for the formation of a new authority that can take a unified and holistic management approach.

Thank you for the opportunity to comment on the Draft FMP and DEIS. Changing from the current management framework, which includes a fisheries management system based largely on population analyses of single fish stocks, three refuges with predominantly single purpose missions and single agency managers, and artificial jurisdictional boundaries that are not based on ecological parameters, to a more holistic, integrated ecosystem approach based on tenets regarding species interactions within an ecosystem is difficult. Such a change in governance will challenge many entrenched interests and will require wholesale change in the U.S. governance framework. The Western Pacific Fishery Management Council is to be commended for taking steps to move towards an improved management structure to achieve long-term conservation goals and sustainable use.

Sincerely,

Eric Gilman

C: Susan B. Fruchter, NEPA Coordinator

TERRITORY OF AMERICAN SAMOA
OFFICE OF THE GOVERNOR
PAGO PAGO, AMERICAN SAMOA 96799

TAUESE P. F. SUNIA
Governor

TOGIOLA T. A. TULAFONO
Lieutenant Governor

1900 c 2000

Serial No. 0289

February 22, 2001

Via Facsimile: (808) 522-8226

Kitty M. Simonds
Executive Director
Western Pacific Regional Fishery Management Council
1164 Bishop Street, Suite 1400
Honolulu, Hawaii 96813

Re: Coral Reef Ecosystem Fisheries Plan

Dear Ms. Simonds:

I would like to take the opportunity to comment on the recent draft of the Council's Coral Reef Ecosystem Fisheries Plan. In this current draft, the Council is proposing to create a marine protected area out to 50 fathoms around Rose Atoll. I am adamantly opposed to this designation.

As you know, I have been personally very interested and active in the U.S. Coral Reef Task Force and in matters pertaining to the Coral Reef Initiative. My administration has endorsed President Clinton's recommendation to set aside 20% of our Territorial waters as no—take marine protected areas. Currently, we are well below this target number, and the Rose Atoll Wildlife Refuge, which extends 3 miles out from the atoll, makes a significant contribution to our total protected area. The Council designation, then, would countervene our policy by subtracting more than 90% of the seas currently protected under the agreement with the U.S. Fish and Wildlife Service and the government of American Samoa. It would also make it difficult to enforce the no-take areas, as the 50 fathom depth can be quite close to the atoll itself. The full area of the refuge is needed for enforcement purposes to protect the coral reefs at the atoll.

More significantly, Rose Atoll and its surrounding three miles are *Territorial* lands and seas. As such, the Council has no jurisdiction in these waters. I respectfully submit that the Council's attempt to designate Rose as a marine protected area makes no sense, legally or environmentally, given its current status.

Executive Office Building-Third Floor • P. O. Box 485 • Pago Pago, American Samoa 96799
Telephone: (684) 633 4116 • Facsimile: (684) 633 2269

I will be attending the U.S. Coral Reef Task Force meeting next week and will look forward to discussing this issue in person with you.

Sincerely,

TAUESE P.F. SUNIA
Governor

Cc: Ufagafa Ray Tulafono, Director DMWR
Lelei Peau, Deputy Director DOC

The Nature Conservancy

88 First Street
Suite 600
San Francisco, California 94105
TEL 415 904-9930
FAX 415 904-9935

International Headquarters
Arlington, Virginia
TEL 703 841-5300

February 23, 2001

Kitty M. Simonds, Executive Director
Western Pacific Regional Fishery Management Council
1164 Bishop Street, Suite 1400
Honolulu, HI 96813
fax: (808) 522-8226

We appreciate your invitation to comment on the Draft Fishery Management Plan for Coral Reef Ecosystems of the Western Pacific Region (DFMP) and accompanying Draft Environmental Impact Statement (DEIS). Our comments here will be primarily limited to the possible effects of the proposed measures on the resources, activities, and values at and around Palmyra, in which, as you know, The Nature Conservancy has an especially strong interest since it purchased the atoll in November 2000.

The mission of the Conservancy is to preserve biodiversity, and Palmyra was acquired to preserve and manage the valuable biodiversity associated with the atoll and related ecosystems. Although the Conservancy does not own the marine territory surrounding the atoll, we are very interested in contributing to the extent possible, to the conservation of resources in the ecosystems surrounding and linked to the atoll itself. This includes the coral reef, deep benthic, and pelagic ecosystems. To that end, we support the recent establishment of the national wildlife refuge at Palmyra and are currently working on various management issues with the U.S. Fish & Wildlife Service. Having reviewed your DFMP, it also appears that the goal of placing Palmyra in conservation status, particularly its 16,000 acres of coral reefs, is consistent with the recommendations of the DFMP.

The Nature Conservancy is very aware of the connectivity of the myriad of Palmyra's marine and terrestrial habitats, although of course much remains to be learned about the types and degrees of connections. We recognize, for example, that the fate of sea turtle populations that range across the entire Pacific is in part dependent on how successfully we care for nesting beaches on Palmyra. Likewise, our successful management of seabird nesting habitat on Palmyra cannot alone ensure the maintenance of the populations that nest there. Their survival is also dependent on the productivity of the oceans in which they feed and sources of mortality that are beyond our immediate control (both of which are affected by fishing activity far from the shores of Palmyra). We also appreciate the challenges of cross-agency coordination and user group involvement that

will be required for a truly ecosystem-based system of management. If the Conservancy can serve any useful role in furthering those efforts, please do not hesitate to request our assistance.

Our vision for the long-term management of Palmyra and related marine ecosystems is one in which relevant federal and Hawaii State agencies, academic and research institutions, the Conservancy, and other non-governmental organizations work closely with the fishing community of Hawaii and other stakeholders to achieve a variety of conservation, fishery, scientific, educational, and other objectives. We believe that foremost among those objectives should be the maintenance of biodiversity and the sustained productivity of all resources.

Our immediate concern is that the measures proposed in the DFMP would prohibit the development of a low-impact catch-and-release shallow-water recreational fishery at Palmyra. As you know, we are planning to allow and operate certain ecotourism activities at Palmyra, including blue-water gamefishing, fly-fishing for bonefish, and casting for other reef-associated species. All these activities would be conducted on a catch-and-release basis. The objective of our ecotourism program is to provide recreational and educational opportunities that are compatible with our conservation goals while generating revenue that can be invested in the conservation program for Palmyra.

We do not believe that the absolute no-take measure proposed for Palmyra is the best alternative, even when judged in terms of conservation alone. Implementation of this measure would preclude our ability to explore and consider the full range of options available at Palmyra—just when we are beginning to do the research and conduct the monitoring needed to make good management decisions.

We urge the Council to reconsider the proposed no-take measure for Palmyra, and specifically, to consider adjusting the Palmyra designation to a "low-use" area in which the option to develop a strictly controlled and well-monitored catch-and-release recreational fishery would be preserved.

Provided below are more detailed comments on why we believe the recreational fishery we envision for Palmyra would generate substantial recreational and conservation benefits with minimal adverse impacts on coral reef resources.

Rationale for the no-take measure at Palmyra:

As discussed further below, we are not convinced that the prohibition of low-level non-consumptive catch-and-release recreational fishing in water shallower than 50 fathoms at Palmyra is necessary or appropriate for the conservation and management of the region's coral reef fisheries.[1] Given that one of the purposes of the Magnuson-Stevens Fishery Conservation and Management Act (M-S Act) is to promote recreational fishing, and catch-and-release fishing in particular,[2] the DFMP and DEIS should pay special attention to the adverse impacts of

[1] The Magnuson-Stevens Fishery Conservation and Management Act requires that the DFMP contain measures that are both "necessary and appropriate for the conservation and management of the fishery" (M-S Act § 303, 16 USC 1853).
[2] M-S Act § 2, 16 USC 1801.

prohibiting recreational catch-and-release fishing at Palmyra and to justify the prohibition in light of that mandate.

The impacts of catch-and-release recreational fishing:

We recognize that any human activity has the potential to adversely affect natural resources and that even catch-and-release fishing can result in the mortality of target and other species. However, we believe that incidental mortalities and other effects can be maintained at such low levels in the strictly controlled fishery that we envision for Palmyra that the environmental impacts would be minimal.

Impacts on habitat: As acknowledged in the DFMP, fishing by rod-and-reel has negligible impact on habitat.

Bycatch: Fly-fishing on reef flats for bonefish is highly selective. Other species occasionally captured while fly-fishing can be released alive and healthy in virtually all cases. Spin-casting on the reef targets a variety of piscivorous species, including carangids, lutjanids, lethrinids, serranids, and sphyraenids. Most are desirable target species. All species caught can be released alive and healthy in virtually all cases.

Impacts on target populations: Given the limited number of visitors to Palmyra, the limited number of anglers allowed on the reef at any given time (8 rods), and the generally moderate catch rate of reef fish species targeted with fly rods, the total catch of reef species will be moderate. All fish caught in the lagoon and on the reef are required to be released alive (bonefish—the primary target species—have very little appeal as food, anyway). The only study we are aware of that assessed the survival rate of caught-and-released bonefish (*Albula vulpes* in South Florida) found that 96 percent of bonefish released after capture by rod-and-reel survived.[3]. As far as we know, no such survival studies have been done for *Caranx ignobilis* or other target reef species, and we acknowledge that the post-release survival of these species is less certain. Another possible impact on reef species—especially large individuals—occurs when a fish is lost due to the line breaking, resulting in the fish having the hook in its mouth. The use of barbless hooks will improve the fish's ability to throw the hook, and the use of non-stainless and non-aluminum hooks will favor rapid decomposition of the hook. A final impact is that individual fish will occasionally be lost to sharks while being fought, but again, the number is likely to be small.

We would be glad to continue to work with the Council and other partners to obtain and analyze the best scientific information on the effects of catch-and-release fishing on coral reef-associated fish species and to formulate any needed fishing restrictions accordingly. We are also committed to conducting a long-term monitoring program that would evaluate the effects of fishing on target species and other resources, and to support a management system that can quickly respond to new information as it becomes available.

[3] (Crabtree et al., 1998) Because the bonefish in the study were held in tanks and repeatedly caught—some of them as many as 13 times over the course of the study—the authors concluded that bonefish caught in the wild would have an even greater survival rate.

The benefits of catch-and-release recreational fishing:

Recreational fishing can provide substantial benefits, and given its relatively minor adverse impacts (especially if catch-and-release), the net benefits can be very high compared to alternative uses, including the no-use option. First, there is the surplus that accrues to individual anglers,[4] as well as to potential anglers that value the opportunity of being able to fish at Palmyra. A charter fishery, as we are proposing to develop at Palmyra, can generate additional benefits in the form of producer surplus. This surplus would accrue to both the business side of the operation—in this case, to the concessionaire and its employees—and the non-profit side of the operation—in this case, to the Conservancy.

Given the mission of the Conservancy and its conservation objectives at Palmyra, this surplus would be transferred back as an input into the management of Palmyra—it would be used to support all our conservation objectives at Palmyra, including the conservation of coral reef ecosystem resources. Without the revenues from the charter fishery, the Conservancy would have fewer resources to invest in the conservation of Palmyra as a whole.

Because the majority of ecotourism revenues are expected to come from fishing, it is unlikely that any other ecotourism activities at Palmyra would be viable without the fishery. The facilities and logistical requirements for the fishery would also indirectly support educational and scientific activities. Without the fishery, there would be very limited, if any, opportunities for public access to Palmyra.

Finally, the presence of recreational fishermen around Palmyra can serve as a deterrent and policing device for illegal fishing—both domestic and foreign. The DEIS, for example, finds that "long-range surveillance and enforcement capabilities are inadequate to police remote coral reef areas" (e.g., in the context of live reef fish trade) (vII:10). A recreational fishing presence at Palmyra could provide effective enforcement at no cost, potentially saving the public some of the estimated "$100,000 per air patrol and $25,000 per surface patrol" (vII:169). The DEIS acknowledges that large no-take zones in the NWHI could "preclude opportunities for fishermen to report illegal foreign and domestic fishing activity" (vII:170). It does not, however, recognize the same adverse impact in the case of Palmyra.

Assessing the impacts of the proposed no-take measure at Palmyra:

To help provide a better baseline against which to assess the impacts of the proposed measure at Palmyra, below is a brief description of the existing and planned fisheries at Palmyra.

The existing recreational fishery: Upon securing a purchase agreement for Palmyra Atoll in January 2000, the Conservancy rehabilitated the airstrip and established a tent camp on Cooper Island. Since then, the Conservancy has hosted a total of about 80 visitors during the course of nine trips made by air. The visitors engaged in a variety of ecotourism activities, including scuba diving, snorkeling, kayaking, photography, and fishing. Most of the visitors (70-80%) did some fishing, particularly flyfishing on shallow flats for bonefish, spin-casting on the reef for a variety

[4] The RIR, for example, cited a study that estimated this surplus to average $95 per angler-trip in the main Hawaiian Islands, and used a range of $25 to $100 per angler-trip in its analysis (vI:RIR/IRFA:26-27).

of piscivorous species, and trolling offshore for pelagic species. We have been operating one 22-foot blue-water fishing vessel and four 14-foot shallow-draft fishing boats for inshore fishing. All fish captured on the reef and within the lagoon were released alive, with the exception of a few fish lost to sharks while fighting and a few fish injured during capture. Fish caught offshore were released alive with the exception of one or two fish per boat-trip that were kept for on-island consumption. Only *ahi*, *ono*, and *mahi-mahi* were retained.

The planned recreational fishery: The recreational activities at Palmyra during the last year have been conducted in part to test the potential of ecotourism at Palmyra. Based on those experiences, as well as experiences elsewhere, we are now working on a detailed plan for ecotourism activities at Palmyra. The primary fishing attractions would be fly-fishing for bonefish on shallow sand flats, spin-casting on the reef, and trolling offshore. Controls on fishing would include:

- catch-and-release only (except a small offshore trip limit for *ahi*, *ono*, and *mahi-mahi* for on-island consumption)
- a limit of eight rods in four boats fishing inshore at any given time
- only method allowed on lagoon sand flats is fly-fishing (for bonefish)
- barbless hooks only
- no fishing in extremely sensitive areas (e.g., as needed for nesting seabirds)

Scope of impact analysis: The only fisheries issues that were determined after the screening process to be "potentially significant" and consequently analyzed in the DEIS were the "sustained participation by fishing communities" and "fairness and equity to fishermen" (vII:127). Given the extent and strictness of the proposed measures, another clearly important issue is the preclusion of the development of new fisheries. We recognize that an attempt was made to assess the "environmental consequences for bioprospecting and other new fisheries" (vII:163) and we acknowledge that forecasting fisheries development is very difficult. But in the case of Palmyra, the Council had knowledge of the existing fishery and of the Conservancy's plans to further develop the fishery. Yet the DEIS includes very little analysis of the obvious adverse direct and indirect impacts to the existing fishery, to the future development of the fishery, and to existing and future non-fishery uses and values at Palmyra.[5]

Recognition of recreational interest: We would like to emphasize to the Council that there is now a substantial recreational interest in the fishery at Palmyra.[6] This interest is held by a fishing community that includes people living in Hawaii, other US states, and abroad. It includes people that would take advantage of the opportunity to fish recreationally at Palmyra as well as those that would benefit from the knowledge that such an opportunity exists—whether they take advantage of it or not.

Conclusions:

[5] The impacts to recreational fishing at Palmyra clearly fall in the category of "adverse environmental effects which cannot be avoided should the proposal be implemented" and should be identified as such in the DEIS (40 CFR 1502.16).

[6] The DFMP's description of the fishery is required to include "any recreational interest in the fishery" (M-S Act 303, 16 USC 1853).

The Conservancy urges the Council to assess more fully the likely impacts of the proposed no-take measure at Palmyra and to consider more fully the alternative of designating Palmyra's coral reefs as a low-use area in which catch-and-release recreational fishing would be allowed. Among the factors the Council should take into consideration are the following:

- that there is an important recreational fishery interest at Palmyra that would be adversely impacted by the proposed measure;
- that catch-and-release inshore fishing at Palmyra would generate substantial recreational benefits;
- that such a fishery would provide financial support for the conservation of all Palmyra's natural resources;
- that such a fishery would enhance the viability of other ecotourism activities at Palmyra, as well as educational and scientific activities, thereby facilitating public access;
- that such a fishery, particularly when strictly controlled as we propose, is likely to result in minimal adverse environmental impacts; and
- that we believe such a fishery would be consistent with:
  - the objectives of the DFMP,
  - the principals of precautionary and ecosystem-based management, and
  - the purposes and policies of the M-S Act, including its national standards for fishery conservation and management

Sincerely,

Chuck Cook

Chuck Cook
Director, Palmyra Project
The Nature Conservancy

cc: Susan B. Fruchter, NEPA Coordinator
Room 5805, OPSP
US Department of Commerce
Washington, DC 20230

CENTER FOR MARINE CONSERVATION

Pacific Regional Office
580 Market Street
Suite 550
San Francisco, CA 94104
Phone: (415) 391-6204
Fax: (415) 956-7441

Headquarters
1725 DeSales Street, NW
Suite 600
Washington, DC 20036
Phone: (202) 429-5609
Fax: (202) 872-0619
Web: www.cmc-ocean.org

23 February 2001

Kitty Simonds, Executive Director
Western Pacific Regional Fishery Management Council
1164 Bishop Street, Suite 1400
Honolulu, HI 96813
FAX: (808) 522-8226

RE: December 2000 Draft Coral Reef Ecosystem Fishery Management Plan

Dear Ms. Simonds:

The Center for Marine Conservation (CMC) submits the following comments on the Draft Coral Reef Ecosystem Fishery Management Plan (CRE-FMP) on behalf of more than 100,000 members nationwide. We thank you for the opportunity to provide comments, and would welcome the opportunity to discuss any of these issues with you further.

Overall, CMC strongly supports the preferred alternative identified in the most recent version of the CRE-FMP. We do have a couple of major concerns, though. We hope to work with you to address these changes through minor revisions of the draft plan. Below, you will find our comments regarding: MSY, OY, and overfishing; marine protected areas; permitting; allowable gear; adaptive management; and jurisdiction.

MSY, OY, AND OVERFISHING

As the Council knows, the Magnuson-Stevens Fishery Conservation and Management Act (the Magnuson-Stevens Act), as most recently amended in 1996, requires all fishery management plans to be consistent with ten National Standards, including "Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry" (16 U.S.C. Sect. 1851 (a)(1). This requirement has two key components: preventing overfishing and achieving optimum yield.

Overfishing is defined as "a rate or level of fishing mortality that jeopardizes the capacity of a fishery to produce the maximum sustainable yield on a continuing basis" (16 U.S.C. Sect. 1802 (29)). Overfished / overfishing refer to a catch rate (i.e., overfishing) and an abundance level (i.e., overfished), as shown in the requirement that "If the Secretary determines at any time that a fishery is overfished, the Secretary shall immediately notify the appropriate Council and request that action be taken to end overfishing in the fishery and to implement conservation and management measures to rebuild affected stocks of fish" (16 U.S.C. Sect. 1854 (e)(2)).

Optimum yield is defined as "the amount of fish which (A) will produce the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities,

Email: JSNowlis@cacmc.org

and taking into account the protection of marine ecosystems; (B) is prescribed as such on the basis of the maximum sustainable yield from the fishery, as reduced by any relevant economic, social, or ecological factor; and (C) in the case of an overfished fishery, provides for rebuilding to a level consistent with producing the maximum sustainable yield in such fishery" (16 U.S.C. Sect. 1802 (28)).

These legal requirements establish three key reference points that should also serve as management triggers. First, the FMP is required to determine an optimum yield (OY), which would generally be stated in terms of the amount of a stock that can be removed during a fishing season. This yield cannot exceed the maximum sustainable yield (MSY), and may be set below MSY for relevant economic, social, or ecological factors. Economic and social factors that might lead to reducing OY below MSY include: maximizing economic efficiency of the fishery; providing opportunities for a range of fishing sectors which may differ in their efficiency; providing stable income and avoiding overcapacity problems; and providing for enhanced non-consumptive use of the resource. Ecological factors that might lead to reducing OY below MSY include: protecting the known ecosystem function played by a particular stock; protecting against inadvertent management mistakes, particularly when information is lacking; and maintaining the resilience of the ecosystem to oceanographic shifts. Due to the economic, social, and ecological nature of most coral reef fisheries, all of these factors are relevant to the CRE-FMP. ***CMC recommends that the Council set a default OY at three-quarters of MSY for well-studied fish stocks, with the potential to reduce OY based on the particular economic, social, and environmental considerations affecting any particular stock.***

The second reference point required by the Magnuson-Stevens Act is an abundance level that would trigger an overfished designation and a rebuilding plan. In the Act, this reference point is identified as the abundance associated with maximum sustainable yield (B_{MSY}) of the fishery. The requirements to prevent overfishing require that management measures achieve the optimum yield (OY) on a continuing basis, and as we highlighted above, OY must not exceed MSY. If catch levels are kept at or below MSY, the abundance of a stock will remain at or above B_{MSY}. The law also makes a direct link between MSY and overfished in the definition of overfishing and in the requirement to rebuild overfished populations back to MSY-levels. ***CMC advises the Council that the Magnuson-Act requires the overfished threshold to be set at MSY levels, although CMC would prefer to see a robust control rule as a means to avoid overfishing.***

The third reference point required by the Magnuson-Stevens Act is a fishing rate that would jeopardize the capacity of the fishery to achieve MSY on a continuing basis. As with the overfished threshold, this reference point is directly tied with MSY. However, this reference point is less clear because fishing rate could refer to the amount of fish caught per unit time (i.e., 1,000 lbs. per year) or could refer to the fishing mortality rate, F_{MSY}—the fraction of a population removed per unit time (i.e., 5% of the standing biomass per year). MSY itself refers to an amount of fish caught per year, but fishery scientists often focus on calculating a fishing mortality rate associated with MSY. If a policy allowed the full MSY to be taken every year, a real-world fishery would almost certainly crash when environmental fluctuations or bad calculations drove it below the MSY level. If instead a policy allowed the fishing mortality rate associated with MSY to be used each year, there would be some years with extremely high catch quotas. Though these high quotas are desirable for some economic reasons, they carry a major disadvantage, particularly for emerging fisheries like those envisioned in the CRE-FMP—they

allow capacity to build up too high. During the early years of the fishery, when abundance is near the unfished levels, quotas will be roughly twice as high as when the fishery has stabilized at MSY levels, assuming the target is to fish the population to roughly half of its unfished abundance. As a result, the industry that develops a reliance on a stock early on will be squeezed to using half the amount of product by the time the system approaches equilibrium. ***For this reason, CMC recommends that the Council define overfishing as any fishing rate (i.e., amount per year) that is greater than MSY or any fishing mortality rate that is greater than the fishing mortality rate (i.e., percent per year).*** Defining overfishing as occurring based on both fishing rates and fishing mortality rates will help to protect both the resource and the fishing industry in the future.

Our recommendations for reference points are superior to those listed in the current draft because they pay closer heed to legal requirements and because they reduce the chances that fishing will lead to ecological or economic disasters. Below, we provide a graphical representation of how the reference points and control rules should be modified from the current draft (see pg. 127).

Regarding the control rule, the Council proposes one with some merits. Utilizing a maximum fishing mortality rate (MFMT) lower than or equal to F_{MSY} level is a good start, as is the scaling back of fishing mortality rates when stocks drop below an MSY abundance level. However, the proposed control rule does not go far enough to insure productive stocks and account for ecosystem considerations. ***We propose the following changes:***

1) ***Cap MFMT at MSY for stocks that are above B_{MSY}, and set it equal to F_{MSY} for stocks below B_{MSY}. If a direct estimate of F_{MSY} is unavailable, E_{MSY} may be used as a proxy, but additional precaution must be built into management somewhere to account for this uncertainty.*** The effort cap is akin to a fishing mortality rate cap, and thus could encourage overcapacity early on in the fishery.

2) ***Set F_{OY} equal to 75% of MSY for stocks that are above B_{OY}, to 75% of $[(B - \alpha B_{OY}) / (B_{OY} - \alpha B_{OY})]$ MSY for stocks below B_{OY} but above αB_{OY}, and to 0 for stocks below αB_{OY}. In these equations, B is the current abundance level and α is the fraction of B_{OY} at which fishing ends. Values of α should range from close to 1 when there is high uncertainty to a minimum of 0.2 when uncertainty is relatively low, but should generally tend towards 0.5 or higher.*** This control rule addresses all Magnuson-Stevens Act requirements and provides a promising future for fish stocks and the fisheries and ecosystems they sustain. Reductions in the fishing rate should come when a stock drops below target levels, not afterwards as proposed in the current draft. It will be almost impossible to maintain stocks at target levels otherwise. Moreover, the reductions need to be decisive in order to avoid inadvertent overfishing due to uncertainties about stock dynamics and about environmental changes. By making the reductions more decisive, as we've proposed here, the Council can dramatically enhance the chances that stocks will remain at productive levels.

3) ***Set B_{MSY} based on biology of the stock when possible. When B_{MSY} is unknown, a proxy equal to 50% of unfished biomass should be used.***

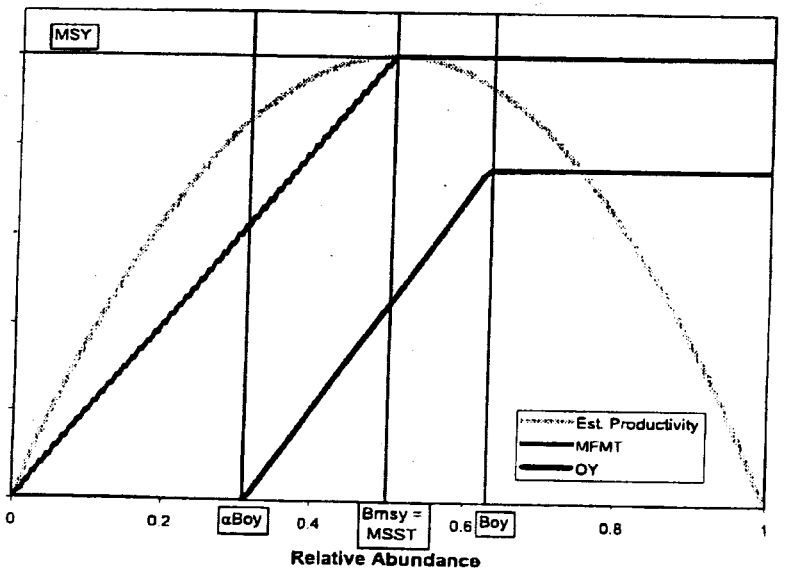
4) ***Set B_{OY} equal to 1.25 B_{MSY} when a direct estimate is available, or higher if we must rely on CPUE or if the stock is known to play an especially important ecosystem role.*** If we assume a Schaeffer recruitment curve, it can be shown that the fishery is expected to stabilize at an abundance $B_{OY} = (2 - f) B_{MSY}$, where f is defined as $F_{OY} = f$ MSY. In this case with $f = 0.75$, B_{OY} would equal 1.25 B_{MSY}. Using 1.3 $CPUE_{MSY}$ provides a small amount of additional buffer necessary because CPUE can often lead to inadvertent overestimates of abundance, but would not be adequate for a stock that provides habitat or food for major parts of the coral reef ecosystem.

5) ***Set MSST equal to B_{MSY}, as required under the Magnuson-Stevens Act.***

6) ***No flag is necessary. The flag identified in the draft serves no purpose because it does not trigger any management action. It should be removed.***

Together, these changes would produce a management framework that looked like the following:

CMC Recommendation



MARINE PROTECTED AREAS / JURISDICTION

Because the CRE-FMP takes an ecosystem approach, it is critical that the Council identifies and recognizes existing marine protected areas under different legal jurisdictions. Generally, the Council has done a good job of doing so in the draft plan. , In addition, the draft CRE-FMP helped to advance much of the no-take area identified by Executive Order 13178 on the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve. Language such as that found on pages 149-150 of the Environmental Impact Statement (EIS) is beneficial and appropriately points out that the draft plan has considered impacts on existing National Wildlife Refuges (NWR). ***CMC also supports the Councils efforts to prohibit cruise ships and uninsured fishing vessels from operating within MPAs of the region.***

However, the draft plan has language elsewhere (pgs. 263-265 of the draft plan) challenging NWR authority and proposing management measures for waters within the boundaries of the refuge system, particularly at Midway Atoll NWR. The National Wildlife Refuge System Administration Act (16 U.S.C.§668dd et seq, as amended) assigns exclusive jurisdiction and authority over activities in the refuges to the U.S. Fish and Wildlife Service,[1] including fishing regulations.[2] While an ecosystem approach requires that the CRE-FMP recognize marine protected areas and other closed areas under different legal jurisdictions, we urge the Council to eliminate any ambiguity as to the Council's jurisdiction to reflect the Council's recognition of U.S.F.W.S. exclusive jurisdiction in these areas (including at the newly created Kingman Reef and Palmyra Atoll NWRs). ***CMC recommends that the Council remove the language challenging that authority.***

This document also fails to acknowledge the Reserve Preservation Areas established pursuant to Executive Orders 13178 and 13196, under the authority of the National Marine Sanctuaries Amendments Act of 2000 (S. 1482). Although EO 13178 is mentioned in the draft plan, many of the Reserve Preservation Areas these Executive Orders created are not mentioned. ***CMC believes the Council must revise the draft plan to address these areas. CMC recommends that the Council add all Reserve Preservation Areas to the draft plan. For those not currently listed, CMC recommends the revisions affirm the prohibitions and exceptions as specified in the Executive Orders.***

PERMITTING

The permitting system identified as the preferred alternative in the draft plan has a great deal of merit. This system would provide for only limited fishing opportunities on poorly-studies fish using individually reviewed permits, while providing more ample opportunities through general permits for better-studies stocks on which a fishery is appropriate. Moreover, the special permitting process would be required for any CRE-FMP resource species fished inside of all marine protected areas, specifically the coral reef ecosystem waters around Johnston Atoll, Wake Island, and any area lacking additional protection in the Northwestern Hawaiian Islands. ***CMC strongly supports this system.***

[1] See Moss, Randolph. "Administration of Coral Reef Resources in the Northwestern Hawaiian Islands." U.S. Department of Justice, letter to John Leshy, James Dorskind, and Dinah Bear, dated September 15, 2000, at 22-23.
[2] Existing fishing regulations for the Refuge system can be found at 50 CFR §32.4 et seq.

One area needs clarification, though. According to the draft plan, research may be permitted within any area, including those that are otherwise no-take (pg. 160). CMC recognizes the need to do some research, including some that might have to take place inside no-take areas. However, it is inadvisable to identify this exemption without clear criteria for what constitutes scientific research and how a permit application would be evaluated. ***CMC recommends that scientific research should be limited in the context of this exemption to scientific studies carried out with the express purpose of improving the coral reef ecosystems and the status of species dependent on them. Permits should be granted only if every effort has been made to minimize the impacts of the research. Permits should only be allowed to perform extractive research in no-take areas if there are no non-extractive alternatives and only if the research products are vital to future management of coral reefs in the U.S. Western Pacific.***

ALLOWABLE GEAR

Overall, the list of allowable gear in the draft plan is exemplary. The list includes only gears that can be used in a manner so as to minimize bycatch and habitat impacts and requires tending of gear that could otherwise be problematic. ***Overall, CMC supports the list of allowable gear, with two exceptions:***

- ***CMC supports a prohibition on the use of a spear with SCUBA at all times in the Pacific Remote Island Areas and the Northwestern Hawaiian Islands.*** The current draft only bans this practice at night, a difficult provision to enforce and one which provides no protection during the day.

- CMC has concerns about the generality of the consideration given to gear not listed in this plan. This provides a potential loophole, and so **CMC supports limiting allowable gear to those types listed in the draft plan. However, if the Council feels it is beneficial to provide opportunity to use unlisted gear, CMC recommends that the draft plan should specify criteria for its use. Specifically, unlisted gear should not be permitted unless it provides nearly no opportunity for bycatch or habitat impacts, while maintaining an appropriate fishing capacity based on ecological and social considerations.**

ADAPTIVE MANAGEMENT

CMC also generally supports the framework provisions of the plan, which will allow the Council and the National Marine Fisheries Service to use adaptive management techniques. CMC supports several of these provisions and hopes to work with the Council and NMFS to implement relevant regulations. However, CMC also has concern about two framework provisions.

CMC recommends that vessel monitoring systems have the potential to be enacted even if the cost of such a system is not fully subsidized with federal funding. CMC believes that under certain circumstances it may be appropriate to ask fishing vessel owners to contribute to the cost, and also believes we should keep the option open that other private or non-federal government funding might be made available for such a program.

CMC further recommends that criteria be established for moving management unit species from the potentially-harvested to the currently-harvested list. While such a move is quite appropriate, it should only happen if four conditions are met: there exists a reliable estimate of the unfished abundance of the species or stock or can otherwise choose a safe abundance target for management; there exists a regular and frequent monitoring to count the abundance of the species or stock; there exists an estimate or reliable proxy for the maximum sustainable yield of the species or stock; and there is good information on the likely ecosystem function of the species or stock, and knowledge that this function can be reduced without causing adverse ecosystem impacts.

Thank you for this opportunity to comment on the draft Coral Reef Ecosystem Fishery Management Plan. CMC applauds your strong efforts at putting together a precautionary and ecosystem-based management plan, and hopes to work with you to correct the problems we have identified above. Do not hesitate to contact Josh Sladek Nowlis at (415) 391-6204 if you have any questions or wish to discuss any of these matters further.

Sincerely,

Joshua Sladek Nowlis
Senior Scientist, Fish and Ecosystems

cc: Susan B. Fruchter, NEPA Coordinator, OPSP, Room 5805, U.S. Department of Commerce, Washington, DC 20230.

ORGANIZATION OF PEOPLE FOR INDIGENOUS RIGHTS
c/o Suite 103, 588 W. Marine Dr.
Hagatna, Guam 96910

Facsimile Transmittal Sheet

Date: 2/23/01

To: WPRFMC (808) 522-8226

From: OPIR % (671) 472-3029

Subject: Comments on Coral FMP

REMARKS: _____

Number of Pages, including this sheet: 4

Please contact _____ at _____

If pages are not received.

ORGANIZATION OF PEOPLE FOR INDIGENOUS RIGHTS
(OPIR)
c/o 588 W. Marine Drive, Suite 103
Hagatna, Guam 96910

February 23, 2001

Western Pacific Regional Fishery Management Council
1164 Bishop Street, Suite 1400
Honolulu, HI 96813

Dear Sir:

I attended the public hearing held on Guam on January 16, 2001 at the Guam Fishermen's Cooperative. I received a copy of the Executive Summary for the Coral Reef Ecosystems Fishery Management Plan handout on which I will base my comments on.

I do not question the need for some action to be taken to protect corals. However, there are natural factors affecting corals that no amount of regulations will remedy. Global warming with concomitant sea level rise, El Nño and La Niña events, typhoons, hurricanes and other weather phenomena are examples of acts of god that can affect corals that are beyond human intervention.

Activities on land can and do adversely impact corals. Runoff from natural or manmade erosion of land contributes significantly to coral die off or stress thereby impacting the species composition and productivity of the reef. It is these activities that must be controlled or mitigated to minimize the adverse effects to the reef. Yes, certain activities by ocean users do negatively affect corals on the reef, but the major impact is by pollution and acts of god.

My oral testimony at the Pelagics FMP hearing was to raise the issue of jurisdiction by the federal government over Guam. I mentioned that the Guam Legislature, in 1981 or 1982, enacted a law extending Guam's boundary to the limits of the EEZ. I also stated that, in 1997, the Guam Legislature enacted a law claiming jurisdiction over all living and non-living resources within Guam's EEZ. And, I said that the United Nations Convention on the Law of the Sea (UNCLOS) went into effect on November 4, 1994 and is now accepted international law. Lastly, I told Pelagics FMP hearing officer that my comments on the Jurisdiction Issue on the Pelagics DEIS are the same as that for the Draft FMP for the Coral Reef Ecosystem.

I now offer additional comments through this written testimony. I will limit my further comments to the Jurisdiction Issue, non-consultation with indigenous people or group and conduct of the public hearing.

The OPIR, founded in 1981, is one of the oldest indigenous rights organizations on Guam. Since 1982, the OPIR has been pursuing at the United Nations the right of the Chamorros to self-determination. The right of the Chamorros to self-determination stems from the fact that Guam was placed by the United States on the United Nations List of Non-Self Governing (NSG List) Territories in 1946. The U. S., by placing Guam on the NSG List, obligated itself to grant the right of self-determination to the indigenous people of Guam – the Chamorros. Also, by placing Guam on the NSG List, the U. S. agreed that it would be known as the "administering Power" of Guam. Another obligation incurred by the U. S., under the U. N. Charter, is the assurance that it gave to the world to assist the indigenous people of Guam, the Chamorros, to develop socially and economically in their quest toward self-determination. This is a treaty obligation of the U. S. and the Constitution of the U. S. recognizes treaty obligations as the "supreme law of the land." In other words, by placing Guam on the NSG List, the administering Power assumes the role of a trustee to the Chamorros until it, U. S., has discharged its obligations to the U. N. by granting the Chamorros their basic human rights to determine their own political status (emphasis added). Therefore, as a trustee, the U. S. cannot express any proprietary interest over the people and resources of Guam.

The people of Guam, the Chamorros, through their elected representatives have reaffirmed their sovereignty over the Exclusive Economic Zone around Guam by the passage of two (2) laws extending Guam's boundary to the limits of the EEZ and asserting jurisdiction of all living and non-living resources. These Guam laws were passed in 1981 (Public Law No. 15-114) and 1995 (Public Law No. 23-17) and codified at 1 GCA §402.

On July 29,1994, Guam's administering Power, the U. S., signed the UNCLOS. The UNCLOS became accepted international law in November 1994. Annex I, Resolution III, 1(a) of the Final Act of the UNCLOS states that, "In the case of a territory whose people have not attained full independence or other self-governing status recognized by the United Nations, or a territory under colonial domination, provisions concerning rights and interests under this Convention shall be implemented for the benefit of the people of the territory with a view to promoting their well-being and development." (Note: The people of Guam are the Chamorros; all others are either settlers or immigrants.)

The indigenous Chamorros are well organized. As I stated above, the OPIR is the oldest of the active organizations. The Nasion Chamoru (Chamoru Nation) is the largest group among the organizations. Fuetsan Famalaoan represents the Chamorro women. The Ritidian Property Owners, Harmon Cliffline Property Owners, Urunao Property Owners and Familian Felisa represent Chamorros whose properties had been taken by the federal government. These different organizations above have formed an "umbrella"

organization called the "Colonized Chamorro Coalition" (CCC), to coordinate actions and activities and to synergistically act in the best interest of the group. The CCC also serves as a "clearing house" for incoming and outgoing information regarding all things affecting Chamorros.

In the case of the Draft CRE FMP, none of the organizations above was aware of any consultation or correspondence on its impact to the Chamorros (discussed by the CCC on 1/18/01). The application of federal laws and regulations without first consulting the Chamorros is un-democratic and a blatant abuse of authority. It was something that frequently happened in the past that should not have been accepted then and certainly not now! If the non-consultation was based on ignorance on the existence of Chamorro organizations then I hope that this testimony will have served a useful purpose.

The conduct of the meeting should be changed so that there is dialogue between your representatives and the attendees. If you had consulted those that would be affected by the federal action during the FMP formulation process then perhaps attendees would not need to ask questions at public hearings.

I am reiterating my request (made at the public hearing) for a hard copy of the FEIS. I can be contacted by telephone during regular workdays at (671 472-3031/3032).

Pas yan Salut,

RUPERT J. LUJAN
Acting Chairman, OPIR

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX

Cross Media Division (CMD-2)
Federal Activities Office - 75 Hawthorne St., San Francisco, CA 94105

FACSIMILE
TRANSMITTAL

TO: Kitty Simmonds

Organization: Westerna Pacific Fisheries Management Council

Subject: DEIS/FMP for Coral Reef Ecosystems in the Western Pacific Region

Ph #:

Fax #: (808) 522-8226

FROM: Shanna Draheim

Ph #: (415) 744-1574

Fax #: (415) 744-1598

E-Mail Address: draheim.shanna@epa.gov

Date Sent: February 26, 2001

Number of pages including cover sheet:

Comments:

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

February 26, 2001

Kitty Simonds
Western Pacific Regional Fishery Management Council
1164 Bishop Street, Suite 1400
Honolulu, HI 96813

Dear Ms. Simonds:

The Environmental Protection Agency (EPA) has reviewed the Draft Environmental Impact Statement (DEIS) for the project entitled **Fishery Management Plan for the Coral Reef Ecosystem of the Western Pacific Region**. Our review is pursuant to the National Environmental Policy Act (NEPA), Council on Environmental Quality (CEQ) regulations (40 CFR Parts 1500-1508), and Section 309 of the Clean Air Act.

The National Marine Fisheries Service (NMFS) and the Western Pacific Regional Fishery Management Council (Council) propose to develop and implement a fishery management plan (FMP) for the Coral Reef Ecosystem (CRE) of the Western Pacific Region, and amend the FMPs for several related fisheries to maintain consistency among the plans. The goal of the CRE - FMP is to take a proactive, precautionary approach to protecting CRE fisheries. The DEIS evaluated four alternatives, including no action, limiting access to the fishery, restricting gear types, and monitoring and permitting. The preferred alternative (#3) includes use of several no-take (where fishing and resource extraction is prohibited) Marine Protected Areas (MPAs), designation of some low-use (limited fishing and resource extraction is permitted) MPAs, a list of allowable gear types, use of permits and monitoring to control impacts to the fishery, prohibition on the collection of live stony coral or rock for commercial purposes, and development of a process for adaptive managment based on future conditions.

EPA supports the ecosystem level approach taken by NMFS and the Council in addressing potential problems due to interactions of humans and coral reefs. The proposed FMP takes a proactive, but balanced approach to protecting coral reef ecosystems in the Western Pacific. The managment plan proposes significant measures to address potential problems, but is flexible to account for changing conditions in the future. EPA also commends NMFS and the Council for integrating this FMP effort with ongoing updates to existing, related FMPs in the Western Pacific Region.

Based on our review of the document, we found that the DEIS sufficiently addresses the environmental impacts of the proposed action. EPA has rated this document **LO, *Lack of***

Objections. (Please see the attached *Rating Factors* for a description of our rating system). EPA encourages NMFS and the Council to continue to integrate this planning activity with other FMP updates, and fully address the potential economic and social impacts from fishery displacement, particularly for native Pacific Islanders.

We appreciate the opportunity to review this DEIS. When the Final EIS is completed, please send two copies to me at the address above (Mail Code: CMD-2). If you have any questions or comments, please feel free to contact me or Shanna Draheim, the primary staff person working on this project. Shanna can be reached at (415) 744-1574 or draheim.shanna@epa.gov.

Sincerely,

Lisa B. Hanf, Manager
Federal Activities Office

Enclosure: Summary of EPA Rating Definitions
Filename: coral reef ecosystem DEIS.wpd
MI#: 003285

cc: Susan B. Fruchter, Department of Commerce, NOAA
Dr. Charles Karnella, NMPS, Pacific Islands Area Office
USFWS, Sacramento

February 25, 2001

To: Ms. Rose Kitty Simonds, Executive Director
Western Pacific Regional Fishery Management Council
1164 Bishop Street, Suite 1400
Honolulu, HI 96813
Fax to: (808) 522-8226 Page 1 of 1

From: Mr. Isaac D. Harp, KAHEA Consultant, Citizen At Large Member - NWHI CRE Reserve
PMB 791, 843 Wainee Street, F-5
Lahaina, HI 96761
Faxed from: (808) 661-5473

Re: DRAFT FISHERY MANAGEMENT PLAN FOR CORAL REEF ECOSYSTEMS OF THE WESTERN PACIFIC REGION (INCLUDING REGULATIONS) AND REGULATORY IMPACT REVIEW/INITIAL REGULATORY FLEXIBILITY ANALYSIS

Aloha Ms. Simonds/Kitty:

Having reviewed the extensive, and no doubt expensive three-volume FMP, DEIS I am dismayed at the Council's misuse of the term "ecosystem." It appears that the Council has little knowledge of what an ecosystem is, let alone an understanding of how to prepare a fishery management plan from an ecosystem perspective. There appears to be little science in the preparation of this Draft. Normally I would spend the time to provide detailed information to each concern I have, but in this case, I feel that this would simply be a waste of my time and the time of the reviewer.

I will make a few simple statements. First, this collection of words is not an ecosystem fishery management plan, simply because several species of marine-life have been excluded from consideration. Secondly, it appears that the Council's FMP, DEIS does not recognize or acknowledge the newly established Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve. Third, it appears that the Council fails to recognize that the State of Hawaii, Department of Land and Natural Resources has developed their own Fishery Management Area plan for State waters, which the Council previously managed, significantly reducing the Council's area of responsibility in the Northwestern Hawaiian Islands.

Considering the fact that the Council has a single small bottom-fish fishery remaining in the area, and that the Northwestern Hawaiian Islands Reserve Council is a few months away from establishing a management plan for the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve, it's unnecessary and a waste of federal funds for your office to continue with the process of reviewing comments to your FMP, DEIS and the preparation of a final FMP.

Thank you for this opportunity to comment.

Sincerely, Isaac D. Harp

Cc: Susan B. Fletcher, NEPA Coordinator

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PACIFIC OCEAN PRODUCERS

965 B NORTH NIMITZ HWY.
HONOLULU, HAWAII 96817
808-537-2905 PH. 808-536-3225 FAX

FAX

To: BOB	**From:** SEAN MARTIN
Fax:	**Pages:** 3 including cover
Phone:	**Date:** February 26, 2001

Please see attached.

February 26, 2001

To Whom It May Concern:

As a permit holder for lobsters in the Northwestern Hawaiian Islands (NWHI), I **support** **the Coral Reef Ecosystem Management Plan** developed by the Western Pacific Fishery Management Council (WESPAC). The NWHI are a valuable asset to the people of the United States and the WESPAC has proven to be an excellent steward to this unique region. By all accounts, the NWHI **continue to be described as beautiful and pristine** after **25 years of conservative and sustainable** fishery management by the WESPAC.

Under careful and conservative management, commercial fishing and ecological goals can be achieved. The Coral Reef Ecosystem Plan will achieve a balance that will sustain this unique and pristine environment for generations to come.

The executive order issued by President Clinton **in his quest for a legacy doe NOT serve the interests** of the American people.

Allow the WESPAC to continue the science based management approach that has proven successful for over 25 years.

Sincerely,

Sean Martin

February 26, 2001

Gentlemen,

I am writing **in support** of the Western Pacific Fisheries Management Council's (WESPAC) **Coral Reef Ecosystem Plan** and ***NOT in support of*** *President Clinton's illegal annexation of the NWHI.*

I am a Hawaii resident born in Hawaii of Hawaiian ancestry. I have extensive first-hand knowledge of the Northwestern Hawaiian Islands **(NWHI)** through years of fishing in the area. I currently hold a NWHI lobster permit and a 750 thousand vessel that have been rendered worthless by President Clinton.

As the President's traveling road show wound its way through Hawaii, a great irony emerged. All involved marveled at the "Pristine" beauty of the area they sought to protect. For 25 years, the WESPAC has managed fisheries of the NWHI in a responsible and sustainable way. **The Coral Reef Ecosystem Plan continues this excellence.**

Aloha,

Jim Cook

FAX 26 February, 2001 8:00 AM HST

To: Ms. Kitty M. Simons

Fax #: (808) 522-8226

From: Conrad Erkelens
Natural and Cultural Resources Manager

Pages Sent: 5

Phone # (808) 471-5455

SUBJECT: Comments on Draft Fishery Management Plan for Coral Reef Ecosystems

Attached comments provided by Commander in Chief, U.S. Pacific Fleet that were also sent via mail on Friday, 23 February 2001.

DEPARTMENT OF THE NAVY
COMMANDER IN CHIEF
UNITED STATES PACIFIC FLEET
250 MAKALAPA DRIVE
PEARL HARBOR, HAWAII 96860-3131

IN REPLY REFER TO:
5090
Ser N46541/0 309
23 FEB 01

Ms. Kitty M. Simons
Executive Director
Western Pacific Regional Fishery Management Council
1164 Bishop Street
Suite 1400
Honolulu, HI 96813

Dear Ms. Simons:

I am responding on behalf of the Commander in Chief, U.S. Pacific Fleet to the request for comments on the Draft Fishery Management Plan for Coral Reef Ecosystems. The enclosure provides comments in this regard. My point of contact is Mr. Conrad Erkelens, who may be reached at (808) 471-5455.

Sincerely,

A. E. RONDEAU
Rear Admiral, U.S. Navy
Deputy Chief of Staff for
Shore Installation Management

Copy to:
CINCPAC (J44)
COMNAVREG HAWAII (N45)
COMNAVMAR GUAM (N45)
PACNAVFACENGCOM (Code 23)

Enclosure:
1. Comments on Draft Fishery Management Plan for Coral Reef Ecosystems of the Western Pacific Volumes I, II, and III, dated December 2000

COMMENTS ON DRAFT FISHERY MANAGEMENT PLAN FOR CORAL REEF ECOSYSTEMS OF THE WESTERN PACIFIC VOLUMES I, II AND III DATED DECEMBER 2000

Note: the following comments/corrections are generally applicable to all three volumes.

1) The Magnuson-Stevens Fishery Conservation and Management Act is referred to using four different names and abbreviations. The act should be referred to consistently throughout all three volumes.

2) There are numerous references to reefs which "...have been degraded as a result of past and on-going military use." (Vol. I page 7, etc.) This is a misleading statement. Nearly all of the significant adverse impacts occurred prior to, during or shortly after WWII. Since the 1970's most of the military's actions in the project area have had beneficial impacts, by reducing or eliminating commercial development and commercial fishing. The "de facto" marine protected status that many areas have had as a result of military restrictions are the very reason many of these sites now support the best remaining fish and coral resources left within the project area. This fact should be clearly made in the Fishery Management Plan (FMP).

   At Farallon De Medinilla (FDM), the Navy has conducted annual surveys of the nearshore marine resources to quantitatively determine the degree of impact military exercises since 1997. The U.S. National Marine Fisheries Service, the U.S. Fish and Wildlife Service (USFWS) and the Commonwealth of the Northern Marianas, Department of Lands and Natural Resource participated in the surveys and contributed reports for the annual assessments. These surveys have consistently shown that the military training at FDM since 1997 has had minimal impact on marine communities, endangered and protected species, and fishery resources. It was noted that endangered and protected species were more prevalent in the 1999 and 2000 surveys compared to 1997. Such a comparison suggests that the ongoing training activities have not resulted in the progressive elimination of endangered and protected species from the area. A paucity of several commercially desirable reef fish suggests that fishing pressure is being exerted on the nearshore resources surrounding FDM.

3) Johnston Atoll is not under jurisdiction of the Navy. It is controlled by, and under the jurisdiction of, the Air Force.

4) Kingman Reef is not under jurisdiction of the Navy. USFWS accepted custody and accountability for Kingman Reef on August 25, 2000. The pending revision of the Executive Order at Office of Management and Budget is currently in progress.

ENCLOSURES (1)

5) Title to Kaula Island (Rock) is in the United States of America and the jurisdiction, control, accountability and custody of Kaula Island are with the Department of the Navy.

6) The FMP designates "No anchoring zones" off Guam and suggests that additional "No anchoring zones" may be established. It is not clear whether this restriction is applicable to fishing vessels over 50 feet in length, or all vessels over 50 feet in length. This should be clarified.

7) Although the Western Pacific Regional Fishery Management Council (WPRFMC) does not have authority over cruise ships, the threats from cruise ship anchors is acknowledged. WPRFMC could make recommendations on measures to ensure that cruise ships are not allowed to anchor in sensitive/vulnerable areas.

8) Red mangroves are not native to Hawaii, but have become well established at many locations within the Main Hawaiian Islands (MHI). The FMP appears to designate mangrove areas within the MHI as Essential Fish Habitat (EFH). If red mangrove areas in the MHI qualify as EFH, they should also qualify as Habitat Area of Particular Concern (HAPC), based upon the criteria presented. This issue should be clarified.

9) The entire bank around Kaula Island is designated as HAPC on page 193 in Vol. I and at several other locations in the three documents. However, on page 196 in Vol. I the HAPC designation appears to be restricted to the Five-Fathom Pinnacle portion of the Kaula bank. This should be clarified.

10) Reference to Kaula Rock should be deleted from page 184 in Vol. II paragraph 5. The island and the waters surrounding it are off limits to the public due to hazards from unexploded ordnance and the islands continued use as a firing range. Commander, Navy Region Hawaii, controls access to the island. The FMP should not attempt to promote access to this area. The presence of exceptional marine resources around Kaula Island is an example of how restricted access, due to military activities, can be very beneficial to marine resources.

11) The FMP designates Saipan Lagoon and Apra Harbor as HAPCs. Clarification is needed to show the boundaries of the HAPC designation. For example, is Inner Apra Harbor included?

12) The statement "Benthic productivity should be determined..." from page 203 Vol. I paragraph 7 should be deleted. Conducting a careful marine ecological assessment prior to the installation of a pier or dock is standard procedure. However, determining benthic productivity is unnecessary and unwarranted in most cases. This should not be included as a standard requirement.

13) The comments about FDM on page 217 Vol. I paragraph 3 are inconsistent with the entire concept of designating MPAs. The military's activities at FDM have made it a

"de facto MPA", which has been shown to support substantial fishery resources. Why should fishermen be given access to an area that has been serving as a replenishment zone for years, and then create new restricted MPAs in adjacent areas? The concept of MPAs is an excellent one. However, the "de facto military MPAs" should be retained.

14) Delete the last sentence ("Clearly some....reef area.") on page 217 Vol. I paragraph 3. It is misleading and inappropriate.

15) The ban on spear fishing with SCUBA or hookah at night should be expanded to a total prohibition against spear fishing with SCUBA or hookah.

16) As future framework provisions are developed to address management of non-fishing related activity impacts, ensure that the Department of Defense is included in all interagency coordination.

February 26, 2001

To: Ms. Kitty Simonds, WPFMC

Re: Coral Reef Ecosystem FMP

Dear Kitty,

I am writing to express my support for the Council's Coral Reef Ecosystem FMP's preferred alternative 3.

The plan affords strong protection to vulnerable areas via a rigorous permit system. The plan also implements no-fishing zones around sensitive Monk Seal habitat.

The preferred alternative allows for continuing sustainable participation in the existing fisheries and demands consultation between the Coral Reef, Bottomfish and Crustacean plan teams to monitor these activities closely.

Timm Timoney

Timm Timoney
#1509
575 Cooke St. #A
Honolulu, HI 96813

RECEIVED

'01 FEB 26 P3:28

WESPAC

February 26, 2001

Ms. Kitty Simonds, Executive Director
Western Pacific Regional Fisheries Management Council
1164 Bishop Street, Suite 1400
Honolulu, HI 96813

Dear Ms. Simonds:

As a member of the Coral Reef Ecosystem Fishery Management Plan Team, I would like to submit the following comments regarding the Draft Environmental Impact Statement (DEIS) submitted by the Western Pacific Regional Fisheries Management Council (WPRFMC) in support of its Coral Reef Ecosystem Fisheries Management Plan (CREFMP). I would like to thank the WPRFMC for the opportunity to provide comments on the DEIS and I look forward to your response to my concerns.

Overall, the Plan Team and its members support the WPRFMC in its attempt to establish a true ecosystem-level of management for coral reef resources in federal waters. Many of us do have some concerns specifically related to the WPRFMC's preferred alternative as stated in the DEIS and I have detailed my specific concerns below. In addition, I have also attached a comparison chart for the WPRFMC's preferred alternative and the new NWHI Coral Reef Ecosystem Reserve as outlined in the final Executive Order issued by President Clinton.

Coral reefs represent the most complex community of species on earth; the very tight inter-dependency of the organisms found on coral reefs results in extremely low net productivity. This low net productivity results in the balance of the reef ecosystem being more susceptible to the impacts of any harvest relative to that seen with single-species FMPs (such as Crustaceans or Bottomfish). As Hawaiian coral reefs may represent an extreme in relation to the above statement (given their isolation and northerly location), I would strongly encourage the WPRFMC to modify its management measures to NOT EXCLUDE existing FMPs (such as Crustaceans or Bottomfish) from coverage where they co-occur on federal coral reefs in the NWHI in order to truly achieve the ecosystem-level of management that the Council is striving for.

MANAGEMENT UNIT SPECIES (MUS)/TAXA

The CREFMP includes "virtually all biota in the coral reef ecosystem" except that it **exempts species covered under existing FMPs** (i.e. crustaceans, most apex predators, certain marine ornamental fish). As such, extremely large trophic gaps exist in the plan suggesting that it would not manage coral reefs at an ecosystem level. The WPRFMC's view that any problems caused by excluding such a large number of important coral reef species from coverage under this plan could be overcome by later discussions between different Plan Teams does not adequately deal with this issue. If this plan is to be based

on ecosystem-level of management it cannot exclude entire coral reef species assemblages from coverage under its management measures at its inception. Given the concerns that already exist over coral reef ecosystem-level impacts by existing fisheries that operate near coral reefs, it's difficult to comprehend how excluding such species from coverage under such a plan will result in effective management of the ecosystem as a whole. No rationalization is provided in the DEIS for how excluding such a wide range of coral reef species (All groupers and anthias species, most jack species, most snapper species, all lobster species, and certain shark species) from MUS under this plan will achieve the ecosystem-level of management stated as a primary goal.

The definitions for maximum sustainable yield (MSY) and optimum yield (OY) are based on parameters related to species' abundance and the replacement rate within a population independent of ecosystem relationships; yet ecosystem-level impacts would occur at levels of take far below that where they would trigger species-level concerns of overfishing. The result is that catch rates that would indicate overfishing under the CREFMP would occur AFTER ecosystem-level impacts had already occurred, resulting in a failure of this plan to manage federal coral reef resources at the ecosystem-level. One way of achieving this might be to set MSY and OY based upon not only species-level impacts, but also on impacts on trophic guilds one level above and below that of the species proposed for fishing. Such an action would deal directly with observations that on coral reefs most species are strongly tied ecologically to complex reef trophic webs.

MANAGEMENT MEASURE: MARINE PROTECTED AREAS (MPAS)

Of primary concern is that the DEIS provides no site-specific justification for the selection of the three "no-take" areas. Significant concerns exist over the selection of Midway (versus Kure Atoll or Pearl & Hermes Atoll, both of which represent more pristine-like habitats with unique coral reef resources and assemblages as documented by the recent multi-agency NOWRAMP expedition to the NWHI) as no-take MPA. The WPRFMC's CRE Plan Team provided the Council with site-specific justification for the selection of the areas they felt (in their professional opinion) deserved no-take MPA status; the lack of inclusion of Kure and Pearl & Hermes[1] without corresponding justification for the inclusion of Midway is suggestive that the selection was NOT based on ecological sensitivity, biodiversity, pristineness, uniqueness or other factors usually used as a basis for designating a "no-take" coral reef MPA.

The recent International Coral Reef Symposium in Bali (October 2000) and the American Association for the Advancement of Science (AAAS) Meeting in San Francisco (February, 2001) both acknowledged the strong need to preserve marine biodiversity and protect important habitat necessary for marine ecosystem function. At both meetings, large numbers of world-renowned scientists reaffirmed that fully-protected reserves (No-Take MPAs) are the most valuable way to achieve this goal. It is therefore perplexing as to why the Council disregarded the advice of the CRE Plan Team (which represents the greatest assemblage of coral reef management and coral reef ecosystem scientists directly available to the WPRFMC), and choose instead to designate a portion of Midway as No- Take MPA. Given the strong reasons presented for such areas as Kure Atoll and Pearl & Hermes Atoll to be totally protected, and the lack of any ecosystem-based justification for Midway, it appears that such designation may have

[1] Coincidentally, both were the sites of recent groundings by WPRFMC-permitted fishing vessels; perhaps supporting the need for such protection.

more to do with inter-agency squabbling over turf control than it does with any serious concern over establishment of well thought-out No-Take MPAs to protect fragile NWHI ecosystems.

The designation of all Federal EEZ waters in the NWHI (other than French Frigate Shoals, Laysan, and Midway) shallower than 10 fathoms (~ 60') to be No-Take MPA is enigmatic for this FMP as the majority of living coral resources in federal waters is thought to occur deeper than 10 fathoms (~ 60'). As such, it's difficult to comprehend how such designation will protect fragile coral reef ecosystems in the NWHI as the DEIS claims, if the majority of habitat to be protected occurs in depths outside of the designated no-take MPA. The best available data suggests that these depths should be deeper and related to the depth profiles of living coral reefs in the areas to be covered (25 fathoms or deeper).

The preferred alternative states that the NWHI no-take MPAs would also apply to existing FMPs; though the stipulation that permits for research can be given for use in the "no-take" MPAs may raise concerns regarding fishing activities occurring under the label of research. A related question is whether the "experimental fishing" recently proposed by the Council for the NWHI Lobster Fishery, whereby fishers would get to keep and sell their catch, would fall under the definition of allowable "research" take in a "no-take" MPA? Suggest that any research conducted within no-take MPAs should be directly related to the management of the no-take MPA itself as a way of avoiding the problem listed above; this could easily be accomplished by modifying the document to state that "All extractive activities would be prohibited in no-take MPAs, except for small harvests related to research directly supporting management of the MPA".

According to the DEIS, the entire NWHI outside of FFS, Laysan and a portion of Midway would be limited-take MPA requiring a Special Permit for any fishing. Such action appears to take an ecosystem-approach towards fisheries impacts and should be encouraged. One problem that exists with the current language in the DEIS is that the preferred alternative **exempts all existing FMPs** from coverage under this provision[2]. Once again, the primary human impact concerns in the NWHI (outside of marine debris) are the impacts of existing fisheries; exempting such fisheries from the permitting provisions of the CREFMP results in a major loophole towards managing the NWHI coral reefs in federal waters at an ecosystem-level. As stated earlier, these NWHI resources represent the vast majority of all federal coral reef habitat; as such, the exemption of existing FMPs from regulation under this plan remains a major obstacle.

In order that decision-making regarding this DEIS is based upon the best available science related to coral reefs, I would strongly encourage the WPRFMC to incorporate the results of the recent multi-agency NOWRAMP expeditions into this document and adjust the management measures to reflect the updated knowledge base regarding the ecological state of coral reef resources in the NWHI. Such results should play a critical role in the designation of any no-take MPAs in the NWHI.

The majority of the Plan Team wholeheartedly supports the Council's efforts to minimize impacts on coral reefs by requiring a provision for vessels to have insurance to

[2] Which covers many food fishes and habitat-forming species (such as black coral which can co-occur within stony coral reef habitat).

cover the cost of vessel removal, pollution liability and habitat mitigation[3] in the event of a grounding. Given that the three most recent groundings of WPRFMC-permitted vessels all occurred within State waters and severely damaged State of Hawai'i coral reef habitat, I would encourage the WPRFMC to insert appropriate language making it clear that such insurance covers impacts within both federal and State waters.

The DEIS in a number of sections fails to appropriately recognize existing MPAs within the NWHI (USFWS National Wildlife Refuge and the new NWHI Coral Reef Ecosystem Reserve). It appears that the document needs to be extensively modified to reflect not only the presence of these existing MPAs, but also the management responsibilities of the agencies that manage them.

MANAGEMENT MEASURE : CORAL REEF ECOSYSTEM FISHERY PERMITS

The major concerns regarding permitting relate to the statement that established **FMP fisheries are exempted.** This does not deal with the concerns raised by the Plan Team, the State, NMFS or USFWS in regards to existing impacts on NWHI coral reefs and certainly does not allow for management at the ecosystem level that this plan purports to accomplish. Currently none of the existing FMPs take into account ecosystem impacts in the issuance of their fishery permits; by excluding these fisheries from consideration of ecosystem impact (by not requiring a CRE FMP Permit) the WPRFMC has created a large loophole for existing coral reef impacts to continue. The view that such concerns can be dealt with later through consultations is problematic given that existing FMP impacts on federal coral reef ecosystems have been repetitively ignored in earlier versions of this document, suggesting that if such impacts are not dealt with through a defined management measure within the CRE FMP, they are unlikely to be dealt with through post-adaptation consultations.

While commercial collection of coral/live rock in Federal EEZ would be prohibited under the preferred alternative, collection would be allowed for research, incidental take under other FMPs[4], and commercial propagation[5]. As stated earlier, concerns exist over the definition of the term "research", and its possible use for commercial purposes (including bioprospecting). **Additionally, the Council added a provision for take of coral for traditional/ceremonial purposes by indigenous peoples,** this may be problematic since it could encourage such take within State waters in the NWHI which would be against Hawai'i State law. The DEIS does not define what an allowable "small" amount of coral/live rock is in regards to allowed take. An additional concern relates to unique endemic coral species that occur in the NWHI being allowed under such take provisions.

[3] Note that the description in the DEIS of insurance coverage on P. 3 differs from the description on P. 144 which has dropped the requirement for habitat mitigative action. The DEIS needs to be corrected to properly reflect the appropriateness of habitat mitigation as one of the actions covered under the insurance requirement.

[4] The existing NWHI Lobster Fishery is known to bring up a wide variety of coral that becomes entangled in its traps. This is a major concern that has been identified by the Plan Team but is ignored in the DEIS; the view that such issues can all be handled "later" through negotiations between Plan Teams is problematic and not indicative of a desire to manage resources at an ecosystem-level.

[5] This last point raises concerns as commercial propagation of coral often involves asexual fragmentation (breaking off of pieces to grow-out and sell – this is not truly self-sustainable aquaculture as it often involves going out and re-collecting more coral to "grow-out") which depending upon how it is accomplished can cause massive stress to colonies, introduce competition and disease, and decrease available ecological habitat for the wide range of species found living on and within the coral reef.

Concerns exist regarding the "Grounds for Denial of General Permit" section: The only stated reasons for denial of a general permit are: less than eighteen years of age, not a U. S. citizen, has a criminal record, has not completed an application form. While such provisions may be appropriate in determining whether someone can vote in a general election, they appear to be woefully inadequate for determining the appropriateness of a fishing activity or potential impact on coral reef ecosystems. The listed provisions provide no basis for determining impact of a proposed activity on the coral reef ecosystem prior to its initiation and are not adequate for properly managing resource use.

Given that Special Permits are required within areas thought to be ecologically sensistive (especially the NWHI and the PRIAs), concerns exist regarding the "Grounds for Denial of Special Permit" section: None of the grounds listed deal specifically with ecosystem-level impacts. This is also problematic given that this is supposed to be an "ecosystem" plan. Under the proposed system, it is conceivable that the impacts on a single species would not be significant, but the ecosystem effects would; for example taking out the dominant male cleaner wrasses from a harem resulting in increased parasitism in reef fish, or the removal of all large parrotfish allowing algal overgrowth of corals.

MANAGEMENT MEASURE: GEAR & METHODOLOGY PROVISIONS

The DEIS states that only "selective" and "non-destructive" gear would be allowed, but **by exempting existing FMPs (which include a wide variety of traps and allowable nets), this provision is NOT dealing with the known existing gear impacts to the coral reef ecosystem in the NWHI.** It's difficult to understand how large numbers of lobster traps which are released from the surface and drop down hard onto the reef environment are "non-destructive". Also given that NMFS observer data shows that more than one hundred and ninety seven (197) bycatch species have occurred in recovered lobster traps in the NWHI fishery, it's extremely difficult to suggest that this is a "selective" method of fishing[6].

FRAMEWORK ACTIONS

Mooring and Anchoring: The Council would ban anchoring in no-take MPAs, **except where the WPRFMC allows** – This provision appears to be inserting a loophole that makes for a regulation on paper only. The Council's preferred alternative calls for the installation of mooring buoys and prohibiting of anchoring where mooring buoys occur; such a situation (without a complete ban on anchoring elsewhere in the NWHI) will concentrate ships in sensitive areas (where presumably the only buoys would be located, as anchoring would be allowed everywhere else). Additional questions relate to who would be responsible for placement and maintenance of mooring buoys.

Vessel Monitoring Systems (VMS): The WPRFMC's Preferred Alternative has moved the CRE Plan Team's requirement for vessels under WPRFMC permit in the

[6] Additionally, this data suggests very strongly that traps are being laid in coral reef areas where one would find such a wide variety of species (as opposed to on sandy areas as Council staff and some fishers claim); if true, this would argue strongly for direct destruction of benthic habitat (coral colonies, etc.). Secondly, removal of such a large range of species as bycatch, even at small levels, would have amplified effects in a coral reef ecosystem.

NWHI to carry an active Vessel Monitoring System (VMS) from being a Management Measure to the Framework Process. Current FMPs do not all require VMS usage in the NWHI and the data is not available to the State (even when these vessels are operating in NWHI State waters outside the jurisdiction of the WPRFMC). Contrasting this, the system proposed by the CRE Plan Team (and modeled after an existing system in place for all large vessels operating throughout the entire Great Barrier Reef) would be monitored round-the-clock by computer[7] and notification automatically sent to appropriate State and Federal agencies when a vessel enters a buffer zone, an off-limits MPA or State waters in the NWHI. Such a system would act as an early warning for both ship's captains and the State of approach and (if unheeded) entry into protected/State waters. VMS can accurately track vessel movements and provide certain information about prohibited fishing activities. The automatic notification provision is important as currently such information is NOT provided to the State of Hawai'i resource trustees, even by those WPRFMC vessels currently using VMS in the NWHI. Such an automated system, had it been in place, would have prevented both the Kure and Pearl & Hermes vessel groundings. Given the highly isolated nature of the NWHI, its expansiveness and the lack of monitoring or enforcement patrols, such a system may be one of the only mechanisms available for protection of natural resources in the NWHI from damage or unauthorized take. I would strongly encourage the WPRFMC to modify the DEIS to include a management measure requiring VMS (with automatic notification to appropriate resource trustees) for all fishing vessels operating in the NWHI.

ADDITIONAL POINTS RELATED SPECIFICALLY TO THE DEIS

While there are published figures for maximum reef growth and productivity occurring at depths of 5 – 15 m for calm waters, embayments and lagoons; such a number (as listed in the DEIS) is inaccurate and misleading for the vast majority of reefs under consideration for this plan as they represent federal waters offshore of oceanic island habitats under strong wave pressure. The result is that the majority of the reef growth (and productivity) occurs far deeper than 15 m for most of the areas under consideration for the CRE FMP. The DEIS should properly reflect this as it directly relates to such issues as depth contours for MPA designation and other management measures. Data from the recent multi-agency NOWRAMP expeditions support the above statements.

The arguments raised in the DEIS that many indigenous peoples are dependant on coral reef resources is true only to the extent that such resources occur in close proximity to islands where these people live; yet over 90% of the coral reef area covered by this plan occurs in remote locations where indigenous use is not an issue. That is not to say that such concerns are not appropriate to be raised in the DEIS along with concerns regarding adjacent fishing communities, and shore-based impacts on federal coral reef ecosystems. But with recognition that the vast majority of the coral reef area covered under the proposed CRE FMP lies in the NWHI where such issues are not really an issue; perhaps the Council should take the time to investigate the appropriateness of creating two separate CRE FMPs: one to deal with federal waters adjacent to inhabited islands in the U. S. Pacific, and a different CRE FMP to deal with the NWHI and the PRIAs. Such an approach would allow for better management of areas that require different approaches towards coral reef management. Such an approach would also allow for better involvement of local management agencies to focus on issues directly

[7] The current VMS system for longlining boats is not automated nor continuously monitored, hence the recent grounding incidents.

related to federal waters adjacent to their jurisdictions. Finally, such an approach would have the side benefit of elevating various island government's concerns within an FMP framework where they are not overwhelmed by the majority of the area (and focus of the FMP) being in the NWHI.

The designation of Habitat Areas of Particular Concern (HAPC) as it relates to Hawai'i needs to be modified as follows:

NWHI: All hard substrate down to a minimum of 25 fm[8], including all lagoonal habitats. As stated earlier, 10 fm is far too shallow for most coral reef habitat on exposed areas of the NWHI.

MHI (In General): ALL Offshore Islets (they're all sea bird refuges). Should also include waters adjacent to National Parks.

Kaua'i: Kaliu Point and Mana Reef.

Moloka'i: South and West Shore Reefs and Embayments.

Hawai'i: Kealakekua Bay is an MLCD. Need to include all Kona Coast FRAs.

The DEIS is misleading in a number of its statements and should be revised accordingly in terms of accuracy. For example the following statement occurs on page 25 (DEIS): "Approximately 80% of the coral reef area that would be managed under the CRE FMP (is) in the NWHI." On the next page is a chart which represents coral reef area; adding up the total coral reef area in federal waters of the NWHI and comparing it with the total for federal waters in the U. S. Pacific, one comes up with a figure of 87% for the NWHI coral reef area that would be managed under the CRE FMP. On the very next page (27, DEIS) is the statement: "By far the largest coral reef area in the EEZ is located in Hawaii (10,004 km^2), of which 90% is in the NWHI (9,124 km^2)." In the space of three adjacent pages, three completely different figures are given for the representative area of coral reef coverage; such inaccuracies question the validity of other information provided in this large DEIS. As such, I respectively suggest that the Council spend an appropriate amount of time reviewing this document for accuracy and consistency and then re-submitting the DEIS for public review.

Given the dramatic changes that have recently occurred in terms of the NWHI federal coral reef areas now under the new NWHI Coral Reef Ecosystem Reserve (NWHICRER), and given the statement (p. 139) that the "CRE FMP attempts to simplify regulations between areas by working to achieve consistent regulations across the various management regimes", there is recognition that the DEIS will need to be re-done to reflect the existing regulations of the NWHICRER. Specifically, the question is how the DEIS will be brought into compliance with the management measures outlined in the Presidential Executive Order for the NWHICRER.

While significant progress has been made on this plan, **the majority of the Council's preferred measures still exempt all other species-level FMPs** from regulation under this ecosystem-level FMP. That view, if maintained by the Council, will continue to be a barrier to the CREFMP functioning as a fisheries management plan of coral reef resources at an ecosystem level. Perhaps of greater importance, such exclusion serves as a barrier to meeting the Council's "Need for Action' (p. 15,DEIS) which states that the CRE FMP is needed:

[8] This should be set to 100 fm in order to be in compliance with the new NWHI Coral Reef Ecosystem Reserve.

-"To anticipate and avoid potential damage to essential and non-renewable coral reef habitat." **Such habitat is currently being impacted in the NWHI by existing WPRMC fisheries which are exempt from most provisions of this plan.**

-"To address the secondary effects of all reef-related fisheries on non-target coral reef resources, thereby encouraging ecosystem-scale management." **This cannot occur if the existing fisheries are exempt from regulation under this plan, and therefore such secondary effects cannot be managed.**

This takes on even stronger repercussions with the realization that the NWHI coral reef **ecosystems are often continuous from State waters into those under WPRFMC control.** The ability to effectively and sustainably manage all[9] coral reef resources in the NWHI may be negatively impacted by the Council's preferred CREFMP as it currently exists and therefore I encourage the Council to strongly consider the recommendations I've listed above in order to help mitigate this concern.

Once again thank you for the opportunity to provide comments on the DEIS. If you have any questions, or I can be of any further assistance, please contact me at 587-0318.

Sincerely,

Dave Gulko, CRE FMP Plan Team Member

Cc: NMFS, Regional Administrator SW Region
NMFS OPR
NMFS Honolulu Office
USFWS Honolulu Office
DLNR Chairperson's Office

[9] Both State and Federal.

Comparison Between Major Provisions of the WPRFMC's Coral Reef Ecosystem FMP (Preferrred Alternative) and the New NWHI Coral Reef Reserve Established by Presidential Executive Order 13178

Prepared by Dave Gulko
WPRFMC Coral Reef Ecosystem Fishery Management Plan Team Member

Management Concerns	WPRFMC Preferred Alternative	NWHI Coral Reef Reserve/EO
Stated Principle Purpose of Each Plan	"To foster sustainable use of multi-species resources in an ecologically and culturally sensitive manner, through the use of the precautionary approach and ecosystem-based resource mgmt."	"To ensure the comprehensive, strong, and lasting protection of the coral reef ecosystem and related marine resources and species of the NWHI."
Advisory Council Make-up In Terms of User Group Representation (Note: both councils have commercial and recreational fisher representatives)	There are no native Hawaiian group NGO, environmental NGO, non-federal marine scientists, tourism industry representatives, or marine educators in voting positions on the Western Pacific Regional Fisheries Mgmt Council.	There are three native Hawaiian group NGO, three environmental NGO, three non-federal marine scientists, one tourism industry representative, and one marine educator in voting positions on the NWHI Reserve Council.
Advisory Council Make-up In Terms of Management Agency Representation Note: NWHI Reserve Council provides for WPRFMC participation on its council, WPRFMC does not currently provide for NWHI Reserve participation on its council.	State of HI Dept. Land & Nat'l Resources (Voting) Nat'l Marine Fisheries Service (Voting) US Fish & Wildlife Service (Non-voting) US Coast Guard (Non-voting) US Dept. of State (Non-voting)	State of HI Dept. Land & Nat'l Resources (Voting) Marine Mammal Commission (Non-voting) Nat'l Marine Fisheries Service (Non-voting) Nat'l Marine Sanct. Prog. (Non-voting) US Coast Guard (Non-voting) US Dept. of State (Non-voting) US Dept. of Defense (Non-voting) US Fish & Wildlife Service (Non-voting) WPRFMC (Non-voting)
Advisory Council Make-up In Terms of Outside (HI) Agency Representation with Voting Power on NWHI Issues	Three from American Samoa (Voting) Two from Guam (Voting) Two from CNMI (Voting) Note: At least 7/13 voting members are from areas outside Hawai'i.	None. Note: All 15 voting members are from Hawai'i.
Limited-use MPA Coverage Under Each Plan (i.e Area of Coverage of Each Plan)	50 fm isobath extending out past 3 nm from the centers of each prominent NWHI atoll, island or shoal.	50 nm out from centers of each prominent NWHI atoll, island or shoal; excludes first 3 nm of State waters around emerged islets and islands.

Management Concerns	WPRFMC Preferred Alternative	NWHI Coral Reef Reserve/EO
General Proposed No-Take MPA Depth Profiles	10 fm (60') for most areas.	100 fm (600') for most areas; though exempts grandfathered bottomfishers and certain trawling from 25 – 100 fm in most areas.
No-Take MPA Sites (Limits of No-Take MPA by Depth) Note: Coral reefs on the outsides of each of the atolls, islands and shoals are thought to have most of their living coral abundance below 10 fm (60') due to wave exposure. GBF = Grandfathered Bottomfishers	Kure (10 fm = 60') Midway (50 fm = 300') – North half only Pearl & Hermes (10 fm = 60') Lisianski (10 fm = 60') Laysan (50 fm = 300') Maro (10 fm = 60') Gardner Pinnacles (10 fm = 60') French Frigate Shoals (50 fm = 300') Necker (10 fm = 60') Nihoa (10 fm = 60')	Kure (100 fm = 600') Midway – not covered Pearl & Hermes (100 fm = 600') Lisianski (100 fm = 600', 25 fm = 150' for GBF) Laysan (100 fm = 600', 50 fm = 300' for GBF) Maro (100 fm = 600', 25 fm = 150' for GBF) Gardner Pin. (100 fm = 600', 25 fm =150' for GBF) French Frigate Shoals (100 fm = 600') Necker (100 fm = 600', 25 fm = 150' for GBF) Nihoa (100 fm = 600', 25 fm = 150' for GBF)
Coral Reef Species Covered Under Each Plan	Includes all coral reef species EXCEPT those covered under other WPRFMC plans regardless of their role in the coral reef ecosystem. Species currently exempted from protection under this plan include: Jacks, Groupers, Snappers, Certain Sharks, and Lobsters.	Includes all species; unclear which species of bottomfish or recreational fish may be exempted (presume it's only those species for which catch records exist for the last five years).
Lobster Fishery	Exempts existing lobster fishery from all rules except No-Take MPAs.	Closed within the Reserve based on 0 level of fishing in 2000.
Bottomfish Fishery	Exempts existing bottomfish fishery from all rules except No-Take MPAs.	Must follow all rules and regulations. Fishery limited to those permit holders which have fished in the NWHI during the last 5 years, cap is average of last 5 year's take.
Precious Coral Fishery	Exempts existing precious coral fishery from all rules except No-Take MPAs.	Closed within the Reserve based on 0 level of fishing in 2000.
Gear Restrictions	Prohibits habitat-destructive and non-selective gear use BUT EXEMPTS EXISTING Lobster, Bottomfish and Precious Coral Fisheries that may use such gear. Allows use of fish traps, surround nets and seine nets.	Severely limits any new gear types for grandfathered bottomfishers and recreational fishery. Allows limited gear types for research, management and native Hawaiian gathering uses. All other gear use prohibited.

Management Concerns	WPRFMC Preferred Alternative	NWHI Coral Reef Reserve/EO
Bioprospecting	Allows for harvesting of corals and rare reef species in the NWHI through use of permit.	As currently stated, bioprospecting is not an allowed activity within the Reserve.
Marine Ornamental Collection	Allows for expanding the marine ornamental industry to the NWHI through use of permit.	As currently stated, marine ornamental collection is not an allowed activity within the Reserve.
Vessel Monitoring System (VMS) Requirements	Currently only applies to Longline fishery, all others exempt. Existing VMS system is non-automated and restricted in terms of its use for enforcement, early warning and management.	Calls for use of VMS for all vessels entering or transiting the Reserve if warranted.
Recreational Fishing	Prohibits SCUBA spearfishing at night. Requires permit for recreational fishing at Midway. Limits gear use.	All currently existing levels of recreational fishing effort are capped at 2000 levels outside of No-Take MPAs. Limits gear use.
Native Hawaiian Uses	Allows new fisheries and fishing by indigenous people under special permit. Allows harvest of live rock and coral under permit (even though the products would be brought back into State waters and may be in conflict with existing State law).	Native Hawaiian non-commercial subsistence, cultural, or religious uses may continue, to the extent consistent with existing law, within the Reserve and Reserve Preservation Areas.
Bycatch	Provides no protection for bycatch caused by existing lobster, bottomfish, precious coral or recreational fisheries. Note: Over 190 bycatch species have occurred in recovered traps in the NWHI lobster fishery.	Eliminates bycatch except that occurring by grandfathered bottomfishers and recreational fishing. Provides for oversight and modification to reduce bycatch.
Habitat Damage	Provides no protection for habitat damage caused by existing lobster, bottomfish, precious coral or recreational fisheries.	Eliminates habitat destruction except that occurring by grandfathered bottomfishers and recreational fishing. Provides for oversight and modification to reduce habitat damage.
Discharge of Materials	No authority to regulate.	Regulates discharge of materials into Reserve waters.
Non-Fishing Activities	No authority to regulate.	Regulated much like a National Marine Sanctuary where activities are assessed for their impact on the Reserve.

Environmental Defense

To:	Western Pacific Fisheries Management Council	**From:**	Stephanie Fried, Rod Fujita
Fax:		**Pages:**	14 + cover
Phone:		**Date:**	February 26, 2001
Re:	CREFMP	**CC:**	

☐ **Urgent** ☐ **For Review** ☐ **Please Comment** ☐ **Please Reply** ☐ **Please Recycle**

Aloha,

Enclosed please find our comments on the Draft CREFMP.

COMMENTS OF ENVIRONMENTAL DEFENSE

CONCERNING

THE DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR CORAL REEF ECOSYSTEMS OF THE WESTERN PACIFIC REGION

February 26, 2001

Contacts:

Rod Fujita, Ph.D – Marine Ecologist
Environmental Defense – Western Regional Office

Stephanie Fried, Ph.D – Sociologist
Environmental Defense – Hawaii Project Office

Environmental Defense is a leading environmental organization combining science, law, and economics to achieve lasting solutions to environmental problems, with over 300,000 members. **Environmental Defense opposes implementation of the Coral Reef Ecosystem Fishery Management Plan (CREFMP) for the following reasons:**

EIGHTY-FIVE PERCENT OF CREFMP MANAGEMENT AREA IS IN THE NORTHWESTERN HAWAIIAN ISLANDS, YET THE NWHI EXECUTIVE ORDERS ARE IGNORED, AND WOULD BE WEAKENED BY THE PROPOSED CREFMP

For close to one year, there has been a broad-based public process to develop Executive Orders 13196 and 13178 (EO) pertaining to the management of the coral reefs in the Northwestern Hawaiian Islands (NWHI). The Western Pacific Regional Fisheries Management Council (Wespac) has been deeply involved in this process. There were ten hearings throughout the state of Hawai'i during this period and over 9,000 people submitted written comments to the Secretary of Commerce. According the Draft CREFMP, close to 85% of the reefs under the jurisdiction of this CREFMP (and 90% of the reefs in Hawai'i) are located in the NWHI (Vol. I, p.26). Nonetheless, the CREFMP makes little reference to the regulations contained in the Executive Order, which are now law. It is as if the Executive Orders do not exist and have no effect on coral reef management in the NWHI.

The CREFMP not only ignores many provisions of the NWHI Executive Order, but replaces some of the protective measures of the EO with less protective measures. It ignores the authority of the NWHI Coral Reef Ecosystem Council. The EOs, which are now law, require the NWHI management entity to have as its primary goal ensuring "the long term conservation and protection of the coral reef ecosystem and related marine resources and species of the NWHI in their natural character." This is stronger and of a different orientation than the CREFMP's goal to "foster sustainable use of multi-species resources."

The EOs limit catches to recent, existing levels of take and effort. The EOs allow existing bottomfishers to continue fishing throughout the NWHI for their economic lifetimes,

through a series of non-transferable permits reflecting the five-year catch history of the fishers. The EOs allow for designation of a coherent network of marine protected areas based on the best available science, whereas the MPAs proposed in the CREFMP appear to be sited primarily to minimize short-term economic impacts. For example, according to Wespac spokesmen, the CREFMP preference for a no-take MPA at Midway Island instead of at fragile Kure Atoll reflects primarily the fact that commercial fishing interests wished to retain their access to Kure and did not see much economic benefit from fishing at Midway. The recent six week long scientific expedition to the NWHI in 2000 found massive coral colonies at Kure —some 30 feet tall – which may be over one thousand years old. The decision to designate a no-take MPA at Midway but not at Kure does not reflect the latest scientific findings.

Under the EOs, as a result of lack of effort and catch in the NWHI lobster and precious corals fisheries during the last year, those fisheries are now permanently closed. The CREFMP, however, appears to assume that those fisheries are still open and lists lobster traps as an allowable gear type for the NWHI.

The EOs provide for management oversight by a carefully balanced Reserve Council more fully representative of the broad range of interests in coral reef protection than is Wespac. The NWHI Reserve Council includes scientists, Kanaka Maoli (indigenous Hawaiian) cultural practitioners, recreational and commercial fishers, ocean tourism operators, and environmentalists as direct members of the Council, not as members of relatively powerless advisory bodies to the Council. Unlike Wespac, the Reserve Council is subject to stringent conflict of interest regulations. NWHI Council members may be removed for conviction of a felony offense, violations of National Marine Sanctuaries Act, Marine Mammal Protection Act, the Migratory Bird Treaty Act, the Endangered Species Act, the Magnuson-Stevens Fishery Conservation and Management Act, or other environmental laws under NOAA's jurisdiction. Unlike Wespac, NWHI Council members who have a financial, personal, or business interest in any matter before the Council or a subcommittee must identify such interest prior to discussion and voting on such matter. In addition, no NWHI Council member may cast a vote on any matter that would provide a direct financial benefit to that member or otherwise give the appearance of conflict of interest under Federal law. The regulations governing the NWHI Council are designed to avoid the conflict of interest problems that have plagued Wespac's operations for years.

Instead of requesting its scientists and consultants to ensure that the CREFMP was consistent with the aims, goals, and regulations of the NWHI EOs, Wespac has invested time and taxpayers' funds in attempts to block or weaken the EOs and in producing misleading documents and "fact sheets" on the NWHI EOs. For example, the February 13, 2001 documents titled "Economic Losses to Bottomfish Fishery as a Result of Executive Order 13196" versions I and II (enclosed) claim -- falsely – that the EOs close Nihoa, Necker, Gardner Pinnacles, Maro Reef, and Lisianski to bottomfishing. According to Wespac "bottomfish gear is lowered at depths ranging form 50 – 150 fathoms."[1] The islands and reefs listed above are open under the EOs to bottomfishing by permit holders at depths from 25 fathoms and deeper, i.e. for the range of the bottomfish fishery. The CREFMP proposes no take zones for the above sites in waters shallower than 10 fathoms. Actually

[1] Wespac, "Summary of the NWHI Bottomfish Fishery," 11/27/00

most of these areas are already closed from 0 to between 10 and 20 fathoms under the Hawaiian Islands National Wildlife Refuge. Wespac claims that the Executive Orders close Laysan Island to bottomfishing. The EOs actually close Laysan to bottomfishing in waters shallower than 50 fathoms, which is what Wespac also proposes in the CREFMP. In its assessment of the "economic impacts" of the EOs on the bottomfish fishery, Wespac does not note its own plans for no take MPAs in the same region. By exaggerating the area closed – i.e. declaring 5 areas left open by the EOs as closed to fishing – by neglecting to mention its own plans for closures in parts of those areas, and existing 10 and 20 fathom closures under the Hawaiian Islands National Wildlife Refuge, and by attributing the loss of the entire bottomfish catch to areas closed from 0 – 25 fathoms, Wespac has wasted taxpayers' funds on a bizarre and unscientific assessment of NWHI resources.

For example, in its "Economic Losses" document, Wespac concludes that the entire take of Necker bottomfish, representing 67% ($157,837) of the Mau Zone fishery, is lost as a result of the E.O. However, this is based on the false assumption that the EOs "close" Necker Island to bottomfishing. The US Fish and Wildlife has historically closed Necker from 0 to 20 fathoms; the EO specifies that Necker is open to bottomfishing from depths of 25 fathoms and deeper; and the CREFMP would close it from 10 fm. It is interesting to note that a November, 2000 Wespac document states that the "economic performance of Mau zone vessels has been generally poor during the 1990s. Analyses... suggest that vessels were, on average, experiencing annual net losses of $7,827 per vessel prior to limited access" and that Wespac's limited access program still resulted in "negative net benefits" to bottomfishers. Their break-even analysis suggested that "the average vessel would have to fish 107 days per year or approximately three times the current average" to break even. "At this level of effort, the fishery could only support three or four vessels."[2]

To make matters worse, in Version I of "Economic Losses to the Bottomfishery as a Result of the Executive Order" presented at Wespac's February, 2001 meeting, Wespac appears to have overestimated the economic losses resulting as a result of NWHI closed areas mandated in the EO. For example, the claim is made that

Gardner Pinnacles are "closed" to bottomfishers; that they represent 8.6% of the total bottomfish revenue, with a value of $67,577;

Maro Reef is "closed" to bottomfishers; represents 5.9% of total NWHI bottomfish revenue, valued at $41,366;

Brooks Bank is closed to bottomfishers; represents 5.9% of total NWHI bottomfish revenue, valued at $64,458;

Lisianski is "closed" to bottomfishers; represents 10.2% of total bottomfish revenue lost, valued at $73,119;

The total loss to the Ho`omalu Zone bottomfish fishery is estimated at 56.7% of the total fishery or $419,708.

[2] Wespac, "Draft Measure to Establish Eligibility Criteria for New Entry into the NWHI Mau Zone Limited Access System." 11/17/00 pages 12, 13

The numbers don't add up. When Environmental Defense pointed out the significant flaws in Wespac's analysis, Wespac hurriedly issued a "revised" table of "economic losses." Despite our input and provision of information concerning the open status of the regions claimed "closed" by Wespac, none of the designations of "closed" areas were changed at all in the Wespac calculations, yet every single dollar amount of landings at each of the regions throughout the NWHI Ho`omalu Zone was altered, some amounts were increased, others decreased. No information was provided on the derivation of these numbers. Wespac stuck to its initial conclusion that 56.7% of the Ho`omalu Zone bottomfish fishery's economic value was "lost" as a result of the EO, but this amount was now increased to $463,341.

It is interesting to note that a November, 2000 Wespac document states that negative impacts on the regional economy of the permanent closure of the NWHI bottomfish fishery "would be minimal, as the contribution of the NWHI bottomfish fishery to overall economic activity in Hawai`i is small."[3]

WESPAC TRACK RECORD IN THE NWHI

Wespac has a clear track record in coral reef ecosystem management in the NWHI, one that should preclude it from taking a leadership role in NWHI ecosystem governance. The NWHI lobster fishery – now excluded from the CREFMP and apparently allowed to continue under Wespac's Crustaceans FMP -- is a case in point. In 1983, after identifying the MSY for NWHI spiny lobster at 300,000 lobster per year:[4][5]

Wespac allowed 5 times (500%) of the MSY to be harvested in: 1985,1989
Wespac allowed 4 times (400%) of the MSY to be harvested in: 1986,1990
Wespac allowed 3 times (300%) of the MSY to be harvested in: 1984
Wespac allowed double & almost triple of the MSY to be harvested in: 1987 and 1992
Wespac allowed 117% of MSY to be harvested in 1991

Between 1983 and 1992 there was only 1 year (1983) where the MSY or less was harvested from the NWHI. In 1993, the fishery crashed and was closed down. Wespac now claims that a "climate-induced reduction in overall ocean productivity" led to the crash. Wespac re-opened it in 1994 and the harvests never recovered. In 1996, Wespac changed its regulations to allow the take of females with eggs and undersized juveniles. It should be noted that lobsters may take seven years to reach sexual maturity. In 1983, fishermen could trap over 3 lobsters per trap; by 1999, they had to set 3 traps to catch one lobster.

In addition, in the back pages of Volume I of the CREFMP (Vol. I, page 324) it is noted that observers found that "pieces of live coral and entire coral heads are caught in some lobster traps and groundline and landed on board the lobster vessel. One observer noted that 'small broken pieces of coral were frequently (as many as one piece per five traps) ? wedged in the

[3] Wespac, "Preliminary Draft EIS, Bottomfish and Seamount Groundfish Fishery in the Western Pacific Region," November 2, 2000, page 2-22
[4] NMFS, "The Present Status of the Spiny Lobster Fishery in Hawaiian Waters," 1981.
[5] NMFS, chart page 3, Table 2, "NWHI lobster fishing effort (trap-hauls) and catch & catch rates by species, 1983-1998."

holes of the traps. Numerous softball-sized and a few basketball sized whole coral heads came up stuck to the mainline."

Dr. James Maragos, one of the world's leading authorities on Pacific Island coral reefs led the October, 2000 interagency scientific expedition to the NWHI. According to Dr. Maragos, "The lobster fishery has not been managed properly and is depleted in the Northwestern Hawaiian Islands. ... The fishery is closed for a good reason: there are no lobsters out there. In our observations during our September-October, 2000 cruise, we found very few lobsters in our surveys of over 170 sites. ... It's clear that management was deficient. This was a virgin fishery in 1980 and has since been fished down to the point where it is now depleted."

SPECIFIC COMMENTS ON THE CREFMP

- The CREFMP exempts species covered by existing FMPs including crustaceans, bottomfish, and precious corals. Given the fact that species in these groups fulfill many different ecological functions, their exclusion from the CREFMP does not make sense. As such, the CREFMP cannot be considered an ecosystem plan. Relegation of their management to separate FMPs simply continues conventional single-species management.

- The practical result of the exemption of several commercially valuable species from the CREFMP is that the proposed MPAs would constitute the sole ecosystem protection mechanism in the CREFMP. If multiple benefits of the MPAs are to be realized, the total size of the MPA network should be considerably larger as a percentage of management area than the 14% proposed in the CREFMP, especially if fishery enhancement and insurance benefits are expected. For example, the science advisory panel to the Channel Islands marine reserves working group recommended that 30%-50% of all major habitat types around the islands be protected within no-take marine reserves in order to realize biodiversity, ecosystem health, and fishery management benefits.

- Council-authorized vessels have run aground in the NWHI two times in the last two years, yet there specific actions are not taken in the CREFMP to prevent more groundings. Actions could include requirement of automatic 24 hour/7day VMS systems which report to several agencies and to the ship's captain when approaching an MPA, reef, bank, or atoll; the loss of permit privileges as result of careless vessel operation.

- The CREFMP proposes that vessels carry insurance for vessel removal, pollution liability and possibly mitigation in the event of grounding "depending on the category of vessel, type of permit, and fishing area." The requirement for vessel insurance is not clear, straight-forward, or applied across the board. It also does not guarantee sufficient finance for mitigation. With loopholes such as these, this measure is likely to prove ineffective.

- The CREFMP claims that it would establish no-take MPAs in federal waters (seaward of 3 nautical miles from islands and atolls), extending for the most part to 10 fathoms. In three cases – one of the Midway Island, located outside the NWHI Reserve – the MPAs are extended to 50 fathoms. The Council appears to ignore not only the EO MPAs but also U.S. Fish and Wildlife's claim that the Hawaiian Islands National Wildlife Refuge areas – 10 fathoms around most of the NWHI, 20 fathoms at Necker, are already closed. The CREFMP's proposed closure to 10 fathoms at Necker appears to be an attempt to weaken both the existing Refuge and the NWHI Coral Reef Ecosystem Reserve established by the EOs.

- The CREFMP does not include measures to control or even measure total fishing mortality. MSY critical points and a harvest policy are described, to meet the requirements of the Magnuson Stevens Act, but do not appear to be implemented in the CREFMP.

- The CREFMP includes pursenets and lobster traps (despite the fact that the EO closes the lobster fishery) in its list of allowable "selective" gears. NMFS found 197 species of bycatch associated with lobster traps in the NWHI. Under the CREFMP allowable gear types, bycatch and discard mortality is inevitable, and much will probably go unreported. The CREFMP prohibits the use of SCUBA and spearguns at night – often used to target large predator species -- but allows this practice during the day. This situation can lead to overfishing of less productive species, some of which may not be assessed or even studied in any way. Incentives for bycatch reduction could include deduction of bycatch mortality from allowable catch; however, this is unworkable under the CREFMP because no catch limits are established.

- Wespac's own Coral Reef Ecosystem Plan Team – consisting of top coral reef scientists – called for specific protection – i.e. prohibitions on take – for napoleon wrasse, giant clam, and bumphead parrotfish. The CREFMP does not take action on these suggestions and allows, instead, Wespac to decide on the issuance of permits for take throughout the CREFMP region.

- The CREFMP does not include any measures to control fishing capacity, which has proven to be the bane of many fisheries. It relies solely on gear and use restrictions and permits. Increased numbers of vessels or individuals using the allowable gear types could increase fishing pressure and fishing mortality.

- The CREFMP fails to adequately cap the number of vessels or individuals fishing under special permits for unassessed species. A truly precautionary policy would strictly limit the number of such vessels or individuals to the minimum number required to collect data essential for stock assessment. This is especially important in coral reefs, due to the high vulnerability of many coral reef species to overexploitation as a result of life history, behavioral, and aggregation characteristics. Under the CREFMP preferred alternative, for example, Wespac allows itself to issue permits for "experimental fishing" in no-take MPAs. This could be abused to allow "experimental take" of lobster in fragile and closed areas, despite the closure of the lobster fishery under the EO.

- The CREFMP gives a high level of discretion to WESPAC with regard to the issuance of special use permits, creating a high potential for abuse (e.g., issuance of too many permits, issuance of permits for fishing that may damage habitat or result in excessive fishing mortality or bycatch, etc.).

- The CREFMP would lump many species into broad categories (Currently Harvested Coral Reef Species, Potentially Harvested Coral Reef Species). Lumping species in this way can mask overfishing, lead to unintentional overfishing through undocumented bycatch/discard mortality, and result in ecosystem overfishing (alteration of trophic structure or other ecosystem structural or functional attributes).

- The CREFMP does not require VMS at the outset, but rather would add a VMS requirement contingent on full federal funding and further WESPAC action. Automatic 24 hour/7 day VMS should be required equipment on any vessel fishing within the management area, because VMS appears to be the most effective way to enforce the boundaries of MPAs, the most important ecosystem management tool proposed either in the CREFMP or in the NWHI EOs. VMS should be utilized to alert State and Federal agencies and the ship's captain when a vessel enters a buffer zone surrounding an MPA or State waters. Furthermore, VMS should not be contingent on full federal subsidy. At least part of the costs of VMS may be borne by fishermen, in return for the privilege of using the public trust for private gain. It is interesting to note that the Coral Reef Ecosystem Plan Team recommended that vessels in the NWHI carry active VMS. In the CREFMP, VMS has been downgraded from a primary Management Measure to the later, slower framework process. In addition, current FMPs apparently do not all require VMS use in the NWHI. Council VMS data is apparently not available to the State of Hawai'i, even for vessels in NWHI State waters. Clearly, there is a need for automatic VMS which sends signals to several parties, including the State of Hawai'i and the captain of the vessel.

- The CREFMP (p. 259) states that allowable catch in the NWHI cannot be divided into individual levels, pursuant to the national moratorium on Individual Transferable Quotas. However, other Councils routinely divide allowable catches into trip limits for individual vessels, leaving some percentage (usually about 25%) of the allowable catch unallocated ("overhead") to prevent the trip limits from being designated as ITQs.

SPECIFIC COMMENTS ON THE REGULATORY FLEXIBILITY ANALYSIS

- The estimated existence and non-market net present values for healthy coral reefs in the proposed management area ($5-19 billion) appear to greatly exceed anticipated net present values of fish catches ($0-175 million).

- The existence value is defined in terms of fishing opportunity only. Ecosystem services provided by coral reefs can be extremely valuable (estimated net present value of $7.47 per square meter in 1999 dollars). In addition, members of environmental groups and other citizens place a high value on pristine areas (according to recent surveys), even if they cannot visit them.

SPECIFIC COMMENTS ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT

- Given how little is known about the vulnerability of many coral reef species to overexploitation and about the impacts of fishing on coral reef structure and function, the primary management principle should be conservation of biodiversity and ecosystem integrity, with allowance of uses compatible with that overarching goal. In contrast, the overarching goal of the CREFMP seems to be sustainable use, accomplished primarily through the protection of the status quo with the exception of new MPAs. Many of the new MPAs proposed in the CREFMP are simply overlays of existing HINW Refuge boundaries and unfortunately may not protect many of the most sensitive and ecological important habitats within the management area. The CREFMP MPAs are, for the most part, inconsistent with the protected area boundaries delineated by the EOs.

- The DEIS focuses exclusively on negative economic impacts of conservation and management measures, and neglects the positive impacts of such measures, such as long-term economic sustainability, insurance against management failures or errors, scientific research, fishery enhancement by no-take MPAs, tourism potential, existence value (defined broadly), etc.

Enclosures:

"Comparison between major provisions of the CREFMP and the NWHI Coral Reef Reserve Established by Presidential Executive Order"

"Economic Losses to Bottomfish fishery as a Result of Executive Order 13196", versions I and II

Comparison Between Major Provisions of the WPRFMC's Coral Reef Ecosystem FMP (Preferrred Alternative) and the New NWHI Coral Reef Reserve Established by Presidential Executive Order 13178

Prepared by Dave Gulko

Management Concerns	WPRFMC Preferred Alternative	NWHI Coral Reef Reserve/EO
Stated Principle Purpose of Each Plan	"To foster sustainable use of multi-species resources in an ecologically and culturally sensitive manner, through the use of the precautionary approach and ecosystem-based resource mgmt."	"To ensure the comprehensive, strong, and lasting protection of the coral reef ecosystem and related marine resources and species of the NWHI."
Advisory Council Make-up In Terms of User Group Representation (Note: both councils have commercial and recreational fisher representatives)	There are no native Hawaiian group NGO, environmental NGO, non-federal marine scientists, tourism industry representatives, or marine educators in voting positions on the Western Pacific Regional Fisheries Mgmt Council.	There are three native Hawaiian group NGO, three environmental NGO, three non-federal marine scientists, one tourism industry representative, and one marine educator in voting positions on the NWHI Reserve Council.
Advisory Council Make-up In Terms of Management Agency Representation Note: NWHI Reserve Council provides for WPRFMC participation on its council, WPRFMC does not currently provide for NWHI Reserve participation on its council.	State of HI Dept. Land & Nat'l Resources (Voting) Nat'l Marine Fisheries Service (Voting) US Fish & Wildlife Service (Non-voting) US Coast Guard (Non-voting) US Dept. of State (Non-voting)	State of HI Dept. Land & Nat'l Resources (Voting) Marine Mammal Commission (Non-voting) Nat'l Marine Fisheries Service (Non-voting) Nat'l Marine Sanct. Prog. (Non-voting) US Coast Guard (Non-voting) US Dept. of State (Non-voting) US Dept. of Defense (Non-voting) US Fish & Wildlife Service (Non-voting) WPRFMC (Non-voting)
Advisory Council Make-up In Terms of Outside (HI) Agency Representation with Voting Power on NWHI Issues	Three from American Samoa (Voting) Two from Guam (Voting) Two from CNMI (Voting) Note: At least 7/13 voting members are from areas outside Hawai'i.	None. Note: All 15 voting members are from Hawai'i.
Limited-use MPA Coverage Under Each Plan (i.e Area of Coverage of Each Plan)	50 fm isobath extending out past 3 nm from the centers of each prominent NWHI atoll, island or shoal.	50 nm out from centers of each prominent NWHI atoll, island or shoal; excludes first 3 nm of State waters around emerged islets and islands.

Management Concerns	WPRFMC Preferred Alternative	NWHI Coral Reef Reserve/EO
General Proposed No-Take MPA Depth Profiles	10 fm (60') for most areas.	100 fm (600') for most areas; though exempts grandfathered bottomfishers and certain trawling from 25 – 100 fm in most areas.
No-Take MPA Sites (Limits of No-Take MPA by Depth) Note: Coral reefs on the outsides of each of the atolls, islands and shoals are thought to have most of their living coral abundance below 10 fm (60') due to wave exposure. GBF = Grandfathered Bottomfishers	Kure (10 fm = 60') Midway (50 fm = 300') – North half only Pearl & Hermes (10 fm = 60') Lisianski (10 fm = 60') Laysan (50 fm = 300') Maro (10 fm = 60') Gardner Pinnacles (10 fm = 60') French Frigate Shoals (50 fm = 300') Necker (10 fm = 60') Nihoa (10 fm = 60')	Kure (100 fm = 600') Midway – not covered Pearl & Hermes (100 fm = 600') Lisianski (100 fm = 600', 25 fm = 150' for GBF) Laysan (100 fm = 600', 50 fm = 300' for GBF) Maro (100 fm = 600', 25 fm = 150' for GBF) Gardner Pin. (100 fm = 600', 25 fm =150' for GBF) French Frigate Shoals (100 fm = 600') Necker (100 fm = 600', 25 fm = 150' for GBF) Nihoa (100 fm = 600', 25 fm = 150' for GBF)
Coral Reef Species Covered Under Each Plan	Includes all coral reef species EXCEPT those covered under other WPRFMC plans regardless of their role in the coral reef ecosystem. Species currently exempted from protection under this plan include: Jacks, Groupers, Snappers, Certain Sharks, and Lobsters.	Includes all species; unclear which species of bottomfish or recreational fish may be exempted (presume it's only those species for which catch records exist for the last five years).
Lobster Fishery	Exempts existing lobster fishery from all rules except No-Take MPAs.	Closed within the Reserve based on 0 level of fishing in 2000.
Bottomfish Fishery	Exempts existing bottomfish fishery from all rules except No-Take MPAs.	Must follow all rules and regulations. Fisbery limited to those permit holders which have fished in the NWHI during the last 5 years, cap is average of last 5 year's take.
Precious Coral Fishery	Exempts existing precious coral fishery from all rules except No-Take MPAs.	Closed within the Reserve based on 0 level of fishing in 2000.
Gear Restrictions	Prohibits habitat-destructive and non-selective gear use BUT EXEMPTS EXISTING Lobster, Bottomfish and Precious Coral Fisheries that may use such gear. Allows use of fish traps, surround nets and seine nets.	Severely limits any new gear types for grandfathered bottomfishers and recreational fishery. Allows limited gear types for research, management and native Hawaiian gathering uses. All other gear use prohibited.

Management Concerns	WPRFMC Preferred Alternative	NWHI Coral Reef Reserve/EO
Bioprospecting	Allows for harvesting of corals and rare reef species in the NWHI through use of permit.	As currently stated, bioprospecting is not an allowed activity within the Reserve.
Marine Ornamental Collection	Allows for expanding the marine ornamental industry to the NWHI through use of permit.	As currently stated, marine ornamental collection is not an allowed activity within the Reserve.
Vessel Monitoring System (VMS) Requirements	Currently only applies to Longline fishery, all others exempt. Existing VMS system is non-automated and restricted in terms of its use for enforcement, early warning and management.	Calls for use of VMS for all vessels entering or transiting the Reserve if warranted.
Recreational Fishing	Prohibits SCUBA spearfishing at night. Requires permit for recreational fishing at Midway. Limits gear use.	All currently existing levels of recreational fishing effort are capped at 2000 levels outside of No-Take MPAs. Limits gear use.
Native Hawaiian Uses	Allows new fisheries and fishing by indigenous people under special permit. Allows harvest of live rock and coral under permit (even though the products would be brought back into State waters and may be in conflict with existing State law).	Native Hawaiian non-commercial subsistence, cultural, or religious uses may continue, to the extent consistent with existing law, within the Reserve and Reserve Preservation Areas.
Bycatch	Provides no protection for bycatch caused by existing lobster, bottomfish, precious coral or recreational fisheries. Note: Over 190 bycatch species have occurred in recovered traps in the NWHI lobster fishery.	Eliminates bycatch except that occurring by grandfathered bottomfishers and recreational fishing. Provides for oversight and modification to reduce bycatch.
Habitat Damage	Provides no protection for habitat damage caused by existing lobster, bottomfish, precious coral or recreational fisheries.	Eliminates habitat destruction except that occurring by grandfathered bottomfishers and recreational fishing. Provides for oversight and modification to reduce habitat damage.
Discharge of Materials	No authority to regulate.	Regulates discharge of materials into Reserve waters
Non-Fishing Activities	No authority to regulate.	Regulated much like a National Marine Sanctuary where activities are assessed for their impact on the Reserve.

Economic Losses to Bottomfish fishery as a Result of Executive Order 13196

REV

February 13, 2001

(Source NMFS NWHI Bottomfish Data 1997-1999)

Zone	Bank	Fishing Status [1]	% of total bottomfish revenue lost	Value ($) of landings sold [2]
Ho'omalu	66 fathom bank	Closed	0.8	$ 5,889.09
Ho'omalu	French Frigate Shoals	Closed	6.5	$ 49,453.75
Ho'omalu	Brooks bank	Closed	5.9	$ 64,458.60
Ho'omalu	St. Rogatien	Open	0	0
Ho'omalu	Gardner Pinnacles	Closed	8.6	$ 67,577.48
Ho'omalu	Raita bank	Open	0	0
Ho'omalu	Maro Reef	Closed	5.9	$ 41,366.53
Ho'omalu	Laysan Island	Closed	2.3	$ 24,347.32
Ho'omalu	N.Hampton	Closed	0	0
Ho'omalu	Pioneer bank	Open	0	0
Ho'omalu	Lisianski	Closed	10.2	$73,119.06
Ho'omalu	Pearl & Hermes	Closed	3.2	$ 20,115.32
Ho'omalu	Salmon bank	Open	0	0
Ho'omalu	Ladd	Open	0	0
Ho'omalu	Nero	Open	0	0
Ho'omalu	Kure	Closed	13.3	$73,381.32
	HO'OMALU TOTAL		**56.7 %**	**$419,708.47**
Mau	Nihoa Island	Open	0	0
Mau	Twin banks	Open	0	0
Mau	Necker Island	Closed	67.09	$ 157,837.99
	MAU TOTAL		**67.09 %**	**$ 157,837.99**

Converting depth based area closures to "straight line boundaries" as required by EO 13196 will close 10 of the 16 bottomfishing banks in the Ho'omalu Zone and one bank in the Mau Zone. To date, there is no indication on how these lines will be drawn. For this reason, the table represents a "worst case" scenario. Impacts presently include a 56.7% reduction of landings for the Ho'omalu Zone and a 67.09% reduction in the Mau Zone.

[2] The NWHI bottomfish fishery ex-vessel value is about $1.1 million per year. Ho'omalu Zone average value is $ 817K per year and Mau Zone is $ 291K per year.

Economic Losses to Bottomfish fishery as a Result of Executive Order 13196

12.B.(6

REV II

February 13, 2001

(Source NMFS NWHI Bottomfish Data 1997-1999)

Zone	Bank	Fishing Status [1]	% of total bottomfish revenue lost	Value ($) of landings sold [2]
Ho'omalu	66 fathom bank	Closed	0.8	$ 6,536.00
Ho'omalu	French Frigate Shoals	Closed	6.5	$ 53,105.00
Ho'omalu	Brooks bank	Closed	5.9	$ 48,505.00
Ho'omalu	St. Rogatien	Open	0	0
Ho'omalu	Gardner Pinnacles	Closed	8.6	$ 70,262.00
Ho'omalu	Raita bank	Open	0	0
Ho'omalu	Maro Reef	Closed	5.9	$ 48,203.00
Ho'omalu	Laysan Island	Closed	2.3	$ 18,791.00
Ho'omalu	N.Hampton	Closed	0	0
Ho'omalu	Pioneer bank	Open	0	0
Ho'omalu	Lisianski	Closed	10.2	$83,334.00
Ho'omalu	Pearl & Hermes	Closed	3.2	$ 26,144.00
Ho'omalu	Salmon bank	Open	0	0
Ho'omalu	Ladd	Open	0	0
Ho'omalu	Nero	Open	0	0
Ho'omalu	Kure	Closed	13.3	$108,666.000
	HO'OMALU TOTAL		**56.7 %**	**$463,341.00**
Mau	Nihoa Island	Open	0	0
Mau	Twin banks	Open	0	0
Mau	Necker Island	Closed	67.09	$ 157,837.99
	MAU TOTAL		**67.09 %**	**$ 157,837.99**

Converting depth based area closures to "straight line boundaries" as required by EO 13196 will close 10 of the 16 bottomfishing banks in the Ho'omalu Zone and one bank in the Mau Zone. To date, there is no indication on how these lines will be drawn. For this reason, the table represents a "worst case" scenario. Impacts presently include a 56.7% reduction of landings for the Ho'omalu Zone and a 67.09% reduction in the Mau Zone.

[2] The NWHI bottomfish fishery ex-vessel value is about $1.1 million per year. Ho'omalu Zone average value is $ 817K per year and Mau Zone is $ 291K per year.

26 February 2001

Western Pacific Regional Fisheries Management Council
1164 Bishop Street, Suite 1400
Honolulu, HI 96813

I have reviewed the Draft Coral Reef Ecosystem Fishery Management Plan (FMP) of the Western Pacific Region volumes I and II. Although the documents contain numerous inconsistencies and unsupported assertions that should be rectified, I have restricted my comments to the larger issues.

Failure to follow the required NEPA process for public involvement:

The Western Pacific Regional Fisheries Management Council has not followed the required process for public review of these documents under the National Environmental Policy Act (NEPA) with respect to public hearings held in the Commonwealth of the Northern Mariana Islands (CNMI). First, the Council failed to follow the requirements of 40 CFR 1506.6(c)(2) state that "(i)f a draft environmental impact statement is to be considered at a public hearing, the agency should make the statement available to the public *at least* 15 days in advance." The notice of availability for the EIS and the schedule for the public hearings was published in the Federal Register on January 5th. The public hearing in the CNMI was held on January 17th. Thus, there were only twelve days between the notice of availability and the public hearing, making it impossible for the Council to have provided the documents for review 15 days prior to the public hearing.

Secondly, the Council did not meet its requirements for making the documents available to the public. At the time the public hearing was held, there were *no* copies of the EIS and accompanying documents available for review anywhere in the CNMI. Copies of the CRE documents had not been provided to the appropriate local agencies authorized to develop and enforce environmental standards, as required under 40 CFR 1502.19(a), and therefore were not available for review by the public at these local agencies. Copies of the CRE documents were made available in only two ways: by mail if requested, and via download off the Council's website. As already pointed out, the short timeframe between the announcement of document availability and the hearing itself made it impossible to obtain a copy of the documents by mail 15 days prior to the public hearing. Given the necessary mail delivery times, it is also very likely that mailed documents would have failed to arrive *any* time before the hearing. Attempts to download the documents from the Council's website were unsuccessful. After three hours of downloading only one-third of the document had been received. Requiring the public to spend upwards of 10 hours downloading a document via modem hardly constitutes a reasonable attempt to provide documents for public review under the spirit and intent of NEPA.

The manner in which public comments were solicited for the CRE FMP is in marked contrast to the manner in which the Council and the National Marine Fisheries Service (NMFS) solicited comments under the pelagics EIS. The public hearing for the pelagics EIS was held on the same day and prior to the hearing for the CRE EIS. Prior to the pelagics public hearing, the Council mailed copies of the pelagics EIS, which was similar in size to the CRE documents, to Council contacts in the CNMI. This allowed people attending the public hearing to have a passing familiarity with the EIS prior to the hearing. To conduct the pelagics public hearing, the Council and the NMFS sent three staff members to present the pelagics preferred alternative, answer questions with respect to the pelagics EIS, and take public comments. In contrast, there were no Council or NMFS staff members sent to conduct the public hearing on the CRE FMP. The CRE FMP public hearing was conducted by local agency staff who, as discussed above, had not received copies of the documents prior to the meeting and therefore were largely unfamiliar with the EIS and FMP. As a result, there was no one at the CRE public hearing knowledgeable enough to answer questions about the CRE documents.

Given the above information, it is reasonable to question whether the Council and the NMFS seriously intended to solicit public comments on the CRE documents, as required by NEPA. Every attempt was made to prevent the public in the CNMI from having sufficient time prior to the public hearing to review the CRE documents. The Council purposely chose not to provide copies of the CRE documents to Council contacts in the CNMI as it had done with the pelagics EIS. Even members of the CRE FMP plan team in the CNMI, who were ostensibly involved in the development of the plan, did not received copies of the revised draft plan. The last draft of the plan provided for plan team review was the December 1999 version. It is therefore unreasonable to expect that the public hearing in the CNMI could have resulted in any meaningful public input on the draft plan and, therefore, the requirements of NEPA have not been met. The Council and NMFS should suspend plans to proceed with the finalization of these documents until the NEPA process is adequately and faithfully carried out.

Ecosystem nature of the CRE FMP

In the Executive Summary, the Council states that the CRE FMP was developed based on the ecosystem based approach. The plan's management unit species include a large number of coral reef taxa in two lists: currently harvested coral reef taxa, and potentially harvested coral reef taxa. Unfortunately, simply listing a large number of species and managing them independently does not constitute ecosystem management under any accepted scientific definition of the term. As defined in the EPAP report, for example:

"a comprehensive ecosystem-based fisheries management approach would require managers to consider all interactions that a target fish stock has with predators, competitors and prey species; the effects of weather and climate on fisheries biology and ecology; the complex interactions between fishes and their habitat; and the effects of fishing on fish stocks and their habitat."

The CRE FMP lacks a management structure that would allow the gathering of data sufficient even to assess minimal impacts of fishing on ecosystem functions. The Council proposes to rely on existing local data collection systems for the collection of data required to make management decisions under the FMP. These existing local systems cannot begin to provide information to assess the interactions between target fish stocks and predators, competitors and prey species, much less any of the other ecosystem level impacts that the EPAP recommends including in management decisions. In many cases, the existing local systems can do little more than evaluate total catch over time in comparison with effort. The Council recognizes this in Section 4.0 Data Richness when it states that local data collection "is generally restricted to commercial landing of a handful of species."

The Council's decision to not require additional permitting or reporting requirements for harvesting of coral reef resources is questionable if the intention is truly to manage at an ecosystem level. Management of fisheries resources at an ecosystem level requires more, not less, data than would be collected under the traditional single species or species complex based FMP. Yet, the data reporting requirements in this alleged ecosystem plan are much lower than the requirements in many of these more traditional plans. To avoid the criticism that the Council is hiding behind the requirement to use only best *available* data as an excuse for not collecting better data, the Council's preferred alternative, and the approach taken in the FMP, should be reevaluated and revised to an approach more in keeping with accepted scientific definitions of, and requirements for, ecosystem management.

Ecosystem Principals Advisory Panel Report to Congress Recommendations:

Section 1.5 Management Approach indicates that the CRE-FMP has attempted to incorporate the recommendations of the Ecosystem Principles Advisory Panel. However, the Council's implementation of these measures is incomplete at best. The proposed plan does a poor job of incorporating the management policies developed by the EPAP into the management structure of the plan, completely ignoring several of the recommended policies that are included in the bulleted list on page 23 of the CRE plan.

For example, the EPAP recommends changing the burden of proof from a requirement to prove that unacceptable impacts have occurred before restrictions in fishing activities are implemented to an

approach that only allows fishing that can be reasonably expected to operate without unacceptable impacts. The report states that in practice this will mean that:

"when the effects of fishing on either the target fish population, associated species, or the ecosystem are poorly known (relative to the severity of the potential outcome), fisheries managers should not expand existing fisheries by increasing allowable catch levels or permitting the introduction of new effort *and should not promote or develop new fisheries for so-called "underutilized species"*" (emphasis added).

In the draft CRE FMP, Section 4.0, Data Richness, it states that "available biological and fishery data are poor for all species" and goes on to say that "(t)here is scant information on life histories, ecosystem dynamics, fishery impact, community structure changes, yield potential, and management reference points for many of the coral reef ecosystem resources despite the fact that a large potential exists for exploitation of coral reef ecosystem resources and fisheries in the near future." Previous versions of the draft CRE FMP recognized that despite the high gross productivity of coral reefs, these ecosystems have low net productivity, making them vulnerable to overfishing.

Yet the current draft CRE FMP proposes to allow fishing for potentially harvested coral reef taxa under a special permit system. The FMP also proposes to allow for increased fishing for currently harvested coral reef taxa without any permit or reporting requirements. Furthermore, the implementation of a permit requirement for currently harvested taxa would be based on analysis of data indicating that the existing "regional permitting" system is inadequate to address the needs of the FMP. This would appear to be a business as usual approach of requiring the showing of adverse impacts prior to making changes in the fishery - not the change in the burden of proof that the EPAP recommends. By both expanding existing fisheries and allowing the opening of new fisheries in the face of extremely limited data on the target species and their ecosystems, the current plan is proceeding completely counter to the recommendations of the EPAP.

The EPAP also recommends implementing a precautionary approach to management that encourages risk adverse decisions in the face of uncertainty. The draft CRE FMP purports to do this under a framework process. However, as discussed above, the plan's proposal to allow unregulated increases in fishing for currently harvested coral reef taxa, and allow the creation of fisheries for coral reef taxa that are not currently harvested in the face of severely limited management data does not meet the definition of the precautionary approach.

Management Unit Taxa and "Adequate" Information

1.6.2 Management Unit Taxa "The coral reef management unit species are divided into two groups of species or taxa: 1) "Currently harvested Coral Reef Taxa (CHRT)", i.e. coral reef organisms that are currently harvested (e.g. from catch report records in federal waters) but not covered by existing FMPs, *for which adequate information is available to begin management....*" (emphasis added). This statement is in direct contradiction to the statement made in Section 4.0, Data Richness which asserts that "available biological and fishery data are poor for all species" and goes on to say that "(t)here is scant information on life histories, ecosystem dynamics, fishery impact, community structure changes, *yield potential, and management reference points* for many of the coral reef ecosystem resources despite the fact that a large potential exists for exploitation of coral reef ecosystem resources and fisheries in the near future" (emphasis added).

The Council has used the argument that there is "adequate" information on the CHRT taxa to support the preferred alternative of not requiring any permit for fishing of these resources at the present time, and implementation of only a general permit if required at a later date. This is in contrast to the recommendations of the CRE plan team to implement a special permit for harvest of all coral reef resources. The CRE plan team recommendation is support by the statement in Section 4.0, Data Richness of the draft plan that data is poor for all species, and that data required for ecosystem level management of these species is virtually non-existent. The Council's statement that "adequate" information is available for these taxa appears to be completely unsupported. Thus, it would appear that the Council's and NMFS' basis for selecting the preferred alternative and the permitting options are also unsupported. Justification for Council's and NMFS' conclusions are required.

MSY, OSY and Overfishing

The first paragraph in the section titled "Data Richness" states that data on coral reef resources, even those currently being harvested, is consistently poor, with only a few species being represented with any data at all. The first sentence of the following paragraph then states "(w)ith this level of data we will establish limits and reference points based on the multispecies coral reef ecosystem as a whole." With the data that contains scant information on "....yield potential and management reference points"? How is the Council proposing to accomplish this? In the absence of data you will nonetheless find something to analyze?

In fact, the entire chapter 4 contains very little information on how, exactly, the Council proposes to calculate MSY, OY and Overfishing limits for, not only individual coral reef taxa, but the coral reef ecosystem as a whole. There is a nice standard discussion of how these limits *can be* developed - if there are sufficient data. There is even a discussion of how ECOSIM *could be* used, if the data were available to support it. However, this is no description of how the Council proposed to calculate these limits in the face of limited or absent data. I believe that this section is actually supposed to describe the manner in which MSY, OY and overfishing criteria *will be* developed - not how they might be developed if things were different. The Council should give some attention to revising this section based on reality and not on some desired altered state.

Conclusions

The marine protected area measures in the current draft of the CRE FMP is improved somewhat over previous versions. However, the document in general fails to meet the recommendations established by the EPAP for ecosystem management of fisheries resources, and also fails to develop adequate mechanisms for managing coral reef resources in a sustainable manner. There are significant gaps in the document, most notably a realistic presentation on the methods for establishing MSY, OY and overfishing criteria using the available data. In addition, the document recognizes that the data necessary to adequately manage coral reef fisheries is not available, and is not likely to be collected under current data collection systems. Yet, the preferred alternative appears to have been developed with complete disregard for this information. In fact, it is not at all clear how the Council arrived at the preferred alternative which bears no resemblance to any recommendation made by the plan team, of which I was a member, or the advisory panel.

Sincerely,

Katharine B. Miller

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

GILBERT S. COLOMA-AGARAN
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTY DIRECTOR
JANET E. KAWELO

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
COMMISSION ON WATER RESOURCES MANAGEMENT
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
LAND
STATE PARKS

February 26, 2001

Ms. Kitty Simonds, Executive Director
Western Pacific Regional Fisheries Management Council
1164 Bishop Street, Suite 1400
Honolulu, HI 96813

Dear Ms. Simonds:

The State of Hawai'i Department of Land and Natural Resources would like to submit the following comments regarding the Draft Environmental Impact Statement (DEIS) submitted by the Western Pacific Regional Fisheries Management Council (WPRFMC) in support of its Coral Reef Ecosystem Fisheries Management Plan (CREFMP). The Department would like to thank the WPRFMC for the opportunity to provide comments on the DEIS and we look forward to your response to our concerns.

Overall, the Department supports the WPRFMC in its attempt to establish a true ecosystem-level of management for coral reef resources in federal waters. We do have some concerns specifically related to the WPRFMC's preferred alternative as stated in the DEIS and have detailed those concerns below.

MANAGEMENT UNIT SPECIES (MUS)/TAXA

The CREFMP includes "virtually all biota in the coral reef ecosystem" except that it exempts species covered under existing FMPs (i.e. crustaceans, many apex predators, certain marine ornamental fish). As such, large trophic gaps would exist in the plan suggesting that it would not manage coral reefs at an ecosystem level. The WPRFMC's view that any problems caused by excluding numbers of important coral reef species from coverage under this plan could be overcome by later discussions between different Plan Teams does not adequately deal with this issue. If this plan is to be based on an ecosystem-level of management, it cannot exclude entire coral reef species assemblages from coverage under its management measures at its inception. No rationalization is provided in the DEIS for how excluding such a wide range of coral reef species (All groupers and anthias species, most jack species, most snapper species, all lobster species, and certain shark species) from MUS under this plan will achieve the ecosystem-level of management stated as a primary goal.

The definitions for maximum sustainable yield (MSY) and optimum yield (OY) are based on parameters related to species' abundance and the replacement rate within a population independent of ecosystem relationships; yet ecosystem-level impacts would

occur at levels of take far below that where they would trigger species-level concerns of overfishing. The result is that catch rates that would indicate overfishing under the CREFMP would occur after ecosystem-level impacts had already occurred, resulting in a failure of this plan to manage federal coral reef resources at the ecosystem-level. One way of achieving this might be to set MSY and OY based upon not only species-level impacts, but also on impacts on trophic guilds one level above and below that of the species proposed for fishing. As part of such a strategy, efforts should be made to develop more complete trophic models for ecosystems where coral reef resources are to be fished. Such actions would deal directly with observations that on coral reefs most species are strongly tied ecologically to complex reef trophic webs.

MANAGEMENT MEASURE: MARINE PROTECTED AREAS (MPAS)

Of primary concern is that the DEIS provides no site-specific justification for the selection of the three "no-take" areas. Significant concerns exist over the selection of Midway (versus Kure Atoll or Pearl & Hermes Atoll, both of which represent more pristine-like habitats with unique coral reef resources and assemblages as observed during the recent multi-agency NOWRAMP expedition to the NWHI) as no-take MPA. It is our understanding that the WPRFMC's CRE Plan Team provided the Council with site-specific justification for the selection of the areas they felt deserved no-take MPA status.

The designation of all Federal EEZ waters in the NWHI (other than French Frigate Shoals, Laysan, and Midway) shallower than 10 fathoms (-.60') to be No-Take MPA is enigmatic for this FMP as the majority of living coral resources in federal waters is deeper than 10 fathoms (- 60'). The best available data suggests that these depths should be deeper and related to the depth profiles of living coral reefs in the areas to be covered (25 fathoms or deeper).

The preferred alternative states that the NWHI no-take MPAs would also apply to existing FMPs; though the stipulation that permits for research can be given for use in the "no-take" MPAs may raise concerns regarding fishing activities occurring under the label of research. A related question is whether the "experimental fishing" being recently proposed by the Council for the NWHI Lobster Fishery, whereby fishers would get to keep and sell their catch, would fall under the definition of allowable "research" take in a "no-take" MPA? We suggest that any research conducted within no-take MPAs should be directly related to the management of the no-take MPA itself as a way of avoiding the problem listed above; this could easily be accomplished by modifying the document to state that "All extractive activities would be prohibited in no-take MPAs, except for small harvests related to research directly supporting management of the MPA".

According to the DEIS, the entire NWHI outside of FFS, Laysan and a portion of Midway would be limited-take MPA requiring a Special Permit for any fishing. Such action appears to take an ecosystem-approach towards fisheries impacts and should be encouraged. One problem with the current language in the DEIS is that the preferred alternative exempts all existing FMPs from coverage under this provision[1]. Once again, the primary human impact concerns in the NWHI (outside of marine debris) are the impacts of existing fisheries. Exempting such fisheries from the permitting provisions of

[1] Which covers many food fishes and habitat-forming species (such as black coral which can co-occur within stony coral reef habitat).

the CREFMP results in a major loophole towards managing the NWHI coral reefs in federal waters at an ecosystem-level. Therefore, the document should reflect recognition that impacts from these existing fisheries may be occurring and require that such potential impacts be studied for adverse effects on the coral reef ecosystem.

DLNR wholeheartedly supports the Council's efforts to minimize impacts on coral reefs by requiring a provision for vessels to have insurance to cover the cost of vessel removal, pollution liability and habitat mitigation[2] in the event of a grounding. Given that the three most recent groundings of WPRFMC-permitted vessels all occurred within State waters and severely damaged State of Hawai'i coral reef habitat, we would encourage the WPRFMC to insert appropriate language making it clear that such insurance covers impacts.

There are inconsistencies between the NWHI MPAs proposed in the DEIS and the NWHI MPAs designated by Presidential Executive Order for the new NWHI Coral Reef Ecosystem Reserve. From DLNR's perspective, we are in the process of creating a Fisheries Management Area (FMA) to cover State waters throughout the NWHI and would like to encourage the Council to work with us to further minimize impacts from activities occurring in federal waters from affecting our State natural resources.

MANAGEMENT MEASURE : CORAL REEF ECOSYSTEM FISHERY PERMITS

The major concerns regarding permitting relate to the statement that established FMP fisheries are exempted. This does not deal with the concerns raised by the Plan Team, the State, NMFS or USFWS in regards to existing impacts on NWHI coral reefs and does not allow for management at the ecosystem level. The view that such concerns can be dealt with later through consultations is problematic. If such impacts are not dealt with through a defined management measure within the CRE FMP, they are unlikely to be dealt with through post-adaptation consultations.

While commercial collection of coral/live rock in Federal EEZ would be prohibited under the preferred alternative, collection would be allowed for research, incidental take under other FMPs[3], and commercial propagation[4]. The DEIS does not define what an allowable "small" amount of coral/live rock is in regards to allowed take. An additional concern relates to unique endemic coral species that occur in the NWHI being allowed under such take provisions.

Concerns exist regarding the "Grounds for Denial of General Permit" section. The listed provisions provide no basis for determining impact of a proposed activity on the

[2] Note that the description of insurance coverage on P. 3 differs from the description on P. 144 which has dropped the requirement for habitat mitigative action. DLNR strongly believes that the DEIS needs to be corrected to properly reflect the appropriateness of habitat mitigation as one of the actions covered under the insurance requirement.

[3] The existing NWHI Lobster Fishery is known to bring up a wide variety of coral that becomes entangled in its traps. This is a major concern that has been identified by the Plan Team but is ignored in the DEIS; the view that such issues can all be handled "later" through negotiations between Plan Teams is problematic and not indicative of a desire to manage resources at an ecosystem-level.

[4] This last point raises concerns as commercial propagation of coral often involves asexual fragmentation (breaking off of pieces to grow-out and sell – this is not truly self-sustainable aquaculture as it often involves going out and re-collecting more coral to "grow-out") which depending upon how it is accomplished can cause massive stress to colonies, introduce competition and disease, and decrease available ecological habitat for the wide range of species found living on and within the coral reef.

coral reef ecosystem prior to its initiation and are not adequate for properly managing resource use.

Given that Special Permits are required within areas thought to be ecologically sensitive (especially the NWHI and the PRIAs), concerns exist regarding the "Grounds for Denial of Special Permit" section: None of the grounds listed deal specifically with ecosystem-level impacts. This is also problematic given that this is supposed to be an "ecosystem" plan. Under the proposed system, it is conceivable that the impacts on a single species would not be significant, but the ecosystem effects would.

MANAGEMENT MEASURE: GEAR & METHODOLOGY PROVISIONS

The DEIS states that only "selective" and "non-destructive" gear would be allowed, but by exempting existing FMPs (which include a wide variety of traps and allowable nets), this provision is not dealing with the known existing gear impacts to the coral reef ecosystem in the NWHI. It's difficult to understand how large numbers of lobster traps which are released from the surface and drop down hard onto the reef environment are "non-destructive". Also given that NMFS observer data shows that more than one hundred and ninety seven (197) bycatch species have occurred in recovered lobster traps in the NWHI fishery, it's difficult to suggest that this is a "selective" method of fishing[5].

FRAMEWORK ACTIONS

Vessel Monitoring Systems (VMS): The WPRFMC's Preferred Alternative has moved the CRE Plan Team's requirement for vessels under WPRFMC permit in the NWHI to carry an active Vessel Monitoring System (VMS) from being a Management Measure to the Framework Process. Current FMPs do not all require VMS usage in the NWHI and the data is not available to the State (even when these vessels are operating in NWHI State waters outside the jurisdiction of the WPRFMC). Contrasting this, the system proposed by the CRE Plan Team (and modeled after an existing system in place for all large vessels operating throughout the entire Great Barrier Reef) would be monitored round-the-clock by computer[6] and notification automatically sent to appropriate State and Federal agencies when a vessel enters a buffer zone, an off-limits MPA or State waters in the NWHI. Such a system would act as an early warning for both ship's captains and the State of approach and (if unheeded) entry into protected/State waters. VMS can accurately track vessel movements and provide certain information about prohibited fishing activities. The automatic notification provision is important as currently such information is not provided to the State, even by those WPRFMC vessels currently using VMS in the NWHI. Such an automated system, had it been in place, would have prevented both the Kure and Pearl & Hermes vessel groundings. Given the highly isolated nature of the NWHI, its expansiveness and the lack of monitoring or enforcement patrols, such a system may be one of the only mechanisms for protection of resources in the NWHI from damage or unauthorized

[5] Additionally, this data suggests very strongly that traps are being laid in coral reef areas where one would find such a wide variety of species (as opposed to on sandy areas as Council staff and some fishers claim); if true, this would argue strongly for direct destruction of benthic habitat (coral colonies, etc.). Secondly, removal of such a large range of species as bycatch, even at small levels, would have amplified effects in a coral reef ecosystem.

[6] The current VMS system for longlining boats is not automated nor continuously monitored, hence the recent grounding incidents.

take. We encourage the WPRFMC to modify the DEIS to include a management measure requiring VMS (with automatic notification to appropriate resource trustees) for all fishing vessels operating in the NWHI.

ADDITIONAL POINTS RELATED SPECIFICALLY TO THE DEIS

While published figures for maximum reef growth and productivity may suggest 5 - 15 m for calm waters, embayments and lagoons; such a number (as listed in the DEIS) is inaccurate and misleading for the vast majority of reefs under consideration for this plan as they represent federal waters offshore of oceanic island habitats under strong wave pressure. The result is that the majority of the reef growth (and productivity) occurs far deeper than 15 m for most of the areas under consideration for the CRE FMP. The DEIS should properly reflect this as it directly relates to such issues as depth contours for MPA designation and other management measures. Observations from the recent multi-agency NOWRAMP expeditions support the above statements.

The arguments raised in the DEIS that many indigenous peoples are dependant on coral reef resources is true only to the extent that such resources occur in close proximity to islands where these people live; yet over 90% of the coral reef area covered by this plan occurs in remote locations where indigenous use is not an issue. That is not to say that such concerns are not appropriate to be raised in the DEIS along with concerns regarding adjacent fishing communities, and shore-based impacts on federal coral reef ecosystems. But with recognition that the vast majority of the coral reef area covered under the proposed CRE FMP lies in the NWHI where such issues are not really a concern; perhaps the Council should take the time to investigate the appropriateness of creating two separate CRE FMPs: one to deal with federal waters adjacent to inhabited islands in the U. S. Pacific, and a different CRE FMP to deal with the NWHI and the PRIAs. Such an approach would allow for better management of areas that require different approaches towards coral reef management. Such an approach would also allow for better involvement of local management agencies to focus on issues directly related to federal waters adjacent to their jurisdictions. Finally, such an approach would have the side benefit of elevating various island government's concerns within an FMP framework where they are not overwhelmed by the majority of the area (and focus of the FMP) being in the NWHI.

The designation of Habitat Areas of Particular Concern (HAPC) as it relates to Hawai'i needs to be modified as follows:

NWHI: All hard substrate down to a minimum of 25 fm, including all lagoonal habitats. As stated earlier, 10 fm is far too shallow for most coral reef habitat on exposed areas of the NWHI.

The DEIS is misleading in a number of its statements and should be revised accordingly in terms of accuracy. One example follows: On page 25 occurs the following statement: "Approximately 80% of the coral reef area that would be managed under the CRE FMP (is) in the NWHI." On the next page is a chart which represents coral reef area; adding up the total coral reef area in federal waters of the NWHI and comparing it with the total, one comes up with a figure of 87% for the coral reef area that would be managed under the CRE FMP as being in the NWHI. On the very next page (27) is the statement: "By far the largest coral reef area in the EEZ is located in Hawaii (10,004 km^2), of which 90% is in the NWHI (9,124 km^2)." In the space of three adjacent pages, three completely different figures are given for the representative area of coral reef coverage;

such inaccuracies raise into question the validity of other information provided in this large DEIS. As such, DLNR respectively suggests that the Council spend an appropriate amount of time reviewing this document for accuracy and consistency and then re-submitting the DEIS for public review.

Given the dramatic changes that have recently occurred in terms of management of the NWHI federal coral reef areas now under the new NWHI Coral Reef Ecosystem Reserve (NWHICRER), and given the statement (p. 139, DEIS) that the "CRE FMP attempts to simplify regulations between areas by working to achieve consistent regulations across the various management regimes", there is recognition that the DEIS should be re-done to reflect the existing regulations of the NWHICRER. Specifically, the question is how the DEIS will be brought into compliance with the management measures outlined in the Presidential Executive Order for the NWHICRER.

While significant progress has been made on this plan, the majority of the Council's preferred measures still exempt all other species-level FMPs from consideration under this ecosystem-level FMP. That view, if maintained by the Council, will continue to be a barrier to the CREFMP functioning as a fisheries management plan of coral reef resources at an ecosystem level. Perhaps of greater importance, such exclusion serves as a barrier to meeting the Council's "Need for Action' (p. 15 DEIS) which states that the CRE FMP is needed:

- "To anticipate and avoid potential damage to essential and non-renewable coral reef habitat." Such habitat is currently being impacted in the NWHI by existing WPRMC fisheries which are exempt from most provisions of this plan.
- "To address the secondary effects of all reef-related fisheries on non-target coral reef resources, thereby encouraging ecosystem-scale management." This cannot occur if the existing fisheries are exempt from consideration under this plan, and therefore such secondary effects cannot be managed.

For the State of Hawai'i and DLNR this takes on even stronger repercussions with the realization that the NWHI coral reef ecosystems are often continuous from State waters into those under WPRFMC control. Coral reef resources in State waters in the NWHI may be negatively impacted by the Council's preferred CREFMP as it currently exists and we encourage the Council to strongly consider the recommendations we've listed above in order to help mitigate this concern.

Once again thank you for the opportunity for our Department to provide comments on the DEIS. If you have any questions, or we can be of any further assistance, please contact Dave Gulko at the Division of Aquatic Resources, 587-0318.

Sincerely,

Ed Coloma-Agaran, Chairperson
Board of Land and Natural Resources

Ms. Kitty Simonds, Executive Director
Western Pacific Regional Fisheries Management Council
1164 Bishop Street, Suite 1400
Honolulu, HI 96813

February 26, 2001

Comments on the Draft Environmental Impact Statement
FISHERY MANAGEMENT PLAN FOR CORAL REEF ECOSYSTEMS OF THE WESTERN PACIFIC REGION, December, 2000

These comments are submitted on behalf of the Sierra Club by Dave Raney, a volunteer member of the Sierra Club's National Marine Wildlife and Habitat Committee. Mr. Raney, a resident of Hawaii, heads the Club's Coral Reef Working Group. He also serves as the Pacific Non-Government Organization Representative to the United States Coral Reef Task Force:

1 GENERAL COMMENTS

We commend the Council for recognizing over five years ago the need to protect the coral reef ecosystems of the U.S. Western Pacific EEZ from emerging technologies and market forces that put them at risk. We acknowledge the considerable time, effort, and money that has gone into the preparation of the DEIS and the Coral Reef Ecosystem FMP (CRE FMP), and we appreciate the Council making the review documents available in CD-ROM format.

We must conclude, however, that the three documents, totaling over one thousand pages, bear mute witness to the difficulty in achieving ecosystem-based resources management under the constraints of the single-species orientation of the Magnuson-Stevens Act. While the Council claims this to be the first ecosystem-based FMP in the United States, we think it more accurate to describe it as the first attempt at an ecosystem-based FMP.

No-take Marine Protected Areas of sufficient size may indeed provide true ecosystem-based management. This concept flowed from the U.S. Coral Reef Task Force and its "National Action Plan to Conserve Coral Reefs," not from the Magnuson-Stevens Act. The boundaries of the no-take MPAs in much of the Northwestern Hawaiian Islands were established by Presidential Executive Orders 13178 and 13196, which established the Coral Reef Ecosystem Reserve. The Council's CRE FMP proposes smaller no-take MPAs in the Northwestern Hawaiian Islands and does not comply with the Executive Orders.

Outside of no-take Marine Protected Areas, the Council attempts ecosystem-based resource management by proposing "ecosystem" adjustments to the species-based Magnuson-Stevens parameters of Optimal Yield and Overfishing. The Council also proposes that the Coral Reef Coral Reef Ecosystem FMP Plan Team "coordinate" with the existing FMP Plan Teams to "recommend methods for minimizing identified impacts to the coral reef ecosystem" from other FMPs, which are exempt from the CRE FMP regulations outside of no-take MPA areas. Yet, we have witnessed numerous occasions where the Council ignored or weakened the recommendations of the CRE FMP Plan Team. At the most recent meeting of the Council, a member of the CRE FMP Plan Team noted that the Plan Team had not met for a long time. Council staff replied that the Plan Team meetings were expensive and the CRE FMP Plan Team would not meet again until the Council budget allowed for such a meeting. This hardly inspires confidence in the use of the CRE FMP Plan Team for timely, precautionary, actions.

We support Objective 6 of the Management Plan, "***To collaborate with other agencies and organizations concerned with the conservation of coral reefs, in order to share in decision-making and to obtain and share data and resources needed to effectively monitor these vast and complex ecosystems.***" We note, however, the Council has been very aggressive in attempting to assert sole authority over the management of marine resources in the EEZ, including assertion of fishing rights within the boundaries of national parks and national wildlife refuges under the jurisdiction of the Department of the Interior.

The coral reef ecosystems of the U.S. Western Pacific EEZ are a public trust to be administered for the benefit of current and future generations of all the citizens of this country. They should not be viewed as resources available only to a select few economic enterprises based on extraction of those resources under the exploitative mandate of the Magnuson-Stevens Act. This is especially true for the Northwestern Hawaiian Islands, where the protection of threatened and endangered wildlife species, and the unique coral reef ecosystems found there, are high national priorities. It is also true for the remote Pacific islands and atolls designated as national parks and national wildlife refuges, where fishing should be allowed only as deemed by the U.S. Fish and Wildlife Service to be of such a scale and location so as to be compatible with the broader purposes of the parks and refuges.

2 SPECIFIC COMMENTS

2.1 **The Preferred Alternative, and the DEIS based upon it, are inconsistent with Executive Orders 13158 and 13196, which established the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve, and designated permanent Reserve Preservation Areas (no-take Marine Protected Areas). The Preferred**

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Alternative, including the no-take MPA boundaries, must be revised to be consistent with these Executive Orders, and the Final EIS must reflect the required changes. WE CANNOT SUPPORT THIS CRE FMP UNLESS, AND UNTIL, IT IS REVISED TO CONFORM WITH THE PROVISIONS OF EXECUTIVE ORDERS 13158 AND 13196.

According to the remarks in paragraph 4, Page 1 of Volume I, the Preferred Alternative is based on the FMP "tentatively" adopted by June, 2000 by the Western Pacific Regional Fishery Management Council (The Council). The DEIS does mention Executive Order 13178 on Page 258, so the authors were aware of the Order. On Page 259 of Volume I, the Draft recognizes that the Executive Order creates Reserve Preservation Areas wherein fishing is prohibited, with certain exceptions allowed for bottomfishing. Oddly, however, the DEIS ignores the fact that the Executive Order renders most of the Council's Preferred Alternative obsolete.

2.2 **The Council, and NMFS, appear to be determined to contest the authority of the Department of the Interior to manage marine resources within national wildlife refuges and national parks.**

The Preferred Alternative would allow commercial fishing within the boundaries of the recently designated Kingman Reef National Wildlife Refuge and the Palmyra National Wildlife Refuge. The marine boundaries of both of these refuges extend to twelve nautical miles, within which commercial fishing would be banned under the provisions of the National Wildlife Refuge Act. The Preferred Alternative would allow commercial fishing in waters seaward of 50 fathoms, significantly encroaching on the marine waters of these refuges. This reduces the buffer areas necessary to protect the birds, turtles, monk seals, and other wildlife species to be protected by the refuges, and would allow fishing in areas where fishing is banned by the U.S. Fish and Wildlife Service.

We assert that the Council must revise its Preferred Alternative and DEIS for Kingman Reef and Palmyra Atoll to be compatible with the marine boundaries and regulations of the national wildlife refuges established there.

2.3 **The CRE FMP exempts the fishery management plans (FMPs) for crustaceans, bottomfish, precious corals, and pelagic fisheries from its regulations, other than those related to no-take Marine Protected Areas. This exemption could allow continuation of fishing practices, such as lobster trap drops, that could damage coral reef habitat.**

See Volume I, Page 140, wherein it is stated "***While the four existing FMPs implemented by the WPRFMC (bottomfish and seamount groundfish, crustaceans, pelagics and precious corals) are exempt from the regulations outlined in the CRE FMP and will observe the management regime of their respective FMPs, the no-take marine protected areas will be in effect for all Council-managed fisheries.***" As noted in our general comments, the Council appears to rely heavily on the CRE FMP Plan Team to address coral reef ecosystem impacts from other FMPs. For this

to be viable, the CRE FMP Plan Team must be adequately funded to allow them to meet as required, and should have more than simply the power to "recommend" changes in other FMPs. There should also be a formal process for reviewing each FMP for its impacts on coral reef habitat and amending each FMP as necessary.

2.4 **Outside of the no-take MPAs, the CRE FMP proposes to manage CRE species by General or Special permits based on the status of species as Currently Harvested Coral Reef Taxa or Potentially Harvested Coral Reef Taxa, for which overfishing limits and reference points will be established based on the coral reef ecosystem as a whole.. We note that this management measure is very primitive at this stage, with little of the required information in place to implement it.**

It is assumed that because species appear on current catch reports that they are "relatively well understood," and only an easily attained General Permit would be required. We do not believe that the ecosystem impacts of removal of many of the Currently Harvested Coral Reef Taxa are well enough understood to justify this approach. For example, gray reef sharks and several species of herbivores are Currently Harvested Coral Reef taxa whose removal could have significant ecosystem impacts. The same is true for removal of jacks, which are managed under the Bottomfish FMP and thereby exempted from the CRE FMP permit requirements.

On Page 129, Volume I, the CRE FMP recognizes that ecosystem overfishing occurs when fishing pressure causes changes to the species composition in a multispecies setting, often resulting in changes in ecosystem function. On Page 131, of the same volume, the CRE FMP proposes that prevention of Ecosystem Overfishing be achieved by monitoring changes in species abundance/composition using "the best available data." This approach would not be sufficiently precautionary, since it would wait until after a change in composition had occurred before taking any action.

2.5 **The criteria for denying a General Permit do not appear to include any considerations related to potential overfishing or damage to coral reef habitat. There should be provision for denying a General Permit on such grounds.**

2.6 **The CRE FMP states that overfishing limits would be set for Currently Harvested Coral Reef Taxa, yet we note the Council rejected the suggested prohibition on the commercial take of Napolean wrasse and Humphead parrotfish, two species which the CRE FMP Plan Team recommended as "protected" species because they are being currently overfished throughout their range. Who sets the overfishing limits, and how?**

2.7 **The CRE FMP proposes that Vessel Monitoring Systems be deferred for action through the Framework Process. We urge that mandatory, 24-hour a day, automated VMS be required for boats transiting the Northwestern Hawaiian**

Islands as part of the initial CRE FMP.

3 CONCLUSION

Thank you for the opportunity to submit our comments on this important document. We repeat that we cannot support the CRE FMP until it is amended to comply fully with the provisions of Executive Orders 13178 and 13196, which established the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve. **In no way do we consider this CRE FMP to be a substitute for the boundaries, policies, and management measures established in the NWHI by Executive Orders.**

Sincerely,

Dave Raney
Sierra Club National Marine Wildlife and Habitat Committee
Coral Reef Working Group

1621 Mikahala Way
Honolulu, HI 96816

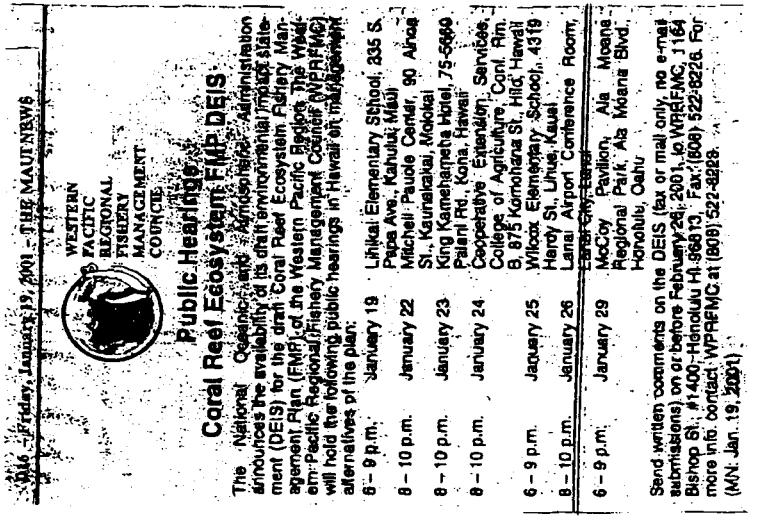
Phone: 808-734-4986
e-mail: d_raney@aloha.net

MEMORANDUM dated 5 January 2001 from Ms Kitty Simonds attached to 3 volumes of the CRE DRAFT FMP/DEIS.

2nd page (backside) notice of Dates, Times, and Locations for Public Hearings on the Coral Reef Ecosystem FMP DEIS.

#3. Kahului, Maui, HI: January 19, 2001, 6 to 9 p.m. Lehi Kai Elementary School, 335 S. Papa Ave., Kahului, HI 96732

**not enough time was given in notifying the public here on Maui of the Public Hearings for the Coral Reef Ecosystem FMP DEIS. I , along with my husband, Isaac, didn't know that a hearing was already scheduled, we learned about it through our daily island newspaper, THE MAUI NEWS, the very same day. It was impossible for us to get there, because we had another obligation scheduled. I have photocopied the actual hearing notice on this page.*



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WESTERN PACIFIC REGIONAL FISHERY MANAGEMENT COUNCIL

Public Hearings on Coral Reef Ecosystem FMP DEIS

The National Oceanic and Atmospheric Administration announces the availability of its draft environmental impact statement (DEIS) for the draft Coral Reef Ecosystem Fishery Management Plan (FMP) of the Western Pacific Region. The Western Pacific Regional Fishery Management Council (WPRFMC) will hold the following public hearings in Hawaii on management alternatives of the plan:

6 – 9 p.m.	January 19	Lihkai Elementary School, 335 S. Papa Ave., Kahului, Maui
8 – 10 p.m.	January 22	Mitchell Pauole Center, 90 Ainoa St., Kaunakakai, Molokai
8 – 10 p.m.	January 23	King Kamehameha Hotel, 75-5660 Palani Rd., Kona, Hawaii
8 – 10 p.m.	January 24	Cooperative Extension Services, College of Agriculture, Conf. Rm. B, 875 Komohana St., Hilo, Hawaii
6 – 9 p.m.	January 25	Wilcox Elementary School, 4319 Hardy St., Lihue, Kauai
8 – 10 p.m.	January 26	Lanai Airport Conference Room, Lanai City, Lanai
6 – 9 p.m.	January 29	McCoy Pavilion, Ala Moana Regional Park, Ala Moana Blvd., Honolulu, Oahu

Send written comments on the DEIS (fax or mail only, no e-mail submissions) on or before February 26, 2001, to WPRFMC, 1164 Bishop St., #1400, Honolulu HI 96813, Fax: (808) 522-8226. For more info. contact WPRFMC at (808) 522-8220.
(MN: Jan. 19, 2001)

vol 2 p213 RESPONSE TO PUBLIC COMMENTS

-the Public Scoping Hearing - Honolulu (Plan Team and EHAP Meeting) 17 September 1999.

-the CRE Plan Team (PT) were not in the Council's conference room at the time the Hearing took place. The CRE PT was in another section of the Council's Office and later it was questioned by the EHAP members amongst themselves, why the PT wasn't present for the Hearing.

-the CRE PT is the science body for the coral reef ecosystems and the term best scientific data available became useless the moment this public scoping hearing took place without the PT in the same room.

vol 2 p185 line 9 should have read: The Kingdom of Hawaii ended with the invasion and overthrow of Kalakaua's sister, Queen Lili'uokalani, on January, 1893.

vol 1 p175 Process to Facilitate Interagency Coordination to Assess....

#5 and #9 are of a concern to me in/around the NWHI:

-scientific projects: a proposal to have a North Pacific Acoustical Laboratory project (NPAL) also known as Acoustic Thermometry Oceanic Climate project (ATOC) at Midway is totally ridiculous as well as pure ignorance of the growing population of monk seals at Midway.

-the Hawaiian monk seals are recolonizing Midway after many years of absence when Midway was bustling with military presence.

-ocean co2 sequestration projects should not be allowed at all in/around the NWHI.

-military activities: the NPAL/ATOC project is a joint venture with Naval Research.

-one military activity that should be allowed in the NWHI is the cleaning up and removing of contaminants that was left after the military left those islands/atolls.

vol 2 p107 continued under Reduced Prey Availability 2nd paragraph

-two leading hypotheses to explain the lack of prey at French Frigate Shoals are....

-since the above is a hypotheses, I'll share my assumptions.

-the local population did not reach its carrying capacity during the mid-1980's and they did not deplete their own food supply. Humans did it for them. through the large-scale harvesting quantity of lobster, octopus and various reef fish, that were brought up in the commercial lobster traps, which many were kept as incidentals.

-natural prey on prey process: the bait is in the trap, the lobster goes in for the bait, the octopus goes in for the lobster, the eels goes in for the octopus, the reef fish and crabs enter the trap as the clean-up crew who scavenge for scraps. This is a natural prey on prey process.

-the numbers do not lie. The lobster fishery was allowed to be harvested at a gung-ho rate in the 80's.

-octopus retained as incidental catch were in the thousands of pounds range per vessel per trip in the 80's.

-the replenishment rate could not catch up with the commercial take of both lobsters and the incidental take of octopus.

-in the 90's the lobster levels were in trouble;

-in the 90's the incidental take of octopus had been drastically reduced to about one hundred octopus (not pounds) were taken for the whole fleet.

vol 1 p324 Lobster Trap

-there is no mesh size listed; only dimensions of the trap.

vol 1 p308 "Moi moi" net

-should be spelled "moe moe" instead which means to lay in wait; ambush.

vol p298 definitions of gear

-Gillnet: moe moe net is not listed and under the above description it does not list the various other names for the same gear. Pai pai is listed but not moe moe.

-gillnets are not a selective type of gear; it catches everything and anything with or without close monitoring. True passive destructive gear.

vol p298
-the Pacific Islanders throw/cast net was rectangular.
-cast net and throw net is the same thing.

vol 1 p165 Fishing Gear and Methods

-ban SCUBA with spear at all times.

vol 1 p125 last paragraph

-I am very surprised that the Council would without hesitation give the Hawaiian people 20% of the commercial value of the resource, etc.

-the Native Panel could not even get the 20% of the Pelagics permits and the 20% quota from the Crustacean fisheries.

-the bottomfish fishery has a "use it or lose it" clause. The Pelagics have 20 or so permits sitting in possession with no vessel.

As for a term used that the indigenous people were using inefficient gear which afforded them long term sustainability is an insult. The indigenous people of the Hawaii and perhaps other Pacific Islanders made use of materials that were available to them and took only what was needed. True sustainability was for nourishment for generations to come and not to maintain a sizeable bank account to be in jeopardy when fisheries are in trouble.

Commercial fishing is like any other business. It has its RISKS. As the saying goes, a boat is like a hole in the water.

VMS should be mandated whether through funding or thrbugh the owner.

The US Coast Guard Enforcement Division is severely under funded. They have the largest piece of the Pacific Ocean to malama (take care) and inadequate funding are preventing them to do their work to the best of their ability and capability.

Mahalo, Tammy A. Harp

Mahalo, Tammy A. Harp

I will not believe that the lobster/crustacean component in the monk seal diet is so small of a percentage.

FINAL
FISHERY MANAGEMENT PLAN
FOR
CORAL REEF ECOSYSTEMS
OF THE
WESTERN PACIFIC REGION

Volume III

Essential Fish Habitat
For
Management Unit Species

Western Pacific Regional Fishery Management Council

October 2001

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I. Description of Essential Fish Habitat for Currently Harvested Coral Reef Taxa

A. Surgeonfish (Acanthuridae)

The surgeonfishes are one of the most prominent groups of reef-dwelling fishes in the tropical Indo-Pacific. They are important food fish on many Pacific islands, where they are typically caught by spearfishing or nets. In recent catch data (1991-1995) for Hawaii, 6 of the top 25 inshore species by weight were acanthurids (Friedlander 1996).[1] In American Samoa, Acanthuridae compose 28% of the reef fish catch (Dalzell et al. 1996), and over 40% of the catch composition by weight in the 1994 artisanal fishery was surgeonfishes. Some species are also sought after for the aquarium trade; those are discussed further as part of a separate management unit species assemblage.

There are no species of surgeonfish endemic to any of the management areas considered in this plan, although *A. triostegus sandvicensis* in Hawaii is recognized as an endemic subspecies. Also, *Zebrasoma flavescens* has a distribution from the North Pacific to southern Japan, but it is abundant only in Hawaii. Twenty-three species of surgeonfish are found in Hawaii (Randall 1996), 39 species in Micronesia (Myers 1991), and 32 species in Samoa .

Generally, acanthurids are diurnal herbivores or planktivores. All acanthurids shelter on the reef at night. *Acanthurus thompsoni, Naso annulatus, N. brevirostris, N. caesius, N. hexacanthus,* and *N. maculatus* feed primarily on zooplankton well above the bottom. *Naso lituratus* and *naso unicornis* browse mainly on leafy algae such as *Sargassum* (Randall 1996).

Surgeonfishes commonly defend territories that are primarily feeding territories; among three different species studied (*Acanthurus lineautus, A. leucosternon,*and *Zebrasoma scopas*), it was noted that each occupied characteristic depth zones and habitat types (Robertson et al. 1979).

Schooling behavior is common in acanthurids, particularly in association with spawning aggregations. Biologists have documented trains of surgeonfishes traveling along the reef to join thousands of other surgeonfish at spawning aggregation sites. Once there, the fish mingle near the substrate and slowly move upward as a group. Near dusk, small groups (6-15 individuals) of fish make spawning rushes to near the water surface and release gametes. Following spawning, fish return to the substrate, form trains, and return to their home reefs.

---

[1] *A . dussumieri*-32,407 lbs, *A. triostegus*-11,705 lbs, *Naso* spp.-9969 lbs, *A. xanthopterus*-5,234 lbs, *A. olivaceous*-4,813 lbs, and *Ctenochaetus strigosus*-3,776 lbs .

Many species also form large single-species or mixed-species schools, apparently for overwhelming territorial reef fish to feed on the algal mats they are protecting. In *Acanthurus nigrofuscus*, for example, such schools may number in the thousands, and the fishes may migrate as much as 500 to 600 m daily to reach the feeding grounds (Fishelson et al. 1987).

Acanthurid eggs are pelagic, spherical, and small, 0.66-0.70 mm in diameter with a single oil droplet to 0.165 mm for *Acanthurus triostegus sandvicensis* (Randall 1961). For that species, hatching occurred in about 26 hours. Watson and Leis (1974) found an egg size of 0.575 to 0.625 mm in diameter for an unidentified acanthurid from Hawaii. Like other coral reef fishes, surgeonfish larvae are typically less abundant in samples taken from the water column near the reef than they are in samples from offshore (Miller 1973). Surgeonfish larvae are primarily found well offshore at depths from 0-100m.

Although surgeonfish generally settle at a larger size than most reef fish, acanthurids are one of the families with juveniles that settle with larval characters still present (Leis & Rennis 1983). Late phase larvae actively swim inshore at night, seek shelter in the reef, and begin the transformation to juveniles (Clavijo 1974). Juvenile surgeonfish have been reported to shelter in tide pools in Hawaii (Randall 1961).

Adult surgeonfish are found in many coral reef habitat types, including mid-water, sand patch, subsurged reef, and seaward or surge zone reef. The largest number of surgeonfish species are typically found in the subsurge reef habitat, which are defined by Jones (1968) to be areas of moderate to dense coral growth corresponding to the subsurge portions of fringing reefs, deepwater reef patches, reef filled bays, and coral-rich parts of lagoons inside of atolls. These species are typically found between 0-30m depth, although surgeonfish do live in depths from 0-150m. Some species of *Naso* have been seen below 200m (Chave & Mundy 1994).

To reduce the complexity and the number of EFH identifications required for individual species and life stages, the Council has designated EFH for Acanthurid assemblages pursuant to Section 600.805(b) of 62 FR 66551. The designation of these complexes is based upon the ecological relationships among species and their preferred habitat. For a broader description of the life history and habitat utilization patterns of individual MUS see Section II. A.1.

Given the pelagic nature of the egg and larval phases of acanthurids, and their subsequent wide distribution, EFH for these life stages of this management unit is designated as extending from the shoreline to the outer boundary of the EEZ to a depth of 50 fm. For juvenile and adult acanthurids, because of their varied habitat preferences, EFH is designated as all bottom habitat and the adjacent water column from 0 to 50 fm.

B. Triggerfish (Balistidae)

The triggerfishes are named for an ability to lock their large, thickened first dorsal spine in an upright position, which can be released only by pressing down on the second dorsal spine (the trigger). When alarmed, or at night, they wedge themselves into a hole in the reef or rocks by erecting the first dorsal spine and pelvic girdle. During the day, most are carnivores of a wide variety or benthic animals including crustaceans, mollusks, sea urchins, other echinoderms, coral, tunicates, and fishes. Some feed largely on benthic algae and zooplankton, including *M. niger* and *M. vidua*, while *Xanthichthys auromarginatus* and *X. mento* feed mainly on zooplankton. Triggerfishes are usually solitary except when they form pairs at spawning time, although the black durgon, *Melichthys niger* may form large aggregations. Eleven species are known from the Hawaiian islands. At least 20 species occur in Micronesia, and at least 16 species occur in Samoa. The range of the family is circumglobal, with some species (e.g., the clown triggerfish, *Balistoides conspicillum*) extending into temperate waters (to South Hokkaido, Japan [Myers 1991]).

The habitat preferences for the family are variable, and may include protected lagoons, high-energy surge zones, ledges and caves of steep dropoffs, sand bottoms, and rocky coral areas (Myers 1991). Preferences may vary from species to species, or may change within a given species depending on the life phase. Of the eleven known Hawaiian species, one (*Canthidermis maculatus*) is strictly pelagic (Randall 1996), rather than reef-associated (and is thus not considered as part of this management unit assemblage). Depth preferences are also variable. Some species frequent the shallow subtidal zone, while others are known only from fairly deep waters (e.g., *Xanthichthys caeruleolineatus*, 75-200 m; Myers 1991). Many species are collected for aquariums; the clown triggerfish *Balistoides conspicillum* is among the most highly prized aquarium fishes.

Balistids produce demersal eggs that may or may not be tended by a parent, usually the female. Unlike most other families of reef fishes, the balistids exhibit extensive maternal care of eggs. This could be related to a harem-based social structure that requires the male to vigorously defend his territory from other males. Balistid eggs are spherical, slightly over 0.5 mm in diameter, and translucent. Eggs are typically deposited in shallow pits excavated by the parents as an adhesive egg mass containing bits of sand and rubble. Triggerfish eggs hatch in as little as 12 hours and no more than 24 hours. The pelagic larval stage can last for quite a while, and some species reach a large size before settling to the bottom. Several species of *Melichthys* can reach as much as 144 mm before settling (Randall 1971, Randall & Klausewitz 1973). Prejuveniles are often associated with floating algae, and may be cryptically colored. Berry and Baldwin (1966) suggested that sexual maturity of *Sufflamen verres* and *Melichthys niger* occurs at approximately half maximum size, at an age of a year or more.

To reduce the complexity and the number of EFH identifications required for individual species and life stages, the Council has designated EFH for Balistidae assemblages pursuant

to Section 600.805(b) of 62 FR 66551. The designation of these complexes is based upon the ecological relationships among species and their preferred habitat. For a broader description of the life history and habitat utilization patterns of individual MUS see Section II. A.54.

For the pelagic larvae of balistids, EFH is designated to include the shoreline to the outer boundary of the EEZ to a depth of 50 fm. For eggs, EFH is designated as the water column and all rocky or gravelly bottom areas from 0–50 fm. For adults and juveniles, EFH is designated as all bottom habitat and the adjacent water column from 0 to 50 fm.

C. Big Eye Scad (*Selar crumenophthalmus)* and Mackerel Scad (*Decapterus macarellus*)

Members of the family Carangidae, the big eye scad (*Selar crumenophthalmus*) and mackerel scad (*Decapterus macarellus*) are regarded as important food fishes in many of the US Pacific Islands. Silvery-blue in color, *Selar spp. and Decapterus spp.* have round spindle shaped bodies and grow to a length of 8 to15 inches. There are six common species of scads that occur in Hawaii, Micronesia, and Samoa: *Decapterus macarellus, D. macrosoma, D. maruadsi, D. Pinnulatus, Selar crumenophthalmus and S. boops*, although *D. macarellus and S. crumenophthalmus* comprise most of the commercial catch. Juvenile big eye scad seasonally form large schools in shallow sandy lagoons, bays and channels during the day where they feed on small shrimps, benthic invertebrates and foraminifera, and may migrate offshore at night (Meyers 1999). Adults generally remain offshore. In Hawaii, the big eye scad (akule) fishery is one of the heathiest commercial fishery in the state. During the annual appearance of juvenile akule (hahalalu), commercial and recreational fishers use a variety of gear including hook and line, surround gill nets and purse seine nets to harvest schools. Similarly, mackerel scad (opelu) are also harvested in this manner.

Depending on species, the ovaries of the female may contain from 30,000 to 200,000 eggs. The eggs are spherical with a single oil globule, non-adhesive and free-floating (Yamaguchi 1953). The spawning of scad occurs in the pelagic environment, although very little information is available concerning the distribution of eggs or larvae of *Selar spp.* and *Decapterus spp.* (but presumably these stages are dispersed widely by ocean currents). Therefore EFH for this life stage is designated as the water column from the shoreline to the outer limits of the EEZ to a depth of 50 fm. Because adult and juvenile scads are reported to occur both in very shallow nearshore waters, and deeper waters offshore, EFH for this life stage is designated as all sandy bottoms and adjacent water column from 0 to 50 fm.

D. Gray Reef Shark (*Carcharhinus amblyrhynchos*; Carcharhinidae)

The Carcharinidae are one of the largest and most important families of sharks, with many common and wide-ranging species found in all warm and temperate seas. They are the

dominant sharks in tropical waters in variety, abundance, and biomass. Most species inhabit tropical continental coastal and offshore waters, but several species prefer coral reefs and oceanic islands.

The gray reef shark (*Carcharhinus amblyrhynchos*) is distributed in tropical waters across the Indo-Pacific from the Red Sea eastward as far as Hawaii. It is often associated with coral reefs, and is one of the species most likely to be encountered by scuba divers. As with other sharks, the eggs of the gray reef shark develop internally. Thus there are no planktonic egg or larval phases. The gestation period for *C. amblyrhynchos* is about 12 months, with from 1-6 pups being produced in a litter. DeCrosta et al. (1984) reported maximum ages from a sample of 30-65 specimens to be 10 years, but Myers (1991) states that sexual maturity is only reached at around 7 years of age, and that the species may live up to 25 years.

Juvenile sharks frequently inhabit inshore areas such as bays, seagrass beds, and lagoon flats before moving into deeper water as they mature. Adult sharks prefer steep outer reef slopes and dropoffs, and the species has been reported from shallow waters to depths of 274 meters (Myers 1991). Adults may move back into shallow inshore areas during mating or birthing events. Some species forage in these shallow areas as well. Reef-associated sharks range widely and are found in a variety of coral reef habitats. Adult female *C. amblyrhynchos* have been reported to aggregate seasonally over shallow reef areas in the Northwestern Hawaiian Islands.

EFH for adult and juvenile *Carcharhinus amblyrhynchos* is designated as all bottom habitat and the adjacent water column from 0 to 50 fathoms. Since eggs and developing young are carried internally, no separate EFH designation for eggs or larvae is applicable.

E. Soldierfish/Squirrelfish (Holocentridae)

Holocentrids are spiny, deep-bodied, usually red fishes with large eyes and mouth, small teeth, large coarse scales, and stout dorsal and anal fin spines. The soldierfish genera *Myripristis, Plectrypops, Pristelepis, Ostichthys*, and the squirrelfish genera, *Neoniphon* and *Sargocentron,* are represented throughout the Indo-Pacific. Soldierfishes and squirrelfishes are nocturnal predators; soldierfish predominantly feed on large zooplankton in the water column, while squirrelfish prey mainly on benthic crustaceans, worms, and small fishes. Most holocentrids prefer low-light environments, and during the day hover along dropoffs, in or near caves and crevices, under rocky or coral overhangs, or among branching corals.

Depth ranges for the various holocentrid species are reported from shallow water down to an average of approximately 40 m, but with some species occurring as deep as 235m. About 17 holocentrid species inhabit Hawaiian waters. At least 13 species of soldierfishes and 16 species of squirrelfishes occur in Micronesia. At least 31 holocentrid species are found in Samoan waters. *Myripristis amaena* is particularly important in the recreational fishery at

Johnston Atoll where it is the species caught in greatest abundance (Irons et al. 1990). It is common in reef fish catches throughout the Hawaiian archipelago.

Little is known about embryonic development and larval cycles in this group. After fertilization, pelagic eggs are distributed in the water column for an indeterminate period of time. Both eggs and larvae are subject to advection by ocean currents. The larval stage is believed to last for several weeks, at the end of which the larvae settle down in refugia on the reef.

Holocentrids are slow growing, late maturing, and fairly long lived. A study (Dee and Parrish 1993) on the reproductive and trophic ecology of *Myripristis amaena* found that sexual maturity for both sexes was reached between 145 and 160 mm SL at about 6 yrs of age. Longevity was determined to be at least 14 years. Fecundity was relatively low, fewer than 70,000 eggs in the most fecund specimen, and increased sharply with body weight. Spawning peaked from early April to early May, with a secondary peak in September. The diet of *M. amaena* was mainly meroplankton, especially brachyuran crab megalops, hermit crab larvae, and shrimps, but also a variety of benthic invertebrates and fishes.

To reduce the complexity and the number of EFH identifications required for individual species and life stages, the Council has designated EFH for Holocentridae assemblages pursuant to Section 600.805(b) of 62 FR 66551. The designation of these complexes is based upon the ecological relationships among species and their preferred habitat. For a broader description of the life history and habitat utilization patterns of individual MUS see Section II. A.9.

In light of the uncertainties about distribution of eggs and larvae of the Holocentridae, EFH for these stages is designated under the Coral Reef Ecosystem FMP as the water column extending from the shoreline to the outer boundary of the EEZ to a depth of 50 fm. EFH for holocentrids in the juvenile and adult stages is designated as all rocky and coral areas and the adjacent water column from 0 to 50 fm. Because caves, crevices and overhangs serve as the primary sheltering habitat for all species of the family Holocentridae, these areas are particularly important habitat.

F. Flag-tails (Kuhliidae)

The flagtail family is comprised of the single genus *Kuhlia*, distributed throughout the Indo-Pacific region. The flagtails are ordinary-looking silvery fishes, usually with banded tails. The Hawaiian flagtail, or 'aholehole (*Kuhlia sanvicensis*), is an endemic species that is much prized as a food fish. 'Aholehole form dense schools by day, often in areas of heavy surge, where they are safe from predators; at night the schools disperse to feed on plankton. Young 'aholehole are often found in tidepools. 'Aholehole may enter brackish and even fresh water areas (Hoover 1993).

Kuhlia marginata is found on Johnston Island and in Micronesia., while *K. mugil* has a wide Indo-Pacific distribution (Myers 1991). *K. rupestris* is a brackish-water species from Guam (Randall 1996).

No information on the egg and larval stages of this species is available so a conservative designation for EFH for these stages was made, from 0-50 fm from the shoreline to the limits of the EEZ. Because adult and juvenile flagtails are generally found in very shallow waters, EFH for this management unit is designated as all bottom habitat and the adjacent water column from 0 to 25 fm.

G. Rudderfishes (Kyphosidae)

Rudderfishes, or sea chubs, are shore fishes that occur over rocky bottoms or associated with coral reefs along exposed coasts. They are distributed throughout the tropical and sub-tropical Indo-Pacific from Easter Island westward to the Red Sea. Adults of species in the genus *Kyphosus* typically swim in schools several meters above the bottom, and are reported to feed on a variety of algae including filamentous Rhodophyta and coarse Phaeophyta such as *Sargassum* (Myers 1991). Three species occur in Hawaii, Micronesia, and Samoa: *Kyphosus bigibbus, K. cinerascens*, and *K. vaigiensis*. Another species, *Sectator ocyurus* has been reported in Hawaii, but is rare and may be a waif from the tropical eastern Pacific. *K. cinerascens* may occur at least to 24 m depth.

Very little is known about reproduction in the kyphosids. The eggs are spherical, pelagic, and 1.0-1.1 mm in diameter (Watson and Leis 1974). The larvae hatch at 2.4–2.9 mm. Eggs and larvae are both subject to advection by ocean currents. The largest pelagic specimen, a juvenile, examined by Leis and Rennis (1983) was 56 mm. Juvenile individuals may be carnivorous for a while before becoming herbivorous (Rimmer 1986). Juveniles often occur far out at sea beneath floating debris.

To reduce the complexity and the number of EFH identifications required for individual species and life stages, the Council has designated EFH for Kyphosidae assemblages pursuant to Section 600.805(b) of 62 FR 66551. The designation of these complexes is based upon the ecological relationships among species and their preferred habitat. For a broader description of the life history and habitat utilization patterns of individual MUS see Section II. A.33.

The scant information available for the developmental life history for eggs, larvae and juveniles for this family indicates that these stages usually occur in the upper layer of pelagic waters. EFH for these stages is designated to extend from the shoreline to the outer boundary of the EEZ to a depth of 50 fm. Because adults are almost always found in very shallow inshore waters, EFH is designated all rocky and coral bottom habitat and the adjacent water column from 0 to 15 fm.

H. Wrasses (Labridae)

The Labridae comprise a large family, second only to the Gobiidae for number of species in the Western Pacific. It is a very diverse family in size and body shape, with adult sizes ranging from less than 5 cm in *Wetmorella albofasciata* to greater than 229cm in the Napoleon, *Cheilinus undulatus*.

Labrids are shallow-water fishes closely associated with coral reefs or rocky substrate, though some species of *Bodianus* occur deeper than 200 m (Smith 1986, Chave & Mundy 1994), and the razorfishes, *Xyrichtys* and *Cymolutes* spp., occur on sand flats (though densities of these two genera tend to decline with distance from coral reefs;). Labrids are diurnal, and at night many bury themselves in the sand, seek refuge in holes and cracks of the reef, or lie motionless on the bottom. During the day, labrids keep close to coral or rocky cover, darting into refugia in the reef or burying themselves in the sand when danger approaches. Labrids can be found in virtually all coral reef habitats, including rubble, sand, algae, seaweeds, rocks, flats, tidepools, crevices, caves, fringing reefs, patch reefs, lagoons and reef slopes (Myers 1991, Randall 1993, Green 1996). Schooling behavior and excursions away from the reef into the water column are usually associated with reproduction (Thresher 1984). The degree of association with reef habitat varies for different species; many members of the family have large home ranges encompassing a wide variety of habitats (Green 1996). In general, many of the smaller species stay confined to very small areas of the reef, while larger species have bigger home ranges (Green 1996). However, even very large species such as *Cheilinus undulatus* return to favored holes or crevices to spend the night or to escape danger (Myers 1991).

The geographic range of the family as a whole includes shallow tropical and temperate seas of the Atlantic, Pacific, and Indian Oceans. Labrids are found throughout shallow areas in the Western Pacific, and include 96 known species in Micronesia (Myers 1991), and 43 species in Hawaii. Fourteen species of wrasses are endemic to Hawaii: *Anampses chrysocephalus*, *Anampses cuvier*, *Bodianus sanguineus*, *Cirrhilabrus jordani*, *Coris ballieui*, *Coris flavovittata*, *Coris venusta*, *Cymolutes lecluse*, *Labroides phthirophagus*, *Macropharyngodon geoffroy*, *Stethojulis balteata*, *Thalassoma ballieui*, *Thalassoma duperrey*, and *Xyrichtys umbrilatus* (Randall 1996). The Hawaiian population of another species, *Bodianus bilunulatus albotaeniatus*, is recognized as a subspecies (Randall 1996). No wrasse species are reported to be endemic to American Samoa. There are no important species of introduced wrasses to the Western Pacific.

There is generally a dearth of information on the life history parameters of age, growth, and mortality of many coral reef fishes, including labrids, and what information exists for some species cannot realistically be applied to the whole family.

Many species migrate to prominent coral or rock outcrops for spawning, including species of *Thalassoma*, *Halichoeres*, *Choereodon*, *Bodianus*, and *Hemigymnus* (Thresher 1984). Sandy

areas are necessary for the sand-dwelling labrids, *Xyrichtys spp.* and *Cymolutes spp.* Labrid eggs are pelagic, spherical, 0.45 to 1.2 mm in diameter, lightly pigmented if at all, and usually contain a single oil droplet (Leis & Rennis 1983, Thresher 1984, Colin & Bell 1991). Larvae hatch at 1.5-2.7 mm and have a large yolk sac, unformed mouth, and unpigmented eyes (Leis & Rennis 1983). Both eggs and larvae are dispersed by ocean currents. Victor (1986) measured the duration of the larval phase of twenty four species of wrasses in Hawaii and found a range of 29.5 days (*Anampses chrysocephalus*) to 89.2 days (*Thalassoma duperrey*), although he noted substantial variability within species, up to a standard deviation of 11 days for some wrasses. Victor (1986) and other authors (Miller 1973, Leis & Miller 1976) have noted that despite their abundance as adults in the nearshore fauna of coral reef habitats, labrid larvae are conspicuously absent from nearshore samples, and common in offshore samples. Some labrid larvae are routinely found in the open ocean (Leis & Rennis 1983).

Like adult wrasses, juvenile labrids inhabit a wide variety of habitats from shallow lagoon flats to deep reef slopes. Green (1996) reported that *Labroides dimidiatus* and *Thalassoma lunare* use deeper reef slope and reef base habitats as recruits, and shallower habitats as adults. Examples of ontogenetic shifts in habitat use are not widely reported for the family, although relatively few studies have examined the topic.

Labrids have some importance as a minor component of the catch of commercial fishermen in Hawaii, according to Division of Aquatic Resources catch statistics from 1991-1995. Two species are present in the top 25 inshore fish species by weight – 4159 lbs of *Bodianus bilunulatus* and 3955 lbs of *Xyrichthys pavo* (Table 15 in Friedlander 1996). Some wrasse species are caught for the aquarium trade, including *Pseudocheilinus octotaenia*, *Cirrhilabrus jordani*, *Thalassoma* spp., *Anampses chrysocephalus*, *Macropharyngodon geoffroy*, and *Novaculichthys taeniourus*, but wrasses are a small portion of the trade in numbers and value (Pyle, pers. comm). In American Samoa, labrids comprise less than 3% of the reef fish catch (Dalzell et al. 1996), while in Guam, Labridae made up 7.3 percent of total landings by weight of the small-boat based spearfishing landings between 1985-1991 (Table 63 in Green 1997). Dalzell et al. (1996) reported that labrids composed approximately 4% of the reef fish catch in Guam. Data on labrids from other sites in the region are either too general to be useful, or lacking.

I. Napoleon Wrasse (*Cheilinus undulatus*)

Within the Labridae, the Napoleon wrasse, *Cheilinus undulatus*, merits special consideration because of its importance as a target species and because its populations, under pressure through overfishing have been declining rapidly. Once an economically important species on Guam, *C. undulatus* is now rarely seen on the reefs, much less reported on the inshore survey catch results (Hensley and Sherwood 1993). Similar declines in the number of sightings are reported from Saipan (Green 1997). Spearfishing, particularly at night when wrasses are more exposed and vulnerable, has significantly decreased the numbers of this very large reef

fish. They are sought after despite accounts of ciguatera poisoning (Myers 1991). A description for the species as it occurs in Micronesia follows (Myers 1991):

The humphead is among the largest of reef fishes. Adults develop a prominent bulbous hump on the forehead and amazingly thick fleshy lips. Adults occur along steep outer reef slopes, channel slopes, and occasionally on lagoon reefs, at depths of 2 to at least 60m. They often have a "home" cave or crevice within which they sleep or enter when pursued. Juveniles occur in coral-rich areas of lagoon reefs, particularly among thickets of staghorn *Acropora* corals. The Napoleon is usually solitary, but occasionally occurs in pairs. It feeds primarily on mollusks and a wide variety of other well-armored invertebrates including crustaceans, echinoids, brittle stars, and starfish, as well as on fishes. It is one of the few predators of toxic animals such as the crown-of-thorns starfish, boxfishes, and sea hares. The thick fleshy lips appear to absorb sea urchin spines, and the pharyngeal teeth easily crush heavy-shelled gastropods like *Trochus* and *Turbo*. Much of its prey comes from sand or rubble.

Cheilinus undulatus ranges across the Indo-Pacific from the Red Sea to the Tuamotus, as far north as the Ryukyus, and south to New Caledonia. Though rare, the species can be found throughout Micronesia, and also in American Samoa.

To reduce the complexity and the number of EFH identifications required for individual species and life stages, the Council has designated EFH for Labridae assemblages pursuant to Section 600.805(b) of 62 FR 66551. The designation of these complexes is based upon the ecological relationships among species and their preferred habitat. For a broader description of the life history and habitat utilization patterns of individual MUS see Section II. A.41.

As indicated above, eggs and larvae of labrids are subject to wide dispersal by ocean currents. Similarly, adult labrids may occur over and utilize a wide range of habitat types that extend beyond the physical boundaries of coral reefs. Thus, EFH for all life stages in the Labridae is designated as the water column and all bottom habitat extending from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.

In light of the continued extreme vulnerability of the Napoleon to overharvesting, it is critical that its preferred habitats are protected so that there may be some opportunity for populations of the species to recover to healthier levels. Thus, cave environments that are known (past or present) habitat for adult napoleon wrasse, and *Acropora* beds that may provide suitable habitat for juvenile napoleon wrasse, are particular valuable habitat for this species.

J. Goatfish (Mullidae)

Goatfishes are important commercial fishes that are highly esteemed as food. All have a characteristic pair of long barbels at the front of the chin housing chemosensory organs, and the barbels are used to probe holes in the reef or nearby open sandy areas for benthic invertebrates or small fishes. Some species are primarily nocturnal, others are diurnal, and a

few are active by day or night. Nocturnal species tend to hover in stationary aggregations or rest on coral ledges by day. In general, goatfishes are found in shallow waters, to depths of around 10m, but some species are reported from deeper waters (e.g., *Mulloides pfluegeri* at 110m [Myers 1991]; *P. porphyreus* at 140m [Randall 1996]).

There are 10 native species of goatfish known from Hawaiian waters, and one accidentally-introduced species from the Marquesas, *Upeneus vittatus*. Two species, *Parupeneus porphyreus* and *P. chrysonemus,* are endemic to Hawaii. Fifteen species are recorded from Micronesia. Thirteen species are recorded from Samoa.

Holland et al. (1993) conducted a study of the movements, distribution, and growth rates of *Mulloidichthys flavolineatus* by using tagging data. *M. flavolineatus* and *M. vanicolensis* were the most abundant mullids found in Hanalei Bay, Kauai (Friedlander et al. 1997). *M. flavolineatus* ranked second in overall mean biomass at 211g/100m^2, with an overall mean numerical density of 1.1 individuals/100m^2. *M. vanicolensis* had higher numbers in patch reef habitat, but the larger fish were present in reef slope habitat, indicating partitioning of habitat by size. *Parupeneus cyclostomus* was the rarest and most mobile of the mullids found in Hanalei Bay, with an overall mean density of 0.01 individuals/100m^2 or 2.02 g/100m^2. The largest individuals were seen in deeper reef slope habitat.

Schooling is common among the mullids, and group spawning and pair spawning have been documented for the family. An aggregation of 300 to 400 individuals was observed spawning at 21m depth off the coast of the U.S. Virgin Islands (Colin & Clavijo 1978). Groups of fish made spawning rushes about 2 meters above the bottom before releasing gametes.

Goatfish have pelagic eggs which are spherical, transparent, and non-adhesive with a single oil droplet. Egg diameters range from 0.63 to 0.93 mm and hatch within 3 days. Large size of larvae at settlement, and wide distribution, suggest that goatfish in general have a larval development period that lasts several weeks. Pelagic eggs and larvae are subject to advection by ocean currents. After settlement, juveniles take approximately one year to reach sexual maturity. Munro (1976) suggested that few live more than 3 years. In *P. porphyreus*, peak spawning occurs somewhere between December and July. Counts of nuclear rings on otoliths indicate a larval period of approximately 40-60 days. The juvenile phase involves rapid color changes, a lengthening of the gut, and an external change in shape. Fishes can mature sexually by about 1.25 years of age. Fecundity was estimated as 11,000 to 26,000 eggs per spawn. Adults in this species may live 6 years or longer (Moffitt 1979).

To reduce the complexity and the number of EFH identifications required for individual species and life stages, the Council has designated EFH for Mullidae assemblages pursuant to Section 600.805(b) of 62 FR 66551. The designation of these complexes is based upon the ecological relationships among species and their preferred habitat. For a broader description of the life history and habitat utilization patterns of individual MUS see Section II. A.32.

EFH for the egg and larval stages of the mullids is designated as the water column extending from the shoreline to the outer boundary of the EEZ to a depth of 50 fm. EFH for the juvenile and adult stages is designated as all rocky/coral and sand-bottom habitat and adjacent water column from 0 to 50 fm.

K. Mullets (Mugilidae)

The Mugilidae, or mullet family, includes silver-sided fishes that generally favor shallow nearshore waters. They can tolerate a wide range of salinities, are often found in brackish water, and occasionally even venture into fresh water. Traditionally, mullets have been an important food resource for people throughout the Western Pacific. Mullets generally feed over the reef or over sandy or mud bottoms. Three species of mullet occur in Hawaii: the common Striped mullet or 'ama'ama (*Mugil cephalus*), the Acute-jawed mullet or uouoa (*Neomyxus leuciscus*), and *Moolgarda engeli*, an introduced species that is proliferating at the expense of the more important striped mullet. At least 8 species in 5 genera are reported from Micronesia (Myers 1991). By weight, the striped mullet is ranked tenth among fish species caught inshore in Hawaii (DAR data in Green 1997), while acute-jawed mullet is the fourth most-important species caught at Johnston Atoll (1989-1990 data, Green1997).

Striped Mullet (*Mugil cephalus*): This species feeds over sandy or muddy bottoms in shallow water, filtering out fine algae and organic detritus material through the gills. Although reported to have circumglobal distribution in subtropical seas, there are no verifiable records in the literature of the occurrence of the species in Micronesia (Myers 1991), and it is possible that other species or subspecies may account for the reportedly wide distribution (Randall 1996).

Very little information is available concerning the distribution of eggs or larvae of mullets. (but presumably these stages are dispersed widely by ocean currents). Therefore EFH is designated as the water column from the shoreline to the outter limits of the EEZ to a depth of 50 fm. Because adult and juvenile mullets are reported to occur almost exclusively in very shallow nearshore waters, EFH for the species is designated as all sand and mud bottoms and the adjacent water column from 0 to 25 fm.

L. Moray Eels (Muraenidae)

Members of Muraenidae, the morays, lack pectoral fins and scales and have a large mouth. Most species have long, fang-like teeth, but some do not. Species with long canines feed mainly on reef fishes, occasionally on crustaceans and octopuses. Species of Echidna and Gymnomuraena with mainly nodular or molariform teeth feed more on crustaceans, especially crabs. Morays have a lengthy pelagic leptocephalus larval stage that has resulted in a very wide distribution. In the Pacific Islands, morays are hunted for food in many locations, even though large individuals may be ciguatoxic. Morays typically remain hidden

within the framework of the reef, and many are more active at night than during the day. There are 38 species of morays in Hawaii, second only to the wrasses for number of species. *Gymnothorax steindachneri* is endemic to Hawaii. At least 53 species are known from Micronesia. At least 47 species are known from Samoa.

Eel eggs are pelagic and spherical with a wide periviteline space, usually no oil droplets and in some species a densely reticulated yolk. The eggs are relatively large, ranging from 1.8 to 4.0 mm. Watson and Leis (1974) collected 145 eels eggs off Hawaii that ranged from 2.4 to 3.8 mm. Brock (1972) found 200,000 to 300,000 ripe eggs in each of four 5.0 to 6.8 kg *Gymnothorax javanicus*. Hatching of an unidentified 1.8 mm muraenid egg took approximately 100 hours (Bensam 1966).

Eels have a characteristic leptocephalus larval stage: a long, transparent, feather-shaped larva that starts out at 5-10 mm and grows up to 200 mm before settlement and metamorphosis. The duration of the planktonic stage is on the order of 3–5 months for moringuids (Castle 1979), 6–10 months for muraenids (Eldred 1969, Castle 1965) and about 10 months for some congrids (Castle and Robertson 1974).

Both juvenile and adult eels inhabit cryptic locations in the framework of the reef or in sand plains for some species. Some species remain so hidden within the reef that they have never been seen alive; their existence is known only from samples taken with the use of poisons.

To reduce the complexity and the number of EFH identifications required for individual species and life stages, the Council has designated EFH for Muraenidae assemblages pursuant to Section 600.805(b) of 62 FR 66551. The designation of these complexes is based upon the ecological relationships among species and their preferred habitat. For a broader description of the life history and habitat utilization patterns of individual MUS, see Section II. A.

Because moray eels eggs and larvae have a pelagic phase, EFH for this life phase is designated as the water column from the shoreline to the outer limits of the EEZ to a depth of 50 fm. The EFH for the adult and juvenile phase is defined to include all coral, rocky and sand-bottom areas from 0 to 50 fm.

M. Octopuses (Octopodidae)

The octopods are mollusks of the class Cephalopoda. Several octopod species are found in the region, and at least two (*Octopus cyanea* and *O. ornatus*) are of some economic importance. While some octopods are known from at least 1,000 meters depth, these deep-water species are not reef-associated. Reef-inhabiting octopods generally occur from the shallowest parts of the reef down to depths of around 50 m. They are bottom-dwelling species that usually occupy holes and crevices in rocks or coral areas; while they can swim rapidly if necessary (especially in escape swimming), octopuses usually avoid swimming in

mid-water. In sandy areas, they may dig burrows or construct shelters built from scattered rocks. Octopods venture out of their dens in search of food, and may swim and crawl over the bottom to distances more than 100m from their holes. In Hawaii, *Octopus cyanea* forages during the day, and is known as "day squid", while *O. ornatus,* the "night squid", forages after dark (Kay 1979).

Octopods lay demersal eggs that are attached in clusters within rocky recesses on the reef. Some (e.g., large specimens of *Octopus cyanea*) may lay up to 700,000 eggs (Van Heukelem 1983). Embryonic development is considered "direct," that is, there is no larval phase. However, the degree of development at hatching may be related to the size of the egg. In those species with smaller eggs (<4mm), hatchlings are less-developed, and first go through a planktonic "paralarval" phase, before settling down to a benthic existence (Young and Harman 1989). Those species with larger eggs (around 17mm range) are typically more developed, and hatch immediately to a benthic stage. In *Octopus cyanea*, eggs are about 3mm in diameter. Newly-hatched juveniles are about 3mm long, and enter a planktonic stage, believed to last around 30-40 days. Similarly, *Octopus ornatus* has a juvenile, planktonic paralarval stage that measures less than 4mm in mantle length (Young and Harman 1989).

The following octopod species are known from Hawaiian waters: *Octopus cyanea, O. ornatus, Berrya hoylei* and *Scaeurgus patagiatus*. An additional three unnamed species are believed present (Young and Harman 1989). *Octopus hawiiensis,* an endemic species originally described in 1837, was only recently observed again in the islands (Hoover 1998). Octopus are a component of the incidental catch of the lobster-trap fishery in the Northwest Hawaiian Islands (WPRFMC 25 May 99). An unnamed species of octopus is known from Waianae, Oahu. It occupies burrows in sandy areas. The burrows have openings about the diameter of a thumb. It is not known whether the octopus digs the burrow, or simply occupies a burrow already dug by another animal (e.g., mantis shrimp). This octopus emerges from its burrow and mimics a flatfish (B. Carlson, pers. comm. 27 Aug 99).

On Tutuila Island, American Samoa, it was reported that octopus accounted for approximately five percent of the catch composition for the shoreline subsistence fishery (Craig et al. 1993). Octopus (*Octopus cyanea* and *O. ornatus*) are reef-associated species commonly taken as food in the Marianas (Myers 1997 in Green October 1997). *Octopus cyanea* was identified as a species found on the reef slope at Rota, and targeted for capture in the local fishery (Smith et al 1989). Octopus are considered a preferred catch item in Saipan (Micronesian Environmental Services, March 1997). Octopus, mainly *Octopus cyanea,* are considered the most sought-after unshelled mollusk.

To reduce the complexity and the number of EFH identifications required for individual species and life stages, the Council has designated EFH for Octopods assemblages pursuant to Section 600.805(b) of 62 FR 66551. The designation of these complexes is based upon the ecological relationships among species and their preferred habitat.

Because some species of octopus have a pelagic paralarval phase that is subject to advection by ocean currents, EFH for this life phase is designated as the water column from the shoreline to the outer limits of the EEZ to a depth of 50 fm. The EFH for the adult and juvenile phase and for the demersal eggs of the octopods, is defined to include all coral, rocky and sand-bottom areas from 0 to 50 fm.

N. Threadfins (Polynemidae)

Threadfins are relatives of the mullets, named for their thread-like lower pectoral rays that are used as feelers which become relatively shorter with growth. Threadfins typically occur over shallow sandy to muddy bottoms, occasionally in fresh or brackish water. One species, *Polydactylus sexfilis,* or moi, occurs in Hawaii, where it is highly valued as a food fish. In Hawaii, it has become rare as a result of intense fishing pressure, and is currently being propagated in hatcheries for use in stock enhancement projects. The same species occurs in Micronesia. Two species occur in Samoa, *P. sexfilis* and *P. plebeius*. The family Polynemidae is distributed throughout the tropical waters of the Atlantic and Indo-Pacific Oceans.

P. sexfilis is a fast-growing species that inhabits turbid waters, and can be found in large schools in sandy holes along rocky shoals and high energy surf zones. In Kaneohe Bay, adults may be found on reef faces, in the depths of the inner bay and in shallow (2-4 m) areas with muddy sand bottoms (Lowell 1971). When moi were more abundant in Hawaii, airplane spotters used to locate large schools and direct net fishermen to the catch. Threadfins are also reported to prefer sandy and mud bottom habitats in Micronesia (Myers 1991).

Spawning takes place for 3-6 days per month and has been observed in Hawaii from June to September, with a peak in July and August (Ostrowski and Molnar 1997). Spawning may be year-round in very warm locations. Spawning occurs inshore and eggs hatch offshore within 14-24 hours depending on water temperature (May 1979). Eggs are small, averaging 0.75 mm in diameter with a large oil globule. Both eggs and larvae are subject to advection by ocean currents. Larvae are pelagic, but after metamorphosis they enter nearshore habitats such as surf zones, reefs, and stream mouths (Ostrowski and Molnar 1997). Young moi, from 150-250 mm long, are found from shoreline breakers to 100 m depth (Lowell 1971). Fishing for juvenile *P. sexfilis*, or moilii, has historically been an important recreational and subsistence seasonal fishery in Hawaii.

To reduce the complexity and the number of EFH identifications required for individual species and life stages, the Council has designated EFH for Polynemidae assemblages pursuant to Section 600.805(b) of 62 FR 66551. The designation of these complexes is based upon the ecological relationships among species and their preferred habitat. For a broader description of the life history and habitat utilization patterns of individual MUS see Section II. A.44.

EFH for the egg and larval stages of the polynemids is designated as the water column extending from the shoreline to the outer boundary of the EEZ to a depth of 50 fm. EFH for the juvenile and adult stages is designated as all rocky/coral and sand-bottom habitat and the adjacent water column from 0 to 50 fm.

O. Bigeyes (Priacanthidae)

Priacanthids are nocturnal zooplanktivores that feed on larger zooplankton such as the larvae of crabs, fishes, polychaete worms and cephalopods. The family is distributed circumtropically and in temperate seas, but some species are limited to the Indo-Pacific or the Hawaiian islands. In Hawaiian waters, 4 species have been recorded: *Heteropriacanthus cruentatus*, the endemic *Priacanthus meeki*, and two deep-water species. In Micronesian waters, *H. cruentatus*, *P. hamrur*, and a deep species from over 200 m depth have been recorded. The shallow-water species are limited to 100 m or less. Five species are recorded from Samoan waters.

The glasseye, *H. cruentatus*, inhabits lagoon or seaward reefs from below the surge zone to a depth of at least 20m. During the day it is usually solitary or in small groups but may gather in large numbers at dusk prior to ascending into the water column for feeding.

Spawning by priacanthids has not been observed, but Colin and Clavijo (1978) reported seeing an aggregation of more than 200 individuals at a reef where many other species were spawning. The eggs of *Pristigenys niphonium* and *Priacanthus macracanthus* are pelagic, spherical, and 0.75 mm in diameter (Suzuki et al. 1980, Renzhai and Suifen 1982). The larvae hatch at 1.4 mm (Renzhai and Suifen 1982). The size of the largest examined pelagic larval specimen was 48 mm (Leis and Rennis 1983). Eggs and larvae are subject to advection by ocean currents. Caldwell (1962) reported a size at settlement for the deepwater subtropical species *Pristigenys alta* of 65mm.

Habits and habitat preferences for the family are similar to those of the holocentrids, in that these fishes prefer shaded overhangs, caves, and crevices on the reef during the daytime. At night, fishes may move out into the water column to feed, and some types are reported to feed over soft-bottom areas.

To reduce the complexity and the number of EFH identifications required for individual species and life stages, the Council has designated EFH for Priacanthid assemblages pursuant to Section 600.805(b) of 62 FR 66551. The designation of these complexes is based upon the ecological relationships among species and their preferred habitat. For a broader description of the life history and habitat utilization patterns of individual MUS see Section II. A.23.

Because the distribution of eggs and larvae of the Priacanthidae have not been thoroughly studied, a precautionary approach is required in establishing EFH for these stages. Therefore, EFH for priacanthid eggs and larvae is designated as the water column extending

from the shoreline to the outer boundary of the EEZ to a depth of 50 fm. EFH for priacanthids in the juvenile and adult stages is designated as all rocky/coral and sand-bottom habitat and the adjacent water column from 0 to 50 fm.

P. Parrotfishes (Scaridae)

Scarids inhabit a wide variety of coral reef habitats including seagrass beds, coral-rich areas, sand patches, rubble or pavement fields, lagoons, reef flats, and upper reef slopes (Myers 1991). They are prominent members in numbers and biomass of shallow reef environments. Scarids are chiefly distributed in tropical regions of the Indian, Atlantic, and Pacific Oceans.

Parrotfishes often occur in large, mixed-species schools which rove long distances while feeding on reefs. A few species are territorial, but the majority are roving herbivores, with the size of the home range increasing with the size of the fish. Choat and Robertson (1975) found that smaller, less mobile scarids are usually associated with cover such as *Acropora* growth. Open areas with large amounts of grazing surface harbor larger, more mobile, and school-forming scarids. Schooling behavior is common among the scarids, both for feeding and spawning.

Species endemic to Hawaii are: *Calotomus zonarchus*, *Chlorurus per spicillatus*, and *Scarus dubius*. Seven species of scarids can be found in Hawaii, 33 species in Micronesia, and 23 species in Samoa.

Scarids spawn in both pairs and groups. Group spawning frequently occurs on the outer slope of the reef in areas with high current speeds. Pair spawnings are frequently observed at the reef crest or reef slope at peak or falling tide. Scarids have been observed to undergo spawning migrations within lagoons and to the outer reef slope (Randall and Randall 1963, Yogo et al. 1980, Johannes 1981, Choat and Randall 1986, Colin and Bell 1991). Some species are diandric, forming schools and spawning in groups often after migration to specific sites, while others are monandric, at times being strongly site-attached with haremic, pair spawning (Choat and Randall 1986). The pelagic eggs and larvae of scarids are subject to dispersal by ocean currents.

To reduce the complexity and the number of EFH identifications required for individual species and life stages, the Council has designated EFH for Scarid assemblages pursuant to Section 600.805(b) of 62 FR 66551. The designation of these complexes is based upon the ecological relationships among species and their preferred habitat. For a broader description of the life history and habitat utilization patterns of individual MUS see Section II. A.42.

Q. Bumphead Parrotfish (*Bolbometopon muricatum*)

The Bumphead parrotfish, *Bulbometopon muricatum*, merits special consideration because of its importance as a target species and because its populations, under pressure through overfishing, have been declining rapidly over much of its range. The Bumphead is a very large parrotfish (to 120cm and 75kg) that typically occurs in schools on clear outer lagoon and seaward reefs at depths from 1-30m. They are often located on reef crests and fronts. In unfished areas they may enter outer reef flats at low tide. The Bumphead is very wary in the daytime but sleeps in groups on the reef surface at night, making it an easy target for spearfishermen. As a result, it has nearly disappeared from most of Guam's reefs. Johannes (1981) cites an example of Bumpheads changing the location of their sleeping site away from the shallow reef flat to the deeper reef slope in Palau in response to increasing nighttime spearfishing. Their range is Indo-Pacific, although they are not found in the Hawaiian Islands. On the Great Barrier Reef, fish of less than 400mm are thought to have different habitat requirements from larger fish, since these smaller fishes are not seen on outer reefs (H. Choat, personal communication).

To reduce the complexity and the number of EFH identifications required for individual species and life stages, the Council has designated EFH for Scarid assemblages pursuant to Section 600.805(b) of 62 FR 66551. The designation of these complexes is based upon the ecological relationships among species and their preferred habitat. For a broader description of the life history and habitat utilization patterns of individual MUS see Section II. A.42.

As indicated above, eggs and larvae of scarids are subject to dispersal by ocean currents. Similarly, adult scarids may occur over and utilize a wide range of coral and other shallow-water habitat types. Thus, EFH for all life stages in the Scaridae is designated as the water column and all bottom habitat from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.

In light of the continued vulnerability of the Bumphead parrotfish to overharvesting, it is critical that its preferred habitats be protected so that there may be some opportunity for populations of the species to recover to healthier levels over time. At present, little information is available regarding the specific habitat requirements of this species. Further research is thus needed to better understand the habitat requirements of the Bumphead parrotfish so that appropriate Habitat Areas of Special Concern can be designated, and other management measures initiated, to better protect this species.

R. Rabbitfish (Siganidae)

Siganids are small (from 20 -50 cm), essentially marine tropical Indo-West Pacific fishes. They have venomous dorsal, anal and pelvic spines. With a single row of flattened, close-set teeth, rabbitfishes feed primarily on algae and seagrasses, although some may occasionally

feed on tunicates or sponges. Because of their herbivorous diet, most species live at depths less than 15 m, but some are trawled from as deep as 50m. Half the species live as pairs on coral reefs, the others usually gather in small schools. One species, *Siganus vermiculatus*, is almost exclusively estuarine; the rest move between estuaries, coral reefs, rocky shores, and other habitats. Rabbitfishes generally spawn on a lunar cycle with peak activity during the spring and early summer. Spawning occurs in pairs or groups on outgoing tides either at night or early in the morning. Juveniles of some species are estuarine. Rabbitfishes are highly esteemed foodfishes. Some of the colorful ones are popular aquarium fishes. None are found in Hawaii. Approximately 16 species are found in Micronesia, and at least 4 species in Samoa.

Spawning by rabbitfishes is typically preceded by a migration to specific and traditional spawning sites. The location varies from near mangrove stands (*S. lineatus*, Drew 1971), to shallow reef flats (*S. canaliculatus*, Manacop 1937, Johannes 1981), the outer reef crest (several spp. at Palau, McVey 1972; Johannes 1978), and even the deeper reef (*S. lineatus*, Johannes 1981). Sites are usually characterized by easy access to the ocean via channels, and large areas of sea grass flats nearby.

Reproduction in the schooling species has been studied in some detail, and in general the eggs are adhesive and demersal (with a few exceptions such as the pelagic eggs of *S. argenteus*); hatching occurs within 1-3 days and yolk sac absorption is completed in about 3 or 4 days (Lam 1974). Fecundity is high: 250,000-500,000 eggs per spawning season (Lam 1974, Gunderman et al. 1983). Larvae are pelagic and feed on phytoplankton and zooplankton. The duration of the larval stage is about 3 weeks in *S. fuscescens* (Hasse et al. 1977) and 3-4 weeks in *S. vermiculatus* (Gunderman et al. 1983). Popper et al. (1976) reported that siganid larvae follow a lunar rhythm in appearing on the reef, typically arriving inshore 3-5 days after a new moon. Fish are 15-20 cm long and sexually mature after one year. Judging by maximum size, some species survive from 2-4 years. *S. argenteus* is unique amongst the Siganidae in having a prejuvenile stage which is distinct from the larval and juvenile stages and is specially adapted for a pelagic life (Hubbs 1958). They can reach sizes of 6-8 cm SL before settling. Not surprisingly, *S. argenteus* has the widest distribution of all rabbitfishes.

The rabbitfishes vary widely in their habitat uses. The schooling species typically move between a wide range of habitats, whereas the pairing species tend to lead a sedentary existence among the branches of hard corals. Rabbitfishes are common on reef flats, around scattered small coral heads, and near grass flats. Gundermann et al. (1983) divided the siganids into two groups on the basis of habitat, behavioral characteristics and coloraton. One group includes species (*S. corallinus, S. puellus*, and *Lo vulpinnus*) that live in pairs, have limited home-ranges on reefs and are brightly colored. The remaining group, including *S. rivulatus* and *S. canaliculatus*, form schools at some stage of their life cycle, may undertake substantial migrations, and assume a coloration similar to their preferred habitat.

Schools of juvenile *S. rostratus* and *S. spinus* swarm on the reef flats of Guam each year during April and May, and occasionally during June and October. Tsuda et al. (1976) studied the feeding and habitat requirements for these fish to determine the likelihood of mariculture of the rabbitfishes, which are highly esteemed for gastronomic and cultural reasons in Guam.

Very little information is available concerning the distribution of eggs or larvae of rabbitfish. Therefore EFH for this life stage is designated as the water column from the shoreline to the outter limits of the EEZ to a depth of 50 fm. Because adult and juvenile rabbitfish are reported to occur almost exclusively in very shallow nearshore waters, EFH for this life stage is designated as all benthic habitats and the adjacent water column from 0 to 25 fm.

S. Barracudas (Sphyraenidae)

The barracudas, all in the single genus *Sphyraena*, are top-level carnivorous fishes that feed mainly on other fishes. Some species are primarily diurnal, while others are nocturnal. Species such as *Sphyraena helleri* school in large groups during the day, but disperse at night to feed. *Sphyraena barracuda* is typically a solitary diurnal predator. In Hawaiian waters, these are the only two species positively recorded. In Micronesian waters, at least 6 species occur. In Samoan waters, at least five species occur.

Juvenile *S. barracuda* occur among mangroves and in shallow sheltered inner reef areas. Adults occur in a wide range of habitats ranging from murky inner harbors to the open sea. *S. forsteri, S. acutipinnis, S. novaehollandiae*, and *S. obtusata* are all schooling barracudas that occur over lagoon and seaward reefs. *S. forsteri* is reported to occur on outer reef slopes to a depth of 300m (Myers 1991). *S. genie* is a larger schooling barracuda that frequently schools within defined territories on submarine terraces and is most often caught at night by trollers in Micronesia. In general, barracudas may be found in almost any tropical marine habitat, including within lagoons and mangrove areas, over coral reefs or sand or mud bottoms, or off of deep outer reef slopes.

Barracudas migrate to specific spawning areas, often in very large numbers at reef edges or in deeper water. The eggs are pelagic, spherical, and range in diameter from 0.7-1.5 mm with a single clear or yellow oil droplet. Eggs hatch within 24-30 hours. Both eggs and larvae may be carried for long distances by ocean currents. Larvae begin to feed within 3 days on small copepods. Larger larvae voraciously feed on zooplankton and other fish larvae. Settlement typically occurs at a length of 18 mm, but *S. barracuda* larvae occasionally drift in the ocean for an indefinite period of time, usually associated with floating debris or algae, developing all the characteristics of juveniles and sometimes attaining large sizes before being delivered inshore. Newly settled juveniles are piscivorous.

Because eggs and larvae of barracudas are subject to wide dispersal by currents, and since the adults may occur over virtually any bottom type, EFH for all life stages in the

Sphyraenidae is designated to extend from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.

T. Turban Shells/Green Snail (Turbinidae)

Turban shells are a gastropod belonging to the family Turbinidae which are distributed throughout the Indo-Pacific region extending into the South Pacific. In Micronesia and the South Pacific, several varieties of turban shells are harvested mainly for food but the shells of certain species are also highly prized for lacquerware and jewelry. The main species of turban shells harvested are the green snail (*Turbo marmoratus*), the rough turban (*T. Setosus*), and the silver-mouth turban (*T. Argyrostomus*).

Green snails share similar habitat with other gastropod species like the trochiids and are generally found in healthy coral reef habitats which receive constant flow of oceanic water. Juveniles are often found on shallow reef crests while adults prefer deeper habitats with well developed reef and abundant coral growth. Very little information is available on the reproduction of green snails as none have been observed spawning in the wild. Lab studies conducted by (Yamaguchi 1988) indicate that ovaries of a well developed female may contain up to 7 million eggs which are then ejaculated and fertilized by male sperm. Although the eggs are heavier than saltwater, they are easily dispersed with slight agitation.

To reduce the complexity and the number of EFH identifications required for individual species and life stages, the Council has designated EFH for Turbinidae assemblages pursuant to Section 600.805(b) of 62 FR 66551. The designation of these complexes is based upon the ecological relationships among species and their preferred habitat.

Because eggs and larvae are subject to advection by ocean currents, EFH for these stages is designated as the water column from the shoreline to the outer limit of the EEZ to a depth of 50 fm. For adults and juveniles, EFH is designated as all bottom habitat and the adjacent water column from 0 to 50 fm.

U. Aquarium Taxa/Species Habitat

Within the jurisdictional waters of the WPRFMC, Hawaii is the main site where commercial collection and sale of coral reef fishes and invertebrates for the aquarium trade is occurring. On Guam, commercial collection at present is quite limited (only one commercial operation is involved in the export of live aquarium fish). On American Samoa, commercial collection of aquarium fishes is allowed by permit, but presently there are no commercial aquarium fish operators. In CNMI, the commercial export of live aquarium fishes is prohibited. No aquarium fish collecting occurs on other U.S. Pacific islands, since these islands are either National Wildlife Refuges or are in use by the military (Green 1997).

Because Hawaii is the area where most commercial harvesting of aquarium species occurs, the aquarium MUS complex is based primarily on those species known from Hawaiian waters. While the descriptions that follow give general information about the distribution of aquarium taxa across the region, EFH is defined primarily on the basis of the occurrence of taxa in Hawaii.

The "Aquarium Species/Taxa"grouping, does not represent a taxonomically related cluster of species. Nonetheless, the species contained in this MUS form a natural assemblage from the ecological standpoint, since most are found in similar habitat, primarily being closely associated with shallow coral areas.[2]

1. Surgeonfishes (Acanthuridae)

Surgeonfishes are among the most common families found on Indo-Pacific coral reefs. They are primarily herbivores and planktivores. The larval period is long, up to around 2.5 months (Randall 1961). Surgeonfish larvae are primarily found well offshore at depths from 0-100m. Like other common adult members of the coral reef fish community, surgeonfish larvae are typically less abundant in samples of the water column near the reef than they are in samples from offshore (Miller 1973). Presumably, the prolonged pelagic larval period contributes to the wide distribution of species in this family. Although surgeonfish larvae generally settle at a larger size than most other reef fish, acanthurids are one of the families wherein juveniles settle with larval characters still present (Leis & Rennis 1983). Late-phase larvae actively swim inshore at night, and seek shelter on the reef. Surgeonfishes have relatively long life spans, up to as much as 40 years (Dalzell et al. 1996).

Yellow tang (*Zebrasoma flavescens*): Although widely distributed in the Indo-Pacific, this species is only abundant in Hawaii. The yellow tang is a popular aquarium fish that represents more than 75% of all aquarium animals caught statewide (Clark and Gulko 1999). They occur singly or in loose groups on coral-rich areas of lagoon and seaward reefs from below the surge zone to at least 46 m depth. Juveniles tend to hide among branches of finger coral, while adults graze near the shore in calm areas.

Z. flavescens tends to prefer the leeward sides of islands, particularly areas of dense coral growth of *Pocillopora damicornis* and *Porites compressa*. It feeds on algae growing exposed on basalt and dead coral heads, as well as in crevices and interstices of the reef that it can reach with its long, thin snout (Jones 1968).

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[3] One exception is the feather-duster worm, a sessile benthic invertebrate that occupies sandy or rubble bottom areas. The species is nonetheless included as part of the aquarium assemblage because of its commercial importance as a harvested aquarium species.

Yellow-eyed surgeon fish (*Ctenochaetus strigosus*): Like the yellow tang, the yellow-eyed surgeon is distributed across the tropical Indo-Pacific, but is only common in Hawaii. Individuals are observed in coral-rich areas of deep lagoon and seaward reefs. In addition to its importance as an aquarium species, it is also a popular food fish.

Achilles tang (*Acanthurus achilles*): This fish is distributed only in the Pacific Islands. It is common in Hawaii and Polynesia, but rare in Micronesia. It is a territorial species that feeds on filamentous and fleshy algae. The Achilles tang is primarily found in the surge zone to a depth of 4 m.

2. Moorish Idol (*Zanclus cornutus;* Zancildae)

The Moorish idol, sole member of this monotypic family, is ubiquitous in areas of hard substrate, from waters less than 1 m deep in turbid inner harbors and reef flats, to clear seaward reefs as deep as 182 m. It is often found in small groups but may sometimes occur in schools of as many as 100 or more individuals. The species has a long larval stage and settles at a large size, >6cm SL for some individuals. As a result, they are ubiquitous wherever hard substrate is found, from turbid inner harbors to clear seaward reefs. They feed mainly on sponges, but will also take other invertebrates and algae. Their range is the Indo-Pacific and tropical eastern Pacific, and they are found throughout the jurisdiction. They are a popular aquarium fish.

3. Angelfishes (Pomacanthidae)

Angelfishes are indisputably among the most beautiful and popular of all aquarium fishes, in many cases commanding very high prices. Six species are found in Hawaiian waters, and four of them are endemic: *Centropyge fisheri, Centropyge potteri, Desmoholacanthus arcuatus,* and *Genicanthus personatus*. At least 26 species occur in Micronesia, and at least 11 species occur in Samoa.

Pomacanthid eggs are small, spherical, nearly transparent, and contain from one to several oil droplets. Hatching occurs within 24 hours after release (Thresher 1984). Feeding by the larvae begins within 2-3 days and settlement to the bottom occurs between 17-39 days (Allen et al. 1998).

Adult angelfishes require suitable shelter in the form of boulders, caves, and coral crevices. Most species occur from 2 to 30 m depth, but a few such as *Centropyge narcosis* are found in waters over 100m deep. Angelfishes are territorial, and males frequently maintain a harem of 2-5 females and defend a territory ranging from a few square meters for some smaller species (e.g., *Centropyge*) to well over 1 sq km for some larger species (e.g, *Pomacanthus*).

Angelfish (*Centropyge shepardi and C. flavissimus*): These are two of the prime target species for the aquarium trade, and are found on Guam. Shepard's angelfish (*C. shepardi*) is usually observed on outer reef slopes at depths between 18-56 m. The lemonpeel angelfish (*C. flavissumus*) inhabits areas of rich coral growth in shallow lagoons or on exposed seaward reefs to depths of 25 m or more.

4. Dragon Moray (*Enchelycore pardalis*; Muraenidae)

Morays, in the family Muraenidae, occur mostly in waters less than 30 m deep. There are 38 species of morays in Hawaii, second only to the wrasses for number of species. *Gymnothorax steindachneri* is endemic to Hawaii. At least 53 species are known from Micronesia. At least 47 species are known from Samoa.

Eel eggs are pelagic, spherical, and relatively large, ranging from 1.8 to 4.0mm. Watson and Leis (1974) collected 145 eels eggs off Hawaii which ranged from 2.4 to 3.8mm. Brock (1972) found 200,000 to 300,000 ripe eggs in each of four 5.0 to 6.8kg *Gymnothorax javanicus*. Hatching of an unidentified 1.8mm muraenid egg took approximately 100 hours (Bensam 1966).

Eels have a characteristic leptocephalus larval stage: a long, transparent, feather-shaped larva that starts out at 5-10 mm and grows up to 200mm before settlement and metamorphosis. The duration of the planktonic stage is on the order of 6-10 months for muraenids (Eldred 1969, Castle 1965).

Both juvenile and adult eels inhabit cryptic locations in the framework of the reef, or in sand plains for some species. Some species remain so hidden within the reef that they have never been seen alive; their existence is known only from samples taken with the use of poisons. Many species emerge to feed and some may even slither over rocks and enter shallow tidepools. *Enchelycore pardalis*, the dragon moray, is a striking fish that is popular with aquarists, and may attain a length of around 1 m. It is distributed throughout the Indo-Pacific. Known in Hawaii as puhi kauila, it is more common in the NWHI than in the MHI.

5. Hawkfishes (Cirrhitidae)

Hawkfishes are small grouper-like fishes in the family Cirrhitidae. In Hawaii, there are 6 species recorded. At least 10 species occur in Micronesia, and at least 8 species occur in Samoa. The colorful species are popular aquarium fishes.

Eggs are pelagic, spherical, and approximately 0.5 mm in diameter. The development at hatching is unknown. A lengthy pelagic larval stage, probably lasting a few to several weeks (Randall 1963) is suggested by the widespread distribution and limited geographic variation of some species.

Adults typically inhabit rock, coral, or rubble of the surge zone, seaward reefs, lagoons, channels, rocky shorelines, and submarine terraces. Some are typically found on heads of small branching corals.

Longnose hawkfish (*Oxycirrhites typus*): The longnose hawkfish, *Oxycirrhites typus*, is a popular aquarium species that feeds mainly on zooplankton, and is usually seen perched on black coral or gorgonians at depths greater than 30 m. The fish is distributed throughout the Indo-Pacific from East Africa to the Americas. The fish is found and collected in Hawaii.

Flame hawkfish (*Neocirrhitus armatus*): This spectacular hawkfish is commonly found along surge-swept reef fronts and marine terraces to a depth of about 11m. It inhabits coral heads of various species, including *Stylophora mordax*, *Pocillopora elegans*, *P. edouxi*, and *P. verrucosa.* The species is distributed in the islands and coastlines of the Pacific plate, and is collected in Guam.

6. Butterflyfishes (Chaetodontidae)

Butterflyfishes are among the most colorful and conspicuous fishes on the coral reef. Many species are corallivores that feed on polyps of corals and other coelenterates. The corallivores tend to be territorial and limited to the shallower depth ranges of the corals that they feed upon (e.g., *Pocillopora meandrina*). Others feed heavily on benthic algae and small benthic invertebrates. Some species, including those of *Hemitaurichthys*, are primarily zooplanktivores which often occur in mid-water aggregations and range into relatively deep water.

Butterflyfish eggs are planktonic and hatch within two days. The duration of the planktonic stage is not well studied, but Burgess (1978) suggested it is likely to be at least several months. Settlement occurs at night and juveniles tend to occupy shallower, more sheltered habitats than adults. The family is represented in Hawaiian waters by 24 species; *Chaetodon fremblii, C. miliaris,* and *C multicinctus* are endemic to Hawaii, and *C. tinkeri* is found only in Hawaii and the Marshall Islands. The family is represented in Micronesian waters by at least 40 species, and in Samoan waters by 30 species. The yellow-crowned butterflyfish *C. flavocoronatus* is listed as a vulnerable species in Guam on the 1996 IUCN Red List.

Threadfin butterflyfish (*Chaetodon auriga*): This species is one of the most common butterflyfishes of areas of mixed sand, rubble, and coral, and typically occurs in shallow waters to a depth of 30m. It is distributed from the Red Sea eastward to Hawaii, and is taken as an aquarium fish in Hawaii and Guam.

Raccoon butterflyfish (*Chaetodon lunula*): This is a nocturnal species (possibly the only nocturnal butterflyfish) that inhabits lagoon and seaward reefs to depths in excess of 30m. It prefers rocky areas with high relief. Juveniles occur in shallows and tidepools. The species is

distributed from East Africa to Hawaii, and is captured for use as an aquarium fish in Hawaii and Guam.

Black-backed butterflyfish (*Chaetodon melannotus*): This species occurs in areas where corals grow luxuriantly, and can be found in shallow waters to depths of over 15 m. The black-backed butterflyfish is found from the Red Sea to American Samoa; it is absent in Hawaii. It has some importance as an aquarium species in Guam.

Saddled butterflyfish (*Chaetodon ephippium*): The saddled butterflyfish is a relatively common inhabitant of lagoon and seaward reefs to a depth oaf around 30m. It prefers areas of rich coral growth and clear water. The species is distributed throughout the Central and Western Pacific, but is uncommon in Hawaii. It is captured for aquarium use in Hawaii and Guam.

7. Damselfishes (Pomacentridae)

The damselfishes are among the most abundant fishes on coral reefs. Most damselfishes occur in shallow water on coral or rock substrata, wherever there is shelter. The species of *Chromis, Dascyllus, Lepidozygus, Amblyglyphidodon, Neopomacentrus*, and *Pomachromis* are aggregating planktivores that often form large schools in the water column. Most members of *Abudefduf, Chrysiptera*, and *Pomacentrus* are omnivores that feed on benthic algae, small invertebrates, or zooplankton. *Plectroglyphidodon johnstonianus* feeds on coral polyps. Other members of *Plectroglyphidodon*, as well as members of *Stegastes*, are aggressively territorial herbivores. Algal feeders frequently cultivate algal mats which they weed of undesirable algae and aggressively defend from other reef inhabitants. The anemonefishes, subfamily *Amphiprioninae*, live in a symbiotic relationship with large sea anemones. No anemonefish are found in Hawaii both because of the absence of host anemones, and the short larval duration, which has apparently prevented distribution of viable larvae to such an isolated location.

Pomacentrid eggs are demersal, elliptical, and adhesive by means of a cluster of fine threads at one end of the egg. Eggs are kept in nests and aggressively guarded by the males. Egg diameters range from 0.49 - 2.3mm. Hatching occurs in 2-4 days for most species, but up to 2 weeks for anemonefish eggs. The planktonic larval stage typically lasts 2-3 weeks but may be longer. Thresher, Colin and Bell (1989) found larval durations for the following genera: *Amphiprion* and *Premnas*: 7-14 days, *Chromis* and *Dascyllus*: 17-47 days with most between 20-30 days, and genera in the subfamily *Pomacentrinae*: 13-42 days. Size at settlement ranges from 7 to 15mm, and several studies suggest that settlement occurs mainly at dusk and at night (Williams 1980, Nolan 1975).

Many damselfishes are suitable for use in aquaria. Three of the species taken in the greatest numbers on Guam are further described below.

Blue-green chromis (*Chromis viridis*): Huge aggregations of this brightly colored chromis may be seen above thickets of branching corals in protected areas. They occur on subtidal reef flats and in lagoons to depths of around 12 m. The species has a wide distribution throughout the Indo-Pacific, from the Red Sea to Line Islands and throughout Micronesia.

Humbug dascyllus (*Dascyllus aruanus*): This damselfish occurs in large aggregations in shallow water, above branching *Acropora* heads. The fishes are strongly associated with their home coral heads. They are a shallow-water species, and are distributed from the Red Sea to the Line Islands, Lord Howe Island, and Micronesia.

Three-spot dascyllus (*Dascyllus trimaculatus*): This popular aquarium species occurs in waters from 1-55m depth. Juveniles shelter among sea anemone tentacles, and adults are found around prominent coral mounds or large rocks. The species has an Indo-Pacific distribution from the Red Sea to the Line Islands, Lord Howe Island, and Micronesia.

8. Turkeyfishes (Scorpaenidae)

The Scorpaenidae, variously known as lionfishes, turkeyfishes, or scorpionfishes, possess venomous dorsal, anal, and pelvic fins in many species. They are stout-bodied, benthic carnivores that typically have fleshy flaps, a mottled coloring, and small tentacles on the head and body. These camouflage features help them to hide and effectively ambush small fishes and crustaceans. Lionfishes and turkeyfishes may swim well above the bottom, whereas small cryptic species of the subfamily Scorpaeninae tend to remain on the bottom and may be quite common in shallow rubbly areas. Fishes in the family are often observed by divers in shallow waters (around 10 m) but may also occur deeper (to at least 50m). In Hawaiian waters, around 25 species in the family are known (Hoover 1993) and 3 are endemic: *Dendrochirus barberi, Pterois sphex*, and *Scorpaenopsis cacopsis*. At least 30 species are known from Micronesia, and at least 22 species are recorded from Samoa.

Most reef scorpaenids (*Scorpaena, Pterois, Dendrochirus*) have 0.7-1.2mm spherical to slightly ovoid eggs embedded in a large, pelagic, sac-like gelatinous matrix (Leis & Rennis 1983). Eggs hatch in 58-72 hours. The duration of the planktonic larval stage is not known.

9. Feather-duster Worms (Sabellidae)

Feather-duster worms are attached benthic invertebrates in the Phylum Annelida, Class Polychaeta. The most conspicuous part of these animals is the large fan, or crown. The body is enclosed in a leathery tube that is mostly embedded in the substrate of the reef, often in sandy or rubble-bottom areas. Feather-duster worms generally prefer shallow, turbid waters, and can be found inhabiting harbors, bays, and similar sheltered areas. Occasionally, they are also found in clearer waters, down to depths of 30m or more.

Collectively, the aquarium fish unit comprises a diverse array of organisms that favor a wide variety of substrates, depths, and habitats. However, in general the group is characterized by a close association with the shallow coral reef environment, and most collecting of the species in the group occurs within a narrowly-defined range, i.e., from near-surface waters to depths usually no greater than about 50 m. The EFH for the juvenile and adult phase of this management unit is therefore designated as all coral, rubble, or other hard-bottom features and the adjacent water column from 0-50 fm. EFH for eggs and larvae of the group (though some eggs are demersal, e.g. in damselfishes) is described to include waters from 0-50 fm from the shoreline to the limits of the EEZ.

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II. Descriptions of EFH for Management Unit Species

Introduction

This report presents a compilation of information that will be used to help to define essential fish habitat (EFH) as part of a Coral Reef Ecosystem (CRE) Fisheries Management Plan (FMP) for the Western Pacific Region pursuant to Sections 303(a) and (b) of the Magnuson-Stevens Act. The development of a CRE FMP is also in keeping with the spirit and intent of Executive Order No. 13089 on Coral Reef Protection, issued by the President on June 11, 1998.

The report presents data for selected fish, invertebrate, and sessile taxa, termed Management Units Species (MUS), occurring within the geographical fishery management units (FMUs) under the jurisdiction of the Western Pacific Regional Fishery Management Council (WPRFMC). Information was gathered through review of available literature, and communication with authorities in the field. For each taxon, an effort was made to locate those data that will be helpful in defining EFHs, including descriptions of the habitat and ecological requirements for each life phase of the organisms under consideration.

For the purpose of this investigation, the taxa included were limited to those known or believed to occur on or in association with coral reefs, at least during some phase of the life cycle. In general therefore, pelagic taxa are excluded from this report. Similarly, those species occurring exclusively in zones deeper than the typical depth for coral reefs (as defined by the lower limits of the photic zone, i.e., 100 m depth), are not included.

A. EFH for Management Unit Species – Fish

1. Acanthuridae (surgeonfishes)

The acanthurids typically have ovate to elongate compressed bodies, a small terminal mouth with a single row of close-set teeth, eyes high on the head, continuous unnotched dorsal and anal fins, and a tough skin with very small ctenoid scales. The common name surgeonfish stems from the presence of one or more pairs of sharp spines on the caudal peduncle which may be used to slash other fish or unwary human handlers. In species of the genera *Acanthurus*, *Ctenochaetus*, and *Zebrasoma*, the single lancet-like spine folds into a groove, while species of *Naso* have 2 fixed, keel-like spines. Some *Naso* species have a horn-like projection on the forehead, and as a result all members of the genus are commonly called unicornfishes. Generally, acanthurids are diurnal herbivores or planktivores. Species of *Ctenochaetus* and some of *Acanthurus* have a thick-walled gizzard-like stomach and often ingest sand with their diet of benthic algae. Some species of *Acanthurus* and many *Naso* spp. feed mainly on zooplankton in the water column. All acanthurids shelter on the reef at night. Reproduction typically occurs on a lunar cycle with greater activity in winter or early spring, but with some activity throughout the year. Spawning events are more frequent at dusk and

involve groups, pairs, or both. The larval stage is long by reef fish standards, and size at settlement is larger than most. Surgeonfishes are important foodfishes on most Pacific islands. This description was composed from Myers (1991) and Randall (1996).

Habitat utilization - Jones (1968) divided the acanthurids from Hawaii and Johnston Island into 4 major habitat types: mid-water (*Acanthurus thompsoni, Naso hexacanthus)*, sand patch (*A. dussumieri, A. mata, A. olivaceous, A. xanthopterus*), subsurge reef (*A. nigrofuscus, A. nigroris, A. sandvicensis, Ctenochaetus hawaiiensis, C. strigosus, Naso brevirostris, N. lituratus, N. unicornis, Zebrasoma flavescens, Z. veliferum*), and seaward reef or surge zone (*A. achilles, A. glaucopareius, A. guttatus, A. leucopareius*) dwellers. The same paper gives extensive descriptions of feeding habits and each species use of the habitat features.

Life history - The biology and life history of surgeonfish have been studied in a number of Western Pacific locations, including *Acanthurus triostegus* in Hawaii (Randall 1961), *Naso brevirostris* in French Polynesia (Caillart 1988), and *Acanthurus nigricauda* and *A. xanthopterus* in Papua New Guinea (Dalzell 1989). Age and growth has been described by a combination of oberving captive specimens, otolith microstructure, length frequency data, and tagging. Lou and Moltschanowskyj (1992) validated daily growth increment formation on otoliths of several juvenile surgeonfish species, and Lou (1993) plotted growth curves for juvenile *Ctenochaetus binotatus* by measuring lapillus growth increments. Surgeonfishes have relatively long life spans. Randall (1961) reported *Naso unicornis* and *Acanthurus xanthopterus* living 15-20 years in captivity. Surgeonfish on the Great Barrier reef have shown an average maximum life span of over 20 years, and 40 years in one instance (Dalzell et al. 1996). Both of these situations involve no mortality from fishing. Hart & Russ (1996) measured *A. nigrofuscus* ages and found a mean age at different reefs on the Great Barrier reef ranging from 5.4 to 9.5 years, with the oldest specimen being 25 years old. Choat and Axe (1996) aged 10 species of acanthurids from the Great Barrier Reef through the use of otoliths and found life spans of 30-45 years in which growth was very rapid in the first 3-4 years of life. In American Samoa, Craig et al. (1997) found *A. lineatus* to grow very rapidly during the first year, 70-80% of total growth, followed by slower growth and a long life, up to 18 years.

Permanent sexual dimorphism is uncommon in the family. There are usually few differences between males and females, though in some species there are size differences, usually larger males. Males of the genus *Naso* frequently have a larger horn than females. Sexual dichromatism only exists during times of spawning, the rest of the time the sexes are similarly colored. Spawning is frequently timed with the lunar cycle, either during a new moon, a full moon, or both. Many surgeonfishes spawn in large aggregations, and others spawn strictly in pairs. Pair spawners may spawn throughout the lunar month (Robertson et al. 1979). The act of reproduction for all surgeonfishes involves a quick upward rush of the participants and a release of gametes into the water column. Spawning rushes typically occur in low light conditions, usually at or near dusk.

Detailed descriptions of spawning behavior and spawning cycles of eight Indo-Pacific surgeonfish species are given in Robertson (1983).

Acanthurids appear to have a peak in spawning activity in late winter and early spring. Spawning of *Acanthurus triostegus* in Hawaii occurs primarily from December to June (Thresher 1984). Watson and Leis (1974) identified peak spawning from March to May, and another peak in October, for many reef fish in Hawaii, including acanthurids. There are instances of year-round spawning, and Randall (1961) suggested that seasonal variations in spawning may be less obvious in the deep tropics where variations in seawater temperature are less pronounced. Large aggregations of acanthurids do occur during spawning events, often near the mouths of channels in the reef and in areas with strong offshore currents (Randall 1961, Johannes 1981).

There are no species of surgeonfish endemic to any of the management areas in this plan, although *A. triostegus sandvicensis* in Hawaii is recognized as a subspecies. Also, *Zebrasoma flavescens* has a distribution from the North Pacific to southern Japan, but it is abundant only in Hawaii. Twenty three species of surgeonfish are found in Hawaii (Randall 1996), 39 species in Micronesia (Myers 1991), and 32 species in Samoa (Wass 1984).

Schooling behavior is common in acanthurids, particularly in association with spawning aggregations. Biologists have documented trains of surgeonfishes traveling along the reef to join thousands of other surgeonfish at spawning aggregation sites. Once there, the fish mingle near the substrate and slowly move upward as a group. Near dusk, small groups (6-15 individuals) of fish make spawning rushes to near the water surface and release gametes. Following spawning, fish return to the substrate, form trains, and return to their home reefs. Many species also form large single-species or mixed-species schools, apparently for overwhelming territorial reef fish to feed on the algal mats they are protecting.

Trophic ecology- Although acanthurids are predominantly herbivores, they are diverse and delicate feeders harvesting a variety of plants and organic materials which are processed in a gut environment characterized by a complex microflora (Choat 1991). Species of *Ctenochaetus*feed on detritus and algal fragments by whisking them from the substrate with comb-like teeth. *Acanthurus thompsoni, Naso annulatus, N. brevirostris, N. caesius, N. hexacanthus,* and *N. maculatus* feed primarily on zooplankton well above the bottom. *Naso lituratus* and *naso unicornis* browse mainly on leafy algae such as *Sargassum* (Randall 1996).

Surgeonfishes commonly defend territories that are primarily feeding territories (Robertson et al. 1979). In a study of the behavioral ecology of *Acanthurus lineautus, A. leucosternon,*and *Zebrasoma scopas*, Robertson et al. (1979) described the morphology, feeding strategies, and social and mating systems of three territorial species that occupied characteristic depth zones and habitat types.

Jones (1968) identified *Acanthurus thompsoni* and *Naso hexacanthus* as zooplankton feeders on copepods, crustacean larvae, and pelagic eggs; *A. dussumieri, A. mata, A. olivaceus, Ctenochaetus hawaiiensis,* and *C. strigosus* as grazers on a calcareus substratum rich in diatoms and detritus; and *A. achilles, A. glaucopareius, A. guttatus, A. leucopareius, A. nigrofuscus, A. nigroris, A. sandvicensis, Zebrasoma flavescens, Z. veliferum, Naso brevirostris, N. lituratus,* and *N. unicornis* as browsers on multicellular benthic algae.

Pacific fisheries- Surgeonfishes are important food fish on many Pacific islands, where they are typically caught by spearfishing or nets. Some species are also sought after for the aquarium trade.

Main Hawaiian Islands - Less than 12% of the catch of inshore fishes reported in DAR commercial statistics from 1991-1995 came from federal waters (Friedlander 1996). For catches reported to DAR between 0-200nm, six of the top 25 inshore species by weight are acanthurids: *A. dussumieri*-32,407 lbs, *A. triostegus*-11,705 lbs, *Naso* spp.-9969 lbs, *A. xanthopterus*-5,234 lbs, *A. olivaceous*-4,813 lbs, and *Ctenochaetus strigosus*-3,776 lbs (Friedlander 1996).

Northwestern Hawaiian Islands - No data is available on catches of surgeonfish in this area, where inshore fisheries are fairly unexploited (see Green 1997).

American Samoa - Craig et al. (1993) reported that no major commercial fishery operates in federal waters in American Samoa. Closer to shore, *Acanthuridae* compose 28% of the reef fish catch (Dalzell et al. 1996). Over 40% of the catch composition by weight in the 1994 artisanal fishery was surgeonfishes (in Craig et al. 1995). In 1994, *A. lineatus* ranked second among all species harvested in both the artisanal and substience fisheries, accounting for 10 % of the total catch of 295 metric tons (Craig et al. 1997). The artisanal fishery captured 28 t of *A. lineatus* by spearfishing. A much smaller amount of that species, only 1-3% of the catch, was taken in the subsistence fishery by use of gill nets, throw nets, rod-and-reels, and handlines.

Guam - At this time, much less than 20% of the total coral reef resources harvested in Guam are taken from federal waters (Myers 1997). Acanthuridae composed 9.12 % of the reef fish catch in Guam (Dalzell et al. 1996). Small-boat based spearfish landings from FY85-91 were 19.0% surgeonfishes by weight (Myers 1996). Further discussion of reef fish catches in Guam can be found in Green (1997).

CNMI - Most reef fish landed in the Northern Mariana Islands are reported as mixed reef fish. Only 1.11% of the catch was assigned to surgeonfishes (Dalzell et al. 1996).

Egg and larval distribution- Acanthurid eggs are pelagic, spherical, and small - 0.66-0.70 mm in diameter with a single oil droplet to 0.165 mm for *Acanthurus triostegus sandvicensis* (Randall 1961). For that species, hatching occured in about 26 hours. Watson and Leis

(1974) found an egg size of 0.575 to 0.625 mm in diameter for an unidentified acanthurid from Hawaii.

Acanthurid larvae are typically diamond-shaped and strongly laterally compressed, with a prominent serrated dorsal spine, two large and serrated pelvic fin spines, and a single smoother spine near the anal fin (Thresher 1984). Late larval stages, roughly 20-25 mm, are orbicular, transparent except for a silvery abdomen and gut, with small scales in narrow vertical ridges on the body (Randall 1996). Spines on the larvae serve to enhance protection from predation, and may be venomous. Lou (1993) reported that *Ctaenochaetus binotatus* larvae fed on various zooplankton for a larval period ranging from 47-74 days. Similarly, Randall (1961) reported a zooplankton diet and a larval duration of 2.5 months for *Acanthurus triostegus sandvicensis*.

Surgeonfish larvae are primarily found well offshore at depths from 0-100m. Like other common adult members of the coral reef fish community, surgeonfish larvae are typically less abundant in samples of the water column near the reef than they are in samples from offshore (Miller 1973).

Although surgeonfish generally settle at a larger size than most reef fish, acanthurids are one of the families with juveniles that settle with larval characters still present (Leis & Rennis 1983). Late phase larvae actively swim inshore at night, seek shelter in the reef, and begin growing scales and intestines to complete the transformation to juveniles (Clavijo 1974). Lengthening of the alimentary track to accommodate an herbivorous diet happens fairly quickly. Juvenile surgeonfish have been reported to shelter in tide pools in Hawaii (Randall 1961). Hart and Russ (1996) found an age-at-maturity for *Acanthurus nigrofuscus* of 2 years. Choat (1991) reported a range of 12-18 months to maturity for acanthurids. Juveniles frequently differ in coloration and behavior from adults.

Adult surgeonfish are found in many coral reef habitat types, including mid-water, sand patch, subsurge reef, and seaward or surge zone reef. The largest number of surgeonfish species are typically found in the subsurge reef habitat, which are defined by Jones (1968) to be areas of moderate to dense coral growth corresponding to the subsurge portions of fringing reefs, deepwater reef patches, reef filled bays, and coral-rich parts of lagoons inside of atolls. These species are typically found between 0-30m depth, although surgeonfish do live in depths from 0-150m. Some species of *Naso* have been seen below 200m (Chave & Mundy 1994).

Acanthurids were the dominant family of fishes in Hanalei Bay in both numbers and biomass (Friedlander 1997). There were high numbers of surgeonfish in shallow, complex backreef habitat. Biomass for the depth stratum 4.3-7.2m was dominated by three surgeonfish species, *A. Tristegus, A. leucopareis,* and *Ctenochaetus strigosus. C. strigosus* and *A. nigrofuscus* were common in the shallow complex backreef as well as in the deep slope and spur and groove habitat types (Friedlander and Parrish 1998).

As an example for the family, *Acanthurus nigrofuscus* form schools that migrate 500 to 600m daily to intertidal feeding areas of algal turf communities. In the summer, the main food items are brown and red algae, while in the winter, it is green algae. Spawning occurs in large schools of 2000 to 2500 fish on selected sites at dusk (Fishelson et al. 1987).

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Management Unit Species: Acanthuridae (surgeonfishes)

	Egg	Larvae	Juvenile	Adult
Duration	26 hours for *A. triostegus sandvicensis*	47-74 days for *C. Binotatus*, 2.5 months for *A. triostegus sandvicensis*	1-2 years	25 yrs for *A. Nigrofuscus* (Hart & Russ 1996), over 40 yrs for *Naso* spp. (Choat & Axe 1996)
Diet	N/A	various zooplankters (Randall 1961)	mostly herbivorous although some may feed on zooplankton	*Acanthurus & Zebrasoma* - algal turfs, *Ctenochaetus* - detritus and sediment, *Naso & Paracanthurus* - mostly zooplankton
Distribution, general and seasonal	some species spawn year-round, but generally there appears to be a peak in spring and early summer; many species show lunar spawning periodicity	year-round distribution, with perhaps more settlement in late summer or fall	coral reef habitats throughout the Western Pacific	coral reef habitats throughout the Western Pacific, spawning aggregations at prominent outcroppings, some species are fairly stationary and territorial while others travel long distances for feeding
Location	water column from the surface to 100m	0-100m, larvae typically are more common in offshore waters than in water over reefs	tide pools, refugia on the reef	bottom and water-column; most between 0-100m but some deeper than 200m
Water column	N/A	pelagic	demersal and mid-water	demersal and mid-water
Bottom type	N/A	N/A	coral, rock, sand, mud, rubble, pavement	coral, rock, sand, rubble, pavement
Oceanic features	subject to ocean currents	subject to ocean currents		spawning aggregations may occur at channels just before or during outgoing tide

2. Carcharhinidae, Sphyrnidae, *Triaenodon obesus* (sharks)

Carcharinidae is one of the largest and most important families of sharks, with many common and wide-ranging species found in all warm and temperate seas. They are the dominant sharks in tropical waters in variety, abundance and biomass. Most species inhabit tropical continental coastal and offshore waters, but several species prefer coral reefs and oceanic islands. All members of *Carcharhinidae* have a circular eye, nictitating eyelids, a first dorsal fin positioned well ahead of the pelvic fins, precaudal pits and well developed lower caudal lobe.

Sharks differ from bony fishes in their cartilagenous skeleton, 5 to 7 gill openings on each side of the head, the frequent presence of a spiracle behind or below the eye, a rough skin composed of small, close-set dermal denticles, the absence of a swimbladder and the presence of a very large liver with large amounts of oil. Many sharks are apex predators in the food chain, feeding on bony fishes, octopuses, squids, shrimps, sea birds, other sharks and rays, sea turtles and marine mammals. Many sharks, including members of *Carcharhinidae* and *Sphyrnidae*, make seasonal migrations to warmer waters in the winter and cooler waters in the summer.

DeCrosta et al. (1984) reported on age determination, growth and energetics of the gray reef shark, the Galapagos shark and the tiger shark in the Northwestern Hawaiian Islands (NWHI). They found maximum ages from a sample of 30–65 specimens of each species to be 10, 15 and 22 years, respectively. The gray reef shark was the most highly piscivorous species with 51% of its diet composed of perciform fish, as well as >12% eels and >22% cephalopods. The Galapagos shark ate primarily cephalopods (43%), tetraodontiform fish (21%), eels (14%) and parrotfish (7 %). The tiger shark was a very opportunistic feeder, with seabirds in 75% of the specimen stomachs, but also sea turtles (33%), lobsters (30%), cephalopods (22%) and tetraodontiform fish (15%).

Sphyrnidae is a small but common family of wide-ranging, warm-temperate and tropical sharks found in continental and insular waters. Depths range from the surface to at least 275 m depth. Hammerheads are very active swimmers, ranging from the surface to the bottom. They are versatile feeders on bony fishes, elasmobranchs, cephalopods, crustaceans and other prey, although some may specialize on other elasmobranchs (Compagno 1984). Sphyrnids are similar to carcharhinids with one obvious exception, a blade-like lateral extension of the head. The head shape serves to spread the eyes and olfactory organs farther apart and may increase electroreception, vision and smell; increases lift and maneuverability; and may be used to pin prey such as rays to the bottom.

Sharks reproduce by internal fertilization. Male sharks can be identified by the presence of a pair of claspers along the medial edge of the pelvic fin. The tiger shark, *Galeocerdo cuvier*, and most sharks are ovoviviparous, developing eggs within the uterus. The sharks of *Sphyrnidae* and *Carcharinidae* except the tiger shark, are viviparous, nourishing embryos by

a placenta-like organ in the female. Some species such as *Nebrius concolor* and *Sphyrna lewini* move into shallow water to give birth. Calm, protected bays such as Kaneohe Bay are important nursery areas for sharks such as *S. lewini*.

Forty species of sharks are known from Hawaiian waters, but 20 of them occur only in deep water. Sharks likely to be associated with coral reefs in Hawaii include the gray reef shark *Carcharhinus amblyrhynchos*, the Galapagos shark *C. galapagensis*, the tiger shark *Galeocordo cuvier*, the blacktip reef shark *Carcharhinus melanopterus*, the sandbar shark *C. plumbeus*, the whitetip reef shark *Triaenodon obesus* and the scalloped hammerhead *S. lewini*. Ten species of carcharhinid sharks and two sphyrnid species, *S. lewini* and *S. mokorran*, are described for Micronesia in Myers (1991). Twelve carcharhinid and two sphyrnids are recorded for American Samoa.

Schooling is well documented for many shark species, especially the hammerheads. These species make long migrations in large groups for the purpose of spawning.

Trophic ecology: Sharks are apex predators on many coral reefs, where their presence may be a good indication of large stocks of fishes upon which they feed. All sharks are carnivorous, feeding on a wide variety of fishes, elasmobranchs and invertebrates including eagle rays, other sharks, reef fish, cephalopods, crustaceans, tuna, baitfishes and mahimahi. Larger species such as tiger sharks and great white sharks feed on those animals as well as porpoises, whales, sea turtles, sea birds, domestic animals, humans occasionally and marine debris, such as tin cans and plastic cups. Many sharks are nocturnal feeders, as sensory organs such as ampullae of Lorenzini are used to detect electomagnetic fields of prey fishes. The same sensory systems, including exceptional smell and a highly developed lateralis system, allow sharks to detect injured prey from considerable distance and lead to opportunistic feeding during the day as well.

Reproductive ecology: Egg and larval distribution are not applicable to sharks because they develop eggs internally. Sharks typically have a gestation period within the female of about 12 months. The gestation period and number of offspring per litter of common Western Pacific Region reef-associated sharks are *Triaenodon obesus* - 13 mths, 1–5 pups; *Carcharhinus albimarginatus* - 12 mths, 1–11 pups; *C. amblyrhynchos* - about 12 mths, 1–6 pups; *C. falciformis* - 2–14 pups; *C. galapagensis* - 6–16 pups; *C. melanopterus* - 8–9 mths, 2–4 pups; *Galeocerdo cuvier* - 12–13 mths, 10–82 pups; *C. plumbeus* - 8–12 mths, 1–14 pups, *Negaprion acutidens* - 1–11 pups; *Sphyrna lewini* - 15–31 pups; and *S. mokorran* - 13–42 pups.

Juvenile sharks frequently inhabit inshore areas such as bays, seagrass beds and lagoon flats before moving into deeper water as they mature. For example, *S. lewini* has well-documented nursery areas in shallow, turbid coastal areas such as Guam's inner Apra Harbor and Kaneohe Bay and Keehi lagoon on Oahu in Hawaii. The southern part of Kaneohe Bay is a major breeding and pupping ground for this species. Pups tend to avoid light, preferring

more turbid water. They school in a core refuge area during the day and then disperse at night, foraging along the base of patch reefs (Clarke 1971, Holland et al. 1993). Schools of young hammerheads forage near the bottom within these bays before moving to deeper outer reef waters as adults.

Size at maturity for reef-associated sharks within the management area are *T. obesus* - 101 cm for females and 82 cm for males, *C. galapagensis* - 205–239 cm for males and 215–245 cm for females, *C. melanopterus* - 131–178 cm for males and 144–183 cm for females, *G. cuvier* - 226–290 cm for males and 250–350 cm for females, C. plumbeus - 131–178 cm for males and 144–183 cm for females, *S. lewini* - 140–165 cm for males and about 212 cm for females, and *S. zygaena* - about 210–240 cm for males and females.

Adult sharks can be found in shallow inshore areas during mating or birthing events. Some species forage in these shallow areas as well. Reef-associated sharks are found in a wide variety of coral reef habitats, and because of their wide-ranging nature, no particular coral reef habitat except the inshore areas important for mating and birthing holds significantly higher numbers of sharks than other habitats. The larger species, such as *Galeocerdo cuvier*, are more often found on outer reef slopes near deep dropoffs. Randall et al. (1993) noted the presence of tiger sharks in lagoon waters of Midway Island during June–August when they prey upon fledgling Laysan albatross. Adult female gray reef sharks *C. amblyrhynchos* aggregate seasonally over shallow reef areas in the NHWI.

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Management Unit Species: Carcharhinidae, Sphyrnidae (sharks)

	Gestation	Juvenile	Adult
Duration	about 12 months	to 5–10 years or more	to 20 years or more
Diet	N/A	carnivorous - fish, elasmobranchs, squid, crustaceans, molluscs, may feed more intensively on crustaceans in inshore nursery areas	carnivorous - fish, elasmobranchs, squid, crustaceans, molluscs
Distribution, general and seasonal	Sphyrnids and some Carcharhinids have inshore nursery grounds	variable among species, *S. lewini* and *Negaprion acutidens* inhabit inshore nursery grounds	Carcharinidae: variable among the family from Indo-Pacific, circumglobal, and circumtropical Sphyrnidae: circumtropical
Location	variable	highly variable, *S. lewini* and *Negaprion acutidens* inhabit inshore nursery grounds	Carcharinidae: highly variable among the family Sphyrnidae: primarily pelagic but use inshore areas for reproduction
Water column	N/A	inshore benthic, neritic to epipelagic, 1–275 m	inshore benthic, neritic to epipelagic, mesopelagic. 1–275 m
Bottom type	N/A	highly variable due to wide-ranging nature of most species	highly variable due to wide-ranging nature of most species
Oceanic features	N/A	unknown	unknown

3. Dasyatididae, Myliobatidae, Mobulidae (rays)

The rays are characterized by a flattened form, a lack of dorsal fins, a distinct tail which has one or more venomous barbs in some families and a small mouth with close-set pavement-like teeth. Water is taken in through a spiracle behind the eye and expelled through gill slits on the underside of the ray. Rays often bury into the sand with only the eyes and spiracle showing. Most rays are carnivorous on shellfish, worms and small burrowing fishes, except the members of Mobulidae that feed on zooplankton in the water column. Rays are ovoviviparous, giving birth to fully developed young that are nourished from vascular filaments within the uterus during gestation.

Dasyatidae - There are 3 species in Hawaii - *Dasyatis violacea*, *D. brevis* and *D. latus*; 4 species in Micronesia - *D. kuhlii, Hymantura uarnak, Taeniura melanospilos* and *Urogymnus asperrimus*; and 2 species in Samoa - *D. kuhlii* and *Hymantura fai*. Sting rays feed on sand-dwelling and reef-dwelling invertebrates and fishes, often excavating large burrows in sand bottoms to capture subsurface mollusks and worms.

Myliobatidae - One species, the spotted eagle ray *Aetobatis narinari*, represents the family in Hawaiian, Micronesian and Samoan waters. Eagle rays feed mainly on hard-shelled mollusks and crustaceans, using their snout to probe through sand and powerful jaws to crush the shells. An average of 4 pups are born per litter after a gestation period of about 12 months. They have a depth range from the intertidal to 24 m. Groups move from reef channels and the reef face during flood tide to feed. Schools of up to 200 individuals have been observed.

Mobulidae - One species of manta ray, *Manta birostris* (which recently has come to include other synonyms, including *M. alfredi*) represents the family in Hawaiian and Micronesian waters. Mantas are the largest of all rays and may attain a width of 6.7 m and a weight of 1,400 kg. They occur singly or in small groups in surface or mid-waters of lagoons and seaward reefs, particularly near channels. They strain zooplankton from the water using cephalic flaps to direct the plankton into the mouth. They occur in all tropical and subtropical seas. Mating and birthing occur in shallow water, and juveniles often remain in these areas before heading into deeper water as adults. During winter, mantas may migrate to warmer areas, or deeper water or disperse offshore.

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Management Unit Species: Dasyatididae, Myliobatidae, Mobulidae (rays)

	Gestation	Juvenile	Adult
Duration	about 12 months for Myliobatidae, avg of 4 pups	little information	little information on longevity
Diet	N/A	small fish, crustaceans, mollusks, worms, zooplankton for Mobulidae, may be a greater emphasis on shellfish for juveniles in shallow water habitats	fish, crustaceans, mollusks, worms, zooplankton for Mobulidae
Distribution, general and seasonal	N/A	*Dasyatis latus* range includes Hawaii and Taiwan, *D. kuhlii* and *Hymantura uarnak* range through the Indo-west-Pacific, *Taeniura melanospilos* and *Urogymnus asperrimus* range the Indo-Pacific, the spotted eagle ray and manta ray are circumtropical	*Dasyatis latus* range includes Hawaii and Taiwan, *D. kuhlii* and *Hymantura uarnak* range through the Indo-west-Pacific, *Taeniura melanospilos* and *Urogymnus asperrimus* range the Indo-Pacific, the spotted eagle ray and manta ray are circumtropical
Location	variable	wide variety of habitats from shallow lagoons to outer reef slopes, nursery areas in seagrass beds, mangroves, and shallow flats are important for many species	wide variety of habitats from shallow lagoons to outer reef slopes, generally located from 0-100m but have been found much deeper
Water column	N/A	demersal and in the water column	demersal and in the water column
Bottom type	N/A	soft (sand and mud), coral reef, pavement	soft (sand and mud), coral reef, pavement
Oceanic features	N/A	unknown	unknown

4. Chlopsidae, Congridae, Moringuidae, Ophichthidae (eels)

There are 15 families of true eels, and these are some of the important ones on Western Pacific Region coral reefs. The eels are characterized by very elongate bodies, lack of pelvic fins, very small gill openings and a caudal fin that, if present, is joined with the dorsal and anal fins.

Members of Muraenidae, the morays, lack pectoral fins and scales and have a large mouth. Most species have long, fang-like teeth, but some do not. Species with long canines feed mainly on reef fishes, occasionally on crustaceans and octopuses. Species of *Echidna* and *Gymnomuraena* with mainly nodular or molariform teeth feed more on crustaceans, especially crabs. Morays have a lengthy pelagic leptocephalus larval stage that has resulted in a very wide distribution. Morays are hunted for food in many locations, even though large individuals may be ciguatoxic. Morays typically remain hidden within the framework of the reef, and many are more active at night than during the day. There are 38 species of morays in Hawaii, second only to the wrasses for number of species. *Gymnothorax steindachneri* is endemic to Hawaii. At least 53 species are known from Micronesia. At least 47 species are known from Samoa.

Members of Chlopsidae, the false morays, resemble morays but have pectoral fins and posterior nostrils open to the margin of the upper lip. Males are typically smaller with larger teeth, which may be used for grasping females during courtship. They probably migrate off the reef to spawn but otherwise stay well hidden within the reef framework. Five species are recorded from Samoa.

Members of Congridae include the conger eels and garden eels. Conger eels have well-developed pectoral fins. Garden eels are smaller, extremely elongate burrowing forms with reduced or absent pectoral fins. They occur in large colonies on sand plains or slopes at depths of 7–53 m with strong currents. They are diurnal planktivores that extend from their burrows to feed on plankton in the current. The large-eye conger, *Ariosoma marginatum*, and the Hawaiian garden eel, *Gorgasia hawaiiensis,* are endemic to Hawaii. Five species are recorded in Samoan waters.

Members of Moringuidae, the spaghetti eels, have extremely elongate bodies with the anus located about two thirds of the way back. They change morphology radically as they mature. Immature spaghetti eels are orange-brown with small eyes and reduced fins. Mature eels have large eyes and a distinct caudal fin and are dark above and silvery below. Females burrow in shallow sandy areas but migrate to the surface to spawn with males, which are pelagic. Six species are recorded from Samoan waters.

Members of Ophichthidae, the snake eels, have elongate, nearly cylindrical bodies with median fins and small pectoral fins. Most species of snake eels are indwellers that stay buried in the sand but a few will occasionally come out and swim across sand, rubble or

seagrass habitats. They appear to be nocturnal, and some species, if not all, come to the surface to spawn at night. Sixteen species are reported from the Hawaiian Islands. The freckled snake eel, *Callechelys lutea*, is endemic to Hawaii, and the magnificent snake eel, *Myrichthys magnificus,* is endemic to the Hawaiian Islands and Johnston Island. At least 26 species are known from Micronesia. Five species are recorded from Samoan waters.

Sexual characteristics of eels vary widely among the different families. Spawning migrations are a general, though not universal, characteristic of eel reproduction. Eel species that migrate for spawning, including members of the congrids, moringuids and ophichthids, tend to be sexually dimorphic, with moringuids displaying the greatest morphological difference between males and females. Nonmigratory eels such as morays and garden eels typically have no definitive external sexual dimorphism. Hermaphroditism has been documented for some species, including some morays, but is not a widespread characteristic of eels. Group spawning of eels has been documented, with large numbers of adults congregating at the water surface at night.

Eel eggs are pelagic and spherical with a wide periviteline space, usually no oil droplets and in some species a densely reticulated yolk. The eggs are relatively large, ranging from 1.8 to 4.0 mm. Watson and Leis (1974) collected 145 eels eggs off Hawaii that ranged from 2.4 to 3.8 mm. Brock (1972) found 200,000 to 300,000 ripe eggs in each of four 5.0 to 6.8 kg *Gymnothorax javanicus*. Hatching of an unidentified 1.8 mm muraenid egg took approximately 100 hours (Bensam 1966).

Eels have a characteristic leptocephalus larval stage: a long, transparent, feather-shaped larva that starts out at 5-10 mm and grows up to 200 mm before settlement and metamorphosis. The duration of the planktonic stage is on the order of 3–5 months for moringuids (Castle 1979), 6–10 months for muraenids (Eldred 1969, Castle 1965) and about 10 months for some congrids (Castle and Robertson 1974).

Both juvenile and adult eels inhabit cryptic locations in the framework of the reef or in sand plains for some species. Some species remain so hidden within the reef that they have never been seen alive; their existence is known only from samples taken with the use of poisons.

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Muraenidae, Chlopsidae, Congridae, Moringuidae, Ophichthidae (eels)

	Egg	Larvae	Juvenile	Adult
Duration	100 hours or more	3–10 months		
Diet	N/A	zooplankton	most are benthic carnivores on fish, octopus, crustaceans; frequently nocturnal garden eels are diurnal planktivores	most are nocturnal benthic carnivores on fish, octopus, crustaceans; the morays of Gymnomuraena, Enchelycore and Sideria feed mainly on crustaceans; garden eels are diurnal planktivores
Distribution, general and seasonal	eggs frequently released near the surface; some are pelagic spawners, others spawn on reefs	predominantly offshore	worldwide in tropical and temperate seas; *Callechelys lutea*, *Ariosoma marginatum*, *Gorgasia hawaiiensis* and *Gymnothorax steindachneri* are endemic to the Hawaiian islands; *Myrichthys magnificus* is endemic to the Hawaiian Islands and Johnston Island	worldwide in tropical and temperate seas; *Callechelys lutea*, *Ariosoma marginatum*, *Gorgasia hawaiiensis* and *Gymnothorax steindachneri* are endemic to the Hawaiian islands; *Myrichthys magnificus* is endemic to the Hawaiian Islands and Johnston Island
Location	near reefs and offshore	predominantly offshore	coral reefs and soft-bottom habitats	coral reefs and soft-bottom habitats
Water column	pelagic	pelagic	demersal	demersal
Bottom type	N/A	N/A	coral reef crevices, holes; sand, mud, rubble	coral reef crevices, holes; sand, mud, rubble
Oceanic features				

5. Engraulidae (anchovies)

The anchovies are a large family of small, silvery schooling fishes that are common baitfish for pole-and-line tuna fisheries. They share many of the characteristics of the clupeids but can be distinguished by their rounded overhanging snout and slender lower jaw. Most species also have a brilliant silver mid-lateral band. Anchovies typically inhabit estuaries and turbid coastal waters. However, but some occur over inner protected reefs, and, at least one, *Encrasicholina punctifer*, is found in the open sea. Anchovies occur in dense schools and feed by opening their mouths to strain plankton from the water with their numerous gill rakers. Two species are known from Hawaiian waters: the endemic Hawaiian anchovy *Encrasicholina purpurea* and the offshore species *E. punctifer*. Seven species are known from Micronesian waters. Four species are known from Samoan waters.

Anchovy eggs are pelagic. In *Coilia, Setipinna* and *Thryssa* they are spherical and of small to moderate size (0.8–1.6 mm). Eggs of *Encrasicholina, Engraulis* and *Stolephorus* are ovate to elliptical and vary from small to large (0.8–2.3 x 0.5–0.8 mm) (Zhang et al 1982, Fukuhara 1983, McGowan and Berry 1984, Ikeda and Mito 1988). Larvae hatch at 2.5–3.7 mm. The size of the largest pelagic specimen examined by Leis and Trnski (1989) was 23–27 mm.

Thryssa baelama occurs in large schools in turbid waters of river mouths and inner bays. The oceanic or buccaneer anchovy *E. punctifer* is mostly pelagic, but it can be found in large atoll lagoons or deep, clear bays. The blue anchovy *E. heterolobus* occurs primarily in deep bays under oceanic influence. Other anchovies occur in estuaries and coastal bays.

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Management Unit Species: Engraulidae (anchovies)

	Egg	Larvae	Juvenile	Adult
Duration				
Diet	N/A	plankton	plankton	plankton
Distribution, general and seasonal			same as adults	Two species in Hawaiian waters: the endemic Hawaiian anchovy *Encrasicholina purpurea* and the offshore species *E. punctifer*. Seven Micronesian species. Four Samoan species.
Location			schools in inshore waters	estuaries and turbid coastal waters but some occur over inner protected reefs and at least one, *Encrasicholina punctifer*, is found in the open sea
Water column	pelagic	pelagic	frequently near the surface	frequently near the surface
Bottom type	N/A	N/A	same as adults	sand, coral reef, rock, mud
Oceanic features	subject to advection by ocean currents	subject to advection by ocean currents		

6. Clupeidae (herrings)

Herrings, sardines and sprats are small planktivorous silvery fishes with a single short dorsal fin near the middle of the body, no spines, no lateral line and a forked caudal tail. They are schooling fishes that are important for food and bait. Round herrings include several species that inhabit coral reefs as well as coastal waters. Sardines typically inhabit coastal waters of large land masses or high islands. In Hawaiian waters, 4 species occur. Two were introduced: the goldspot sardine *Herklotsichthys quadrimaculatus* unintentionally from the Marshall Islands in 1972 and the Marquesan sardine *Sardinella marquensis* intentionally from the Marquesas between 1955 and 1959, but it never became abundant. The other two Hawaiian species are the delicate roundherrring *Spratelloides delicatulus*, which is an inshore species that occurs in small schools over coral reefs, and the red-eye roundherring *Etrumeus teres*, although it is rare. In Micronesian waters, there are at least 6 species of Clupeidae. In Samoan waters, 9 species have been recorded.

Clupeid eggs are spherical and vary among species from small to large (0.8–2.1 mm). They are thought to be pelagic in all tropical taxa except *Spratelloides*, which has demersal eggs (McGowan and Berry 1984, Jiang and Lim 1986). Clupeid larvae range from 1.6 to 4.7 mm long at the time of hatching. The size of the largest pelagic specimens examined by Leis and Trnski (1989) ranged from 21 to 33 mm.

The gold spot sardine, or herring, is an important food fish in many areas. It schools near mangroves and above sandy shallows of coastal bays and lagoons during the day and moves into deeper water at night to feed. In Belau, it migrates to tidal creeks to spawn from November to April (Myers 1991). The blue sprat *Spratelloides delicatulus* generally schools near the surface of clear coastal waters, lagoons and reef margins where it feeds on plankton.

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Management Unit Species: Clupeidae (herrings, sprats and sardines)

	Egg	Larvae	Juvenile	Adult
Duration				
Diet	N/A	plankton	plankton	plankton
Distribution, general and seasonal			same as adults	Four species in Hawaiian waters; two introduced: *Herklotsichthys quadrimaculatus* and *Sardinella marquensis*, and two others: *Spratelloides delicatulus* and *Etrumeus teres*. At least 6 species occur in Micronesian waters, and at least 9 species occur in Samoa.
Location			schools in inshore waters	estuaries and turbid coastal waters but some occur over inner protected reefs
Water column	pelagic	pelagic	frequently near the surface	frequently near the surface; 0–20 m
Bottom type	N/A	N/A	same as adults	sand, coral reef, rock, mud
Oceanic features	subject to advection by ocean currents	subject to advection by ocean currents		most species tend to accumulate in relatively clear coastal, lagoon, and seaward reef waters

7. Antennariidae (frogfishes)

Frogfishes have bulbous bodies, jointed elbow-like pectoral fins that are used like arms, small holes behind the pectorals for gill openings and large upturned mouths. The first dorsal spine is modified to a lure consisting of the slender ilicium tipped with the esca (bait), which is used to attract prey. The frogfishes are very well camouflaged piscivores with cryptically colored prickly skin and fleshy or filamentous appendages. They are able to lure prey by waving the esca above their head, then striking quickly with a large mouth. They are able to swallow prey longer than themselves because of a highly distensible body. At intervals of 3 to 4 days, reproductive females lay thousands of tiny eggs embedded in a large, sometimes scroll-shaped gelatinous mass. Habitats where frogfish are found include bottoms of seagrass, algae, sponge, rock or corals from tidepools to lagoon and seaward reefs. In Hawaiian waters, 6 species are found, with one endemic: the Hawaiian freckled frogfish *Antennarius drombus*. At least 12 species occur in Micronesia, and at least 7 species in Samoa. Frogfishes are rare on most coral reefs and are present only in low numbers if at all.

Spawning by anglerfishes involves the production of a large, jelly-like egg mass. Frogfishes appear to be sexually monomorphic, with the only difference between sexes being the expanded size of the female prior to releasing eggs. For those species that have been observed spawning—*Histrio histrio* (Mosher 1954, Fujita and Uchida 1959), *Antennarius nummifer* (Ray 1961) and *A. zebrinus* (Burgess 1976)—spawning occurred in pairs after a quick spawning rush to the surface. Egg masses, or "rafts," or "scrolls," vary in size from species to species but are usually quite large. That of *H. histrio* is about 9 cm long (Mosher 1954, Fujita and Uchida 1959); that of *A. multiocellatus, A. tigrinus* and *A. zebrinus* is slightly larger (Mosher 1954, Burgess 1976); and that of *A. nummifer* is about 5 cm across and about 7 cm high (Ray 1961). Some species have immense egg rafts, including a raft produced by *A. hispidus* in an aquarium that was 2.9 m by 15.9 cm (Hornell 1922). Since rafts can be produced at 3-to 4-day intervals for many species, fecundity is extremely high for the frogfishes. Eggs hatch within 2–5 days. For *H. histrio*, growth and development is extremely fast, and an entire generation can take as little as 21 days (Adams 1960). Other species likely have much longer development and life spans.

A different spawning mode has been documented for members of at least two genera, *Lophiocharon* and *Histiophryne*, which brood eggs attached to the body of the male. The eggs are much larger (3.2–4.2mm) and more advanced at hatching than for pelagic spawners (Pietsch and Grobecker 1987).

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Management Unit Species: Antennariidae (frogfishes)

	Egg	Larvae	Juvenile	Adult
Duration	2–5 days	days for *H. histrio*, but likely weeks for other species		*H. histrio* may only live a month or so; little information on others but likely to live much longer
Diet	N/A	likely zooplankton	similar to adult	ambush small fish which they lure close by waving an esca that resembles food
Distribution, general and seasonal				shallow tropical and temperate seas worldwide; 6 species in Hawaii with one endemic: the Hawaiian freckled frogfish *Antennarius drombus*. At least 12 species in Micronesia, and at least 7 species in Samoa.
Location	large egg "raft" released at the surface after a fast spawning rush			from tidepools to lagoon and seaward reefs
Water column	pelagic	pelagic	demersal	demersal; 1–130 m, but most at less than 30 m
Bottom type	N/A	N/A	seagrass, algae, sponge, rock or corals	seagrass, algae, sponge, rock or corals
Oceanic features	subject to advection by ocean currents	subject to advection by ocean currents		

8. Anomalopidae (flashlightfish)

Flashlightfish are small, dark fishes with luminous organs under each eye, blunt snouts, large mouths and a forked tail. The lime-green light is produced biochemically by bacteria within the light organ. The light may be used to attract zooplankton prey, to communicate to other flashlightfish or to confuse predators. They are usually at depths from 30 to 400 m but may be found much shallower in some locations. They remain hidden during the day and venture out at night to feed, tending to occur shallower on dark, moonless nights. Flashlightfish do not occur in the Hawaiian Islands, but two species occur in Micronesian waters: *Anomalops katoptron* and *Photoblepheron palpebratus*. *A. katoptron* also occurs in Samoan waters.

The eggs of *A. katoptron* and *P. palpebratus* are of moderate size (1.0–1.3 mm) with a mucous sheath. They are positively buoyant (Meyer-Rochow 1976). The larvae of *A. katoptron* hatch at 2.6–3.3 mm.

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Management Unit Species: Anomalopidae (flashlightfishes)

	Egg	Larvae	Juvenile	Adult
Duration		hatch at a size of 2.6–3.3 mm		
Diet	N/A	zooplankton	zooplankton	zooplankton
Distribution, general and seasonal				none found in Hawaiian Islands; 2 species in Micronesia, *Anomalops katoptron* and *Photoblepheron palpebratus*
Location			same as adult	hidden in caves or crevices by day; active in the water column by night
Water column	pelagic	pelagic	same as adult	demersal by day, and in the water column by night; 5–400 m
Bottom type		N/A	coral reef	coral reef
Oceanic features	subject to advection by ocean currents	subject to advection by ocean currents		

9. Holocentridae (soldierfishes/squirrelfishes)

Holocentrids are spiny, deep bodied, usually red fishes with large eyes and mouth, small teeth, large coarse scales and stout dorsal and anal fin spines. The family is divided into two subfamilies: the Myripristinae (soldierfishes of the genus *Myripristis, Plectrypops, Pristelepis* and *Ostichthys* are found in the Indo-Pacific; the latter two occur in deep water) and the Holocentrinae (squirrelfishes of the genus *Neoniphon* and *Sargocentron*). Soldierfishes lack a well-developed preopercular spine and a pointed snout, both of which are present in squirelfishes. The spine on the preopercle of squirrelfish may be venomous. Soldierfishes and squirrelfishes are both nocturnal predators, but soldierfish predominantly feed on large zooplankton in the water column while squirrelfish prey mainly on benthic crustaceans, worms and small fishes. During the day, most holocentrids hover in or near caves and crevices or among branching corals.

About 17 holocentrid species inhabit Hawaiian waters, some of them in very deep water. At least 13 species of soldierfishes and 16 species of squirrelfishes occur in Micronesia. At least 31 holocentrid species are found in Samoan waters.

Holocentrids are slow growing, late maturing and fairly long lived. A study (Dee and Parrish 1993) on the reproductive and trophic ecology of *Myripristis amaena* found that sexual maturity for both sexes was reached between 145 and 160 mm SL at about 6 years of age. Longevity was determined to be at least 14 years. Fecundity was relatively low, fewer than 70,000 eggs in the most fecund specimen, and increased sharply with body weight. Spawning peaked from early April to early May, with a secondary peak in September. The diet of *M. amaena* was mainly meroplankton, especially brachyuran crab megalops, hermit crab larvae and shrimps but also a variety of benthic invertebrates and fishes.

M. amaena is particularly important in the recreational fishery at Johnston Atoll where it is the species caught in greatest abundance (Irons et al. 1990). It is common in reef fish catches throughout the Hawaiian archipelago.

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Management Unit Species: Holocentridae (soldierfishes/squirrelfishes)

	Egg	Larvae	Juvenile	Adult
Duration		probably several weeks, settle at large size (up to 30 mm or more)	6 years for *M. amaena*	at least 14 years (Dee and Radtke 1989)
Diet	N/A	zooplankton	diet similar to adults	Myropristis spp.: mostly meroplankton, especially brachyuran crab megalops, hermit crab larvae and shrimps, but also a variety of benthic invertebrates and fishes, Holocentrinae: feed mainly on benthic crustaceans
Distribution, general and seasonal	spawning peak in April–May and another in Sept. for *M. amaena* at Johnston Atoll	generally, a recruitment peak in June-July and another in Feb.–March, but a lot of variation	tropical Atlantic, Indian, and Pacific Oceans	tropical Atlantic, Indian, and Pacific Oceans
Location				
Water column	pelagic	pelagic	demersal in caves and crevices during the day; demersal and in the water column at night	demersal in caves and crevices during the day ; demersal and in the water column at night
Bottom type	N/A	settle in refugia on the reef	coral reef caves and crevices, also within the branches of branching corals	coral reef caves and crevices, also within the branches of branching corals
Oceanic features	subject to advection by ocean currents	subject to advection by ocean currents		

10. Aulostomidae (trumpetfishes)

Trumpetfishes are very elongate with a compressed body, a small mouth, a long tubular snout, small teeth and a small barbel on the chin. The one Indo-Pacific species occurs in three color patterns: uniformly brown to green, mottled brown to green and uniformly yellow. They feed on fishes and shrimps by slowly moving close to the prey, often in a vertical stance, and then darting forward to suck the prey in through its snout. Trumpetfishes inhabit rocky and coral habitats of protected and seaward reefs from below the surge zone to a depth of 122 m. They have an ability to blend in with a background of coral branches or seagrasses by hanging vertically in order to sneak up on unwary prey. They also camouflage themselves by traveling with schools of surgeonfishes or large individual fish to sneak up on prey. There are three species in the world, but only one in the Indo-Pacific, *Aulostomus chinensis*. It is found in Hawaii, Micronesia and Samoa.

Spawning by *A. chinensis* has been observed off One Tree Island, Great Barrier Reef. At dusk, a male and female made a spawning ascent of 5–8 m to release gametes before returning to the bottom (in Thresher 1984). The pelagic eggs of *A. chinensis* are spherical, smooth and 1.3 to 1.4 mm in diameter. Larvae are approximately 4.8 mm at hatching (Watson and Leis 1974).

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Management Unit Species: Aulostomidae (trumpetfish)

	Egg	Larvae	Juvenile	Adult
Duration	approximately 4 days	4.8 mm at hatching		
Diet	N/A	likely small zooplankton	similar to adults	ambush predators of small fishes and crustaceans
Distribution, general and seasonal			similar to adults	one Indo-Pacific species, *Aulostomus chinensis*
Location	pelagic	pelagic	similar to adults	protected and seaward reefs from below the surge zone to 122 m
Water column	pelagic	pelagic	similar to adults	reef-associated; 1–122 m
Bottom type	N/A	N/A	similar to adults	coral reef and rock
Oceanic features	subject to advection by ocean currents	subject to advection by ocean currents		

11. Fistularidae (cornetfish)

Cornetfishes have a very elongate body like the trumpetfish but differ in the body being vertically flattened rather than laterally compressed and by having a forked caudal fin with a long median filament. Like the trumpetfish, cornetfish feed by sucking small fishes and crustaceans into their long tubular snout. They are seen in virtually all reef habitats except areas of heavy surge. They are usually seen in open sandy areas and may occur in schools of similarly sized individuals. One species, *Fistularia commersonii*, is seen on Hawaiian, Micronesian and Samoan coral reefs, and another species is seen only in deep water.

Fistularid eggs are pelagic and large, with a diameter of 1.5–2.1 mm (Mito 1961). The larvae hatch at 6–7 mm (Mito 1961). Hatching occured in about 7 days for *Fistularia petimba* (Mito 1966). The size of the largest examined pelagic fistularid specimen examined by Leis and Rennis (1983) was 145 mm.

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Management Unit Species: Fistularidae (cornetfish)

	Egg	Larvae	Juvenile	Adult
Duration	4 –7 days	6 mm at hatching		
Diet	N/A	likely small zooplankton	similar to adults	ambush predators of small fishes and crustaceans
Distribution, general and seasonal			similar to adults	two Indo-Pacific species: *Fistularia commersonii* and one deepwater species
Location	pelagic	pelagic	similar to adults	virtually all coral reef habitats except areas of high surge; most common in sandy areas where it may form schools of similarly sized fish
Water column	pelagic	pelagic	similar to adults	reef-associated; 1–128 m
Bottom type	N/A	N/A	similar to adults	sand, coral reef, rock
Oceanic features	subject to advection by ocean currents	subject to advection by ocean currents		

12. Syngnathidae (pipefishes/seahorses)

Pipefishes and seahorses have a long tubular snout with a very small mouth, which they use to feed in a pipette-like manner on small free-living crustaceans such as copepods. Some species clean other fishes. Many species are small and generally inconspicuous bottom dwellers that feed on minute benthic and planktonic animals. The syngnathids have very unique parental care in which the female deposits eggs into a ventral pouch on the male, which carries the eggs until hatching. Most species are rarely seen on reefs in the management area, partly because of their small size and inconspicuous nature. They occur in a wide variety of shallow habitats from estuaries and shallow sheltered reefs to seaward reef slopes, though they are generally limited to water shallower than 50 m. There are 8 species reported from Hawaiian waters, where the redstripe pipefish *Dunckerocampus baldwini* is endemic. At least 37 species occur in Micronesian waters, and at least 17 species occur in Samoa.

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Syngnathidae (pipefishes/seahorses)

	Egg	Larvae	Juvenile	Adult
Duration		likely weeks to months		
Diet	N/A		similar to adults	small free-living crustaceans such as copepods; minute benthic and planktonic invertebrates
Distribution, general and seasonal				circumtropical and temperate; 8 spp. reported from Hawaiian waters, where the redstripe pipefish *Dunckerocampus baldwini* is endemic. At least 37 species in Micronesian waters, and at least 17 in Samoa
Location	male carries eggs in a ventral pouch	offshore waters	occasionally found in the open sea in association with floating debris	wide variety of shallow habitats from estuaries and shallow sheltered reefs to seaward reef slopes
Water column	male carries eggs in a ventral pouch	pelagic	similar to adults	benthic and free-swimming
Bottom type	N/A	N/A	similar to adults	coral, rock, mud, seagrass, algae
Oceanic features		subject to advection by ocean currents		

13. Caracanthidae (coral crouchers)

The coral crouchers consist of one genus, *Caracanthus*, and 4 small species. They are small, deep-bodied, ovoid fishes with venomous dorsal spines and small tubercles covering the body. They are found exclusively among the branches of certain *Stylophora, Pocillopora* and *Acropora* corals, where they feed on alpheid shrimps and other small crustaceans. The name coral crouchers comes from their tendency to tightly wedge themselves into the coral branches when threatened. One species, the Hawaiian orbicular velvetfish *Caracanthus typicus*, is found in Hawaiian waters and is endemic. Two species are found in Micronesian and Samoan waters: the spotted coral croucher *C. maculatus* and the pigmy coral croucher *C. unipinna*. *C. maculatus* is common among the long branches of large pocilloporid corals such as *Pocillopora eydouxi*, *Stylophora mordax* and ramose species of *Acropora*. *C. unipinna* is found in *S. mordax* and ramose species of *Acropora*.

The spawning mode and development at hatching of coral crouchers is not known. Caracanthid larvae are very similar to Scorpaenid larvae. The size of the largest examined pelagic specimen was 16.5 mm (Leis and Trnski 1989).

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Management Unit Species: Caracanthidae (coral crouchers)

	Egg	Larvae	Juvenile	Adult
Duration				
Diet	N/A	zooplankton		alpheid shrimps and other small crustaceans
Distribution, general and seasonal			same as adults	Indian and Pacific Ocean; one endemic species in Hawaii - *Caracanthus typicus*, two species in Micronesia
Location			same as adults	exclusively among the branches of certain *Stylophora, Pocillopora*, and *Acropora* corals
Water column	probably pelagic; gelatinous egg masses float	pelagic; 0–100m depth	demersal	demersal
Bottom type	N/A	N/A	*Stylophora, Pocillopora*, and *Acropora* corals	*Stylophora, Pocillopora* and *Acropora* corals
Oceanic features	subject to advection by ocean currents	subject to advection by ocean currents		

14. Tetrarogidae (waspfish)

Waspfishes are closely related to scorpionfishes but have dorsal fins that originate over or in front of the eyes, typically do not have scales and tend to be more compressed. They have extremely venomous spines. They feed on small fishes and crustaceans. No species are found in Hawaiian waters, and only one species is found in Micronesia: the mangrove waspfish *Tetraroge barbata*, which inhabits muddy inshore waters of mangrove swamps and may also move into freshwater rivers.

There is little information on waspfish reproduction, but it is likely to be very similar to that for Scorpaenidae. They likely produce small to medium eggs embedded in a large, pelagic, sac-like gelatinous matrix.

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Management Unit Species: Tetrarogidae (waspfishes)

	Egg	Larvae	Juvenile	Adult
Duration				
Diet	N/A	zooplankton	ambush small fishes and crustaceanss	ambush small fishes and crustaceans
Distribution, general and seasonal	no information on spawning in the wild			Indo-West Pacific; little seasonal difference in distribution
Location				estuarine or freshwater habitats; mangroves or rivers
Water column	probably pelagic; gelatinous egg masses float	pelagic; 0–100m depth	demersal	demersal
Bottom type	N/A	N/A		mangroves, rock, rubble, mud
Oceanic features	subject to advection by ocean currents	subject to advection by ocean currents		

15. Scorpaenidae (scorpionfishes)

Scorpionfishes are so named for the venomous dorsal, anal and pelvic fins of many species. They are stout-bodied, benthic carnivores that typically have fleshy flaps, a mottled coloring and small tentacles on the head and body. These camouflage features help them to ambush small fishes and crustaceans. Scorpionfish lie on the reef and wait for unwary prey to come near, when they pounce on the prey with a large mouth full of small viliform teeth. Many feed mainly at dusk or during the night. Lionfishes and turkeyfishes of the subfamily Pteroinae have greatly enlarged pectoral fins, elongate dorsal fin spines and bright colorations. The lionfish and turkeyfish species may swim well above the bottom, whereas small cryptic species of the subfamily Scorpaeninae tend to remain on the bottom and may be quite common in shallow rubbly areas. In Hawaiian waters, 13 species are known and 3 are endemic: *Dendrochirus barberi, Pterois sphex* and *Scorpaenopsis cacopsis*. At least 30 species are known from Micronesia. At least 22 species are recorded from Samoa.

Most reef scorpaenids (*Scorpaena, Pterois, Dendrochirus*) have 0.7–1.2 m spherical to slightly ovoid eggs embedded in a large, pelagic, sac-like gelatinous matrix (Leis and Rennis 1983). Eggs hatch in 58–72 hours. The duration of the planktonic larval stage is not known. Older larval stages are described by Miller, Watson and Leis (1979).

Harmelin-Vivien and Bouchon (1976), analyzing the stomach contents of 17 species of scorpionfish from Tuléar, Madagascar, find that crustaceans generally were a dominant component of their diet. Only one species, *S. gibbosa,* fed exclusively upon fishes, while others fed on a mixture of fish and crustaceans. Seven species fed mainly on crustaceans such as brachyurans, shrimps and polychaetes. Their diets were supplemented with small amounts of galatheids and amphipods. Feeding tended to be heavier at night than during the day, but feeding was apparent for both night and day for all species.

Several biologists and aquarium collectors have noted reduced numbers of the endemic Hawaiian turkeyfish, *Pterois sphex*. Sightings of this previously more abundant species have become very infrequent. Its numbers may have been reduced by collecting efforts driven by its popularity as an aquarium fish. Randall et al. (1993) lists it as occasional in caves or ledges inside and outside the lagoon at Midway Atoll, but it is now very rare in the main Hawaiian Islands.

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Management Unit Species: Scorpaenidae (scorpionfishes)

	Egg	Larvae	Juvenile	Adult
Duration	little information, but 58–72 hrs for *Scorpaena guttata* (David 1939)		2–3 yrs for 2 Mediterranean species	
Diet	N/A	zooplankton	ambush small fishes and invertebrates	ambush fish and invertebrates; *Scorpaenopsis diabolus* feeds exclusively on fishes (Harmelin-Vivien et al. 1976)
Distribution, general and seasonal	little information on spawning in the wild		worldwide in tropical and temperate seas; little seasonal information, but probably recruitment peak in summer or fall	worldwide in tropical and temperate seas; small home ranges; little seasonal difference in distribution
Location			reef and hard-bottom associated	reef and hard-bottom associated
Water column	pelagic; gelatinous egg masses float	pelagic; 0–100m depth	demersal	demersal
Bottom type	N/A	N/A	coral reef, rock, rubble	coral reef, rock, rubble
Oceanic features	subject to advection by ocean currents	subject to advection by ocean currents		

16. Serranidae (groupers)

Egg and Larvae

Serranid fertilized eggs are spherical, transparent and range in size from 0.70 to 1.20 mm in diameter. Each egg contains a single oil globule 0.13 to 0.22 mm in diameter. Based on the available data, the length of the pelagic larval stage of groupers is 25-60 days (Kendall 1984, Leis 1987). The wide geographic distribution of serranids is thought to be due to this relatively long pelagic larval phase. Serranid larvae are distinguishable by their kite-shaped bodies and highly developed head spination (Heemstra and Randall 1993).

Juvenile

Very little is known about the distribution and habitat utilization patterns of juvenile serranids. Research has found that transformation of pelagic serranids into benthic larvae takes place between 25 mm to 31 mm TL (Heemstra and Randall, 1993). The juveniles of some species of serranids are known to inhabit sea-grass beds and tide pools.

Adult

Serranids inhabit coral reefs and rocky bottom substrate from the shore to a depths of at least 400 m. Serranids typically are long-lived and have relatively slow growth rates. Based on the available data, groupers appear to be protogynous hermaphrodites. After spawning for one or more years the female undergoes sexual transformation, becoming male. Some species of serranids spawn in large aggregations, others in pairs. Individual males may spawn several times during the breeding season. Some species of groupers are known to undergo small, localized migrations, of several km to spawn. Except for occasional spawning aggregations, most species of groupers are solitary fishes with a limited home range (Heemstra and Randall, 1993). Based on the results of tagging studies, it has been found that serranids are resident to specific sites, often residing on a particular reef for years .

Groupers are typically ambush predators, hiding in crevices and among coral and rocks in wait for prey (Heemstra and Randall 1993). Adults reportedly feed during both the day and night. The diet of adult serranids includes brachyuran crabs, fishes, shrimps, galatheid crabs, octopus, stomatopods, fishes and ophiurids (Heemstra and Randall, 1993, Morgan 1982, Randall and Ben-Tuvia 1983, Harmelin-Vivien and Bouchon 1976)

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Management Unit: Serranidae (groupers)

	Egg	Larvae	Juvenile	Adult
Duration	Incubate in 20-35 days	Pelagic duration : 25-60 days	Metamorphosis to demersal habitat at ~25-31 mm TL	Long-lived, slow growing
Diet	N/A	No information available	No information available	Primarily feed in demersal habitat. Diet includes crabs, shrimp, octopus and fish.
Distribution	Serranid eggs have a relatively long pelagic phase that results in wide distribution	Serranid larvae have a relatively long pelagic phase that results in wide distribution	Throughout Indo-Pacific. Juveniles of some species Inhabit shallow reef areas (sea-grass beds and tide pools).	Throughout Indo-Pacific. Inhabit shallow coastal coral reef areas to deep slope rocky habitats (0-400 m)
Water Column	Pelagic	Pelagic	Demersal	Demersal
Bottom Type	N/A	N/A	Wide variety of shallow-water reef and estuarine habitats	Primary forage habitat is shallow to deep reef and rocky substrate.
Oceanic Features	Subject to advection by prevailing currents	Subject to advection by prevailing currents	N/A	N/A

17. Grammistidae (soapfish)

The soapfishes are small, grouper-like fishes that emit a toxic slime to deter predation by larger fishes. They are secretive fish that occur on reef flats, shallow lagoon and seaward reefs, often in small caves, under ledges or in holes at depths up to 150 m. They are nocturnal predators on fishes, crustaceans and a variety of invertebrates. They are represented in Hawaii by three species of the genus *Liopropoma* and two species of *Pseudogramma*. At least one species, *L. aurora*, is endemic. There are 6 species of soapfishes in Micronesia and 4 species in Samoan waters. The taxonomy of the soapfish is frequently under debate, and it has been placed in at least 4 other families. Randall (1996) treats Grammistinae as a subfamily of the Serranidae.

The grammistids, like the serranids, are generally hermaphroditic, although Smith (1971) reported that members of *Liopropoma* appeared to be secondary gonochorists, with separate sexes but clearly derived from hermaphroditic ancestors. Smith and Atz (1966) reports that members of *Pseudogramma* are hermaphroditic. All are typically solitary and territorial. *Diploprion* and *Liopropoma* appear to have pelagic eggs, while P*seudogramma* has large, bright red eggs that are probably demersal. The duration of the planktonic phase is not known, but the size of the largest examined pelagic specimen was 12.6–14.5 mm (Leis and Rennis 1983).

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Management Unit Species: Grammistidae (soapfishes)

	Egg	Larvae	Juvenile	Adult
Duration				
Diet	N/A	zooplankton	similar to adult	small fishes, crustaceans and other invertebrates
Distribution, general and seasonal			similar to adult	Atlantic, Pacific, and Indian Oceans; 5 species in Hawaii with at least one endemic; at least 6 species in Micronesia
Location	pelagic; possibly demersal for *Pseudogramma* spp.	predominantly offshore		outer reef slopes, reef flats, lagoons, wave-washed seaward reefs
Water column	pelagic; possibly demersal for *Pseudogramma* spp.	pelagic	demersal; 1-150 m	demersal; 1–150 m
Bottom type		N/A	similar to adults	secretive inhabitants of caves, crevices on coral reefs and rocky substrate
Oceanic features		subject to advection by ocean currents		

18. Plesiopidae (prettyfins)

Prettyfins, or longfins, are characterized by a disjunct lateral line, preopercle with a double border and long pelvic fins. They are nocturnal predators on small crustaceans, fishes and gastropods. They are secretive during the day. No species are recorded for the Hawaiian islands, and 3 species are recorded for Micronesian waters. Three species are recorded in Samoan waters. The comet *Calloplesiops altivelis* is a popular aquarium fish that is relatively uncommon in Micronesia. The red-tipped longfin *Plesiops caeruleolineatus* is a common, but seldom seen, fish on exposed outer reef flats and outer reef slopes to a depth of 23 m. The bluegill longfin *P. corallicola* is relatively common on reef flats under rocks or in crevices.

Prettyfin reproduction is similar to the closely related dottybacks. They are demersal spawners in which the male tends the egg mass. Mito (1955) reported that *P. semeion* eggs are 0.9 by 0.6 mm, and are deposited in a single layer on the underside of a rock.

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Management Unit Species: Plesiopidae (prettyfins)

	Egg	Larvae	Juvenile	Adult
Duration	15 days by a mouth-brooding species in an aquarium (Debelius and Baensch 1994)	3 months for a related basslet	3 years for a related basslet	
Diet	N/A	zooplankton	probably similar to adult	small crustaceans, fishes, and gastropods
Distribution, general and seasonal				3 species recorded for Micronesian waters; none in Hawaiian waters
Location	near adult territory; often in caves or crevices	primarily offshore	similar to adults	outer reef slopes and flats
Water column	demersal; or carried in the mouth of the male	pelagic	demersal; 3-45 m	demersal; 3–45 m
Bottom type	cleared patch of rock or coral	N/A	same as adults	holes and crevices on coral reefs; also sand and rock
Oceanic features		subject to advection by ocean currents		

19. Pseudochromidae (dottybacks)

Dottybacks are small (<65mm) elongate fishes with a long continuous dorsal fin. Two genera are present in Micronesian waters: *Pseudochromis* has a disjunct lateral line, whereas *Pseudoplesiops* lacks one. Members of *Pseudoplesiops* typically remain hidden within the reef framework and are rarely seen except when an ichthyocide is used. Some members of *Pseudochromis* are brightly colored and are sought after for the aquarium trade. The dottybacks are carnivores of small crustaceans, polychaete worms and zooplankton. The dottybacks are demersal spawners, and some may brood eggs in the mouth of the male. Females of *Pseudochromis* produce a spherical mass of eggs that is guarded by the male. Dottybacks are not present in Hawaiian waters, while 10 species are present in Micronesian waters. Five species are recorded for Samoan waters.

Dottybacks are hermaphrodites. Males are typically larger than females. Some species are obviously sexually dichromatic, while others are not. Pseudochromoid egg balls range in diameter from 7 mm with about 60 eggs in *Assessor macneilli* (Thresher 1984) to 5–8 cm with 8,200 to 17, 500 eggs for *Acanthoclinus quadridactylus* (Jillet 1968). Individual *Pseudochromis fuscus* eggs are 1.25 mm in diameter, slightly elongate spheroids attached by several adhesive threads. Incubation periods range from 3 to 5 days at approximately 29°C. Hatching typically occurs at night, shortly after sunset. Newly hatched larvae of *P. fuscus* are 2.5 mm, and feeding typically begins on the first day after hatching (Lubbock 1975). Jillett (1968) estimates a planktonic larval stage of 3 months for *A. quadridactylus*, which reaches sexual maturity in approximately 3 years.

Pseudochromis cyanotaenia is sexually dichromatic, relatively common near holes and crevices of exposed outer reef flats and reef margins to a depth of 4 m, often occurs in pairs and feeds on small crabs, isopods and copepods. *P. fuscus* is common near small patches of branching corals on shallow sandy subtidal reef flats and lagoons.

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Management Unit Species: Pseudochromidae (dottybacks)

	Egg	Larvae	Juvenile	Adult
Duration	3–5 days for *Pseudochromis fuscus* (Thresher 1984)	3 months	3 years for an Australian species *Acanthoclinus quadridactylus*	
Diet	N/A	zooplankton	probably similar to adult	small crustaceans, polychaete worms, and zooplankton
Distribution, general and seasonal				10 species recorded for Micronesian waters; none in Hawaiian waters
Location	near adult territory; often in caves or crevices	primarily offshore	similar to adults	exposed outer reef flats and reef margins; also near small patches of branching corals on shallow sandy subtidal reef flats and lagoons
Water column	demersal; or carried in the mouth of the male	pelagic	demersal; 0–100m	demersal; 0–100m
Bottom type	cleared patch of rock or coral	N/A	same as adults	holes and crevices on coral reefs; also sand
Oceanic features		subject to advection by ocean currents		

20. Acanthoclinidae (spiny basslets)

Acanthoclinids are closely related to the pseudochromids but differ in having more dorsal and anal fin spines and 1or 2 instead of 3 to 5 pelvic rays. Basslets in general produce demersal eggs and have a tendency towards oral incubation. Eggs are typically tended by the male or brooded by them in the case of brooders. Other basslets have eggs that hatch within 3–16 days and larvae that have a planktonic stage of up to 3 months. The basslets are fairly secretive inhabitants of coral reefs, but some species are conspicuous as they hover near shelter. They are often collected for aquariums. There are 10 known species, but only 3 occur in the Indo-Pacific, with none in Hawaii and one species in Micronesia. Hiatt's basslet *Acanthoplesiops hiatti* is a tiny species (to 21 mm) that has been collected from shallow-washed seaward reefs in Micronesia.

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Management Unit Species: Acanthoclinidae (spiny basslets)

	Egg	Larvae	Juvenile	Adult
Duration	3–16 days	months		
Diet	N/A		similar to adults	small crustaceans, polychaete worms, and zooplankton
Distribution, general and seasonal				West-central Pacific; one species *Acanthopesiops hiatti* found in Micronesia
Location		offshore waters	shallow wave-washed seaward reefs	shallow wave-washed seaward reefs
Water column	demersal	pelagic	reef-associated; 1–65 m	reef-associated; 1–65 m
Bottom type			coral or rock shelter	coral or rock shelter
Oceanic features		subject to advection by ocean currents		

21. Cirrhitidae (hawkfish)

Hawkfishes are small grouper-like fishes characterized by projecting cirri on the tips of the dorsal spines. The common name comes from their tendency to perch themselves on the outermost branches of coral heads or other prominences. They use enlarged lower pectoral rays to support their body or to wedge themselves in place. All are carnivores of small benthic crustaceans and fishes. The species thus far studied are protogynous hermaphrodites, and the males are territorial and defend a harem of females. Courtship and spawning occur at dusk or early night throughout the year in the tropics. Spawning occurs at the apex of a short, rapid paired ascent. The pelagic larval stage probably lasts a few to several weeks (Randall 1963). In Hawaii, there are 6 species recorded. At least 10 species occur in Micronesia, and at least 8 species occur in Samoa. The colorful species are popular aquarium fishes.

Hawkfishes range in size at maturity from less than 10 cm to almost a meter. Most species are sexually monomorphic. Pair spawning occurs with the male making quick ascents with each of the members of his harem in rapid succession. Eggs are pelagic, spherical and approximately 0.5 mm in diameter. The development at hatching is unknown. A lengthy pelagic stage is suggested by the widespread distribution and limited geographic variation of some species. The smallest specimen examined by Leis and Rennis (1983) was 2.7 mm, and the largest pelagic specimen examined was 33.0–37.9 mm. Juveniles of most species resemble the adults.

Adults typically inhabit rock, coral or rubble of the surge zone, seaward reefs, lagoons, channels, rocky shorelines and submarine terraces. Some are typically found on heads of small branching corals. The longnose hawkfish *Oxycirrhites typus* is a popular aquarium fish that feeds mainly on zooplankton and is usually seen perched on black coral or gorgonians at depths greater than 30 m.

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Management Unit Species: Cirrhitidae (hawkfishes)

	Egg	Larvae	Juvenile	Adult
Duration		weeks to months		
Diet	N/A		similar to adults	carnivores of small benthic crustaceans and fishes; the longnose hawkfish *Oxycirrhites typus* feeds heavily on zooplankton
Distribution, general and seasonal				most are Indo-West Pacific; 6 species in Hawaii, at least 10 species in Micronesia, and at least 8 species in Samoa
Location	near adult territory	generally offshore	similar to adults	the surge zone, seaward reefs, lagoons, channels, rocky shorelines and submarine terraces. Some are typically found on heads of small branching corals
Water column	pelagic	pelagic	demersal	demersal
Bottom type	N/A	N/A	rock, coral, or rubble	rock, coral, or rubble
Oceanic features	subject to advection by ocean currents	subject to advection by ocean currents		

22. Apogonidae (cardinalfishes)

The cardinalfishes are named for the red color of some of the species, although most are fairly drab and many are striped. They are characterized by two dorsal fins, large eyes, a large mouth and double-edged preopercles. Most species are small, less than 12 cm. They are typically nocturnal, remaining hidden under ledges or in holes in the reef during the day. Most prey mainly on large zooplankton, but some feed primarily on small benthic crustaceans. A few species form dense aggregations immediately above mounds of branching corals. As far as is known, all species are brood spawners in which the male carries the eggs in his mouth until they hatch. Ten species occur in Hawaii, and at least 58 species occur in Micronesia. *Apogon erythrinus*, *A. maculiferus*, and *A. menesemus* are endemic to the Hawaiian Islands. At least 36 species occur in Samoa.

External sexual dimorphism is slight or nonexistent in the cardinalfishes, except for females that are noticeably swollen with eggs prior to spawning. Temporary color differences during courtship and spawning occur in a few species. Apogonid species display a variety of different seasonal spawning patterns, from year-round spawning to spring and fall peaks. Spawning may also be tied to the phases of the moon.

Schooling behavior is important in some species of cardinalfishes. The fragile cardinalfish *A. fragilis* occurs in large aggregations above branching corals. Despite these aggregations, courtship and spawning in cardinalfishes are always paired rather than group activities. The female often initiates courtship, which involves prolonged tight side-by-side swimming until spawning occurs and the female releases a ball of eggs which the male quickly circles back to and inhales. The male broods the eggs in the mouth for anywhere from 2 to 8 days. The eggs, up to 22,000 of them, are bound together by threads that originate from one pole of the egg and, in some species, a fine mucous membrane. Upon hatching, the eggs become planktonic larvae ranging in size from 1.0–3.3 mm. The planktonic larval stage lasts approximately 60 days, until larvae settle out at a size ranging from 10 to 25 mm.

Cardinalfish are found in water depths from 1 to 80 m. Members of the genera *Apogonichthys, Foa* and *Fowleria* are typically secretive, cryptic inhabitants of seagrasses, algal beds or rubble of sheltered reefs and reef flats. The bay cardinalfish *Foa brachygramma* is usually found around dead coral, sponge or heavy plant growth in shallow bays such as Kaneohe Bay, Oahu, and Tumon Bay, Guam.

Chave (1978) detailed the ecology of 6 species of Hawaiian cardinalfishes, all of which remain in holes and caves in the daytime and emerge at night to feed on zooplankton and benthic invertebrates. The habitat requirements of each species was distinct. Some species remain near the substrate at night (*A. snyderi* and *A. erythrinus*), while others occur in midwater (*A. menesemus*, *A. maculiferus* and *A. waikiki*), and *Foa brachygramma* occurs in both locations. *A. snyderi* eats mostly sand dwelling invertebrates in sandy, bright, flat

substrate, *A. maculiferous* eats mostly midwater zooplankton near dawn, and *A. erythrinus* eats crustaceans only (Chave 1978).

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Management Unit Species: Apogonidae (Cardinalfishes)

	Egg	Larvae	Juvenile	Adult
Duration	2–8 days	approximately 60 days		
Diet	N/A	zooplankton; tintinnids (Watson 1974)	feed on plankton at night; some species eat primarily small benthic crustaceans	feed on plankton at night; some species eat primarily small benthic crustaceans
Distribution, general and seasonal	throughout the year, spring and fall peaks for some species	throughout the year, spring and fall peaks for some species	Atlantic, Pacific, and Indian Ocean	Atlantic, Pacific, and Indian Ocean
Location	within the father's mouth	predominantly offshore	coral reefs	coral reefs
Water column	within the father's mouth	pelagic	demersal and mid-water at night for feeding on zooplankton; 1-80m depth	demersal and mid-water at night for feeding on zooplankton; 1–80 m depth
Bottom type	N/A	N/A	coral reef ledges, holes, flats, rubble, within the branches of branching corals	coral reef ledges, holes, flats, rubble, within the branches of branching corals
Oceanic features				

23. Priacanthidae (bigeyes)

Priacanthids have very large eyes, moderately deep compressed bodies, oblique mouths with a projecting lower jaw, small conical teeth in a narrow band in each jaw, an opercle with 2 flat spines and a serrate preopercle with a broad spine at the corner. They are usually red but are able to change quickly to silver or blotches of silver and red. They are nocturnal zooplanktivores on larger zooplankton, such as the larvae of crabs, fishes, polychaete worms and cephalopods. The family is distributed circumtropically and in temperate seas, but some species are limited to the Indo-Pacific or the Hawaiian Islands. In Hawaiian waters, 4 species have been recorded: *Heteropriacanthus cruentatus*, the endemic *Priacanthus meeki* and two deep-water species. In Micronesian waters, *H. cruentatus*, *P. hamrur* and a deep species from below 200 m depth have been recorded. The shallow-water species are limited to 100 m or less. Five species are recorded from Samoan waters.

The glasseye *H. cruentatus* inhabits lagoon or seaward reefs from below the surge zone to a depth of at least 20 m. During the day it is usually solitary or in small groups but may gather in large numbers at dusk prior to ascending into the water column for feeding.

Spawning by priacanthids has not been observed, but Colin and Clavijo (1978) reports seeing an aggregation of more than 200 individuals at a reef where many other species were spawning. The eggs of *Pristigenys niphonium* and *Priacanthus macracanthus* are pelagic, spherical and 0.75 mm in diameter (Suzuki et al. 1980, Renzhai and Suifen 1982). The larvae hatch at 1.4 mm (Renzhai and Suifen 1982). The size of the largest examined pelagic larval specimen was 48 mm (Leis and Rennis 1983). Caldwell (1962) reports a size at settlement for the deep-water subtropical species *Pristigenys alta* of 65 mm.

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Management Unit Species: Priacanthidae (bigeyes)

	Egg	Larvae	Juvenile	Adult
Duration		from 10 mm to about 60 mm		
Diet	N/A	various zooplankton	similar to adults	larger zooplankton such as the larvae of crabs, fishes, polychaete worms and cephalopods; also crustaceans and soft-bodied invertebrates
Distribution, general and seasonal				worldwide in tropical and temperate seas, but 3 Indo-Pacific genera, 1 Hawaiian endemic
Location				lagoon or seaward reefs from below the surge zone to a depth of at least 80 m
Water column	pelagic	pelagic	demersal and mid-water column	demersal and mid-water column; some species very deep
Bottom type	N/A	N/A		coral reef crevices or overhangs during the day; may feed over soft substrate at night
Oceanic features	subject to advection by ocean currents	subject to advection by ocean currents		

24. Malacanthidae (tilefishes)

The tilefishes have elongate bodies with one sharp opercular spine and a long continuous dorsal fin. They have viliform and canine teeth for taking a variety of benthic animals along with substantial amounts of plankton. They usually occur in pairs on sandy and rubbly areas of outer reef slopes. They frequently build a burrow into which they retreat when threatened, often piling rubble on top. They can be found in depths from 6 to 115 m in mud, sand, rubble or talus areas of barren seaward slopes. The family is distributed worldwide in tropical and temperate seas. The family is represented in Hawaiian waters by a single species, *Malacanthus brevirostris*, and in Micronesian waters by the same species plus four more: *Hoplolatilus cuniculus, H. fronticinctus, H. starcki* and *M. latovittatus*. Two species are present in Samoan waters: *M. brevirostris* and *M. latovittatus*.

Accounts of spawning are few, but pairs typically make a short spawning ascent to release pelagic, spheroid eggs, about 0.7 mm in diameter with a single oil globule. After a larval phase of undetermined duration, *Malacanthus* settle to the bottom at a size of about 6 cm and immediately construct burrows under rocks in shallow water (Araga 1969).

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Management Unit Species: Malacanthidae (Tilefishes)

	Egg	Larvae	Juvenile	Adult
Duration		weeks or months	settlement at a size of about 6 cm	
Diet	N/A		benthic invertebrates and plankton	benthic invertebrates and plankton
Distribution, general and seasonal				3 Indo-Pacific genera
Location			shallow sheltered habitats	outer reef slopes
Water column	pelagic	pelagic	demersal	demersal
Bottom type	N/A	N/A	sand, mud, rubble	sandy and rubbly areas
Oceanic features	subject to advection by ocean currents	subject to advection by ocean currents		

25. Echineididae (remoras)

Remoras have a broad flat head uniquely modified for suction that allows them to attach to other marine animals. Some species are host specific while others use a variety of hosts such as sharks, rays, large bony fishes, sea turtles or marine mammals. Some species are free swimming. The two species of *Echeneis* are not host-specific and are free-living part of the time. Remoras are circumglobal in their distribution. In Hawaii and in Micronesia, the sharksucker *E. naucrates* is the most common, although *Remora remora* may be found on large sharks and *Remorina albescens* on mantas. Five species are recorded from Samoan waters, including *E. naucrates, R. remora,* and *Phtheirichthys lineatus*, which was attached to a hawksbill turtle. *Remoropsis pallidus* and *Rhombochirus osteochir* were found attached to marlin.

Johnson (1984) reports that eggs of *E. naucrates* and *R. remora* are large (1.4–2.6 mm), pelagic and spherical, although Nakajima et al. (1987) reports *E. naucrates* eggs are negatively buoyant. Newly hatched eggs are 4.7–7.5 mm long. The size of the largest examined pelagic larval stage was 14.5–22 mm (Leis and Trnski 1989).

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Management Unit Species: Echineididae (remoras)

	Egg	Larvae	Juvenile	Adult
Duration		size at hatching ranges from 3.7 to 7.5 mm		
Diet	N/A	zooplankton	similar to adults	zooplankton such as copepods and isopods; zoobenthos such as small crustaceans; detritus, and small fishes (Randall 1967)
Distribution, general and seasonal	little information on seasonal patterns		circumglobal	circumglobal
Location			coastal and pelagic waters	coastal and pelagic waters; often attached to sharks, rays, large bony fishes, sea turtles, or marine mammals
Water column	pelagic	pelagic	same as adults	pelagic; either free swimming or attached to large reef-associated inhabitants
Bottom type	N/A	N/A	N/A	N/A
Oceanic features	subject to advection by ocean currents	subject to advection by ocean currents		

26. Carangidae (jacks, *papio, ulua*)

Eggs and larvae

There are few extant studies of the distribution of carangid eggs and larvae. Carangid eggs are planktonic, spherical and 0.70-1.3mm in diameter (Laroche et al. 1984, Miller et al. 1979). The eggs usually contain one to several oil globules. The eggs hatch 24-48 hours after spawning in water temperatures from 18 to 30 C° (Laroche et al. 1984). The larvae are relatively small (1 - 2 mm) at hatching and contain a relatively large yolk sac. The larvae are moderately deep bodied and large headed with well developed preopercular spines (Miller et al. 1979). According to Miller et al. (1979) carangid larvae are common in nearshore waters surrounding the Hawaiian Archipelago.

Juvenile

Juvenile carangids are often found in nearshore and estuarine waters and may form small schools over sandy inshore reef flats (Lewis et al. 1983, Meyers 1991). Available diet studies suggest that juvenile carangids are planktivorous and feed on fish larvae and planktonic crustaceans

Adult

The carangids are distributed throughout tropical and subtropical waters in the Indo-Pacific. They are widely distributed in shallow coastal waters, estuaries, shallow reefs, deep reef slope, banks and seamounts (Sudekum et al. 1991). Juvenile and adult carangids are an important component of shallow reef and lagoon fish catches throughout the management area. Adult carangids are large highly-mobile predators that range widely through the reef and deep slope habitat from depths of 0- 250m. A single species (*Seriola dumerili*) has been documented to forage at depths of up to 355 m (Myers 1991, Ralston et al. 1986). Although most of the large jacks utilize the complete water column in their habitat range they are associated primarily with demersal habitat.

In general adult carangids are piscivourous, they also prey on crustaceans, gastropods, and cephalopods. *Caranx ignobilis*, one of the most abundant species of jacks found in Hawaii is primarily piscivourous, preying primarily on reef-associated fish. The most recent study of the feeding habits of *C. ignobilis* concludes that the predominance of reef fishes in its diet indicates that shallow-water reef areas are important foraging habitat for these fish. The occurrence of small pelagic fish and squid in the diet of C. ignobilis indicates that part of its foraging also occurs in the water-column (Sudekum at al. 1991).

Reproductive information is sparse for most species. In Hawaii the sex ratio for *C. ignobilis* is slightly skewed toward females 1:1.39 (Sudekum et al. 1991). Peak spawning occurs between May and August, although gravid fish are present in the Northwestern Hawaiian Islands (NWHI) between April and November. Spawning occurs in pairs within larger

aggregations during the new and full moon (Johannes 1981), on offshore banks and shallow nearshore reefs (Myers 1991).

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Management Unit: Carangidae (jacks)

	Egg	Larvae	Juvenile	Adult
Duration	24 - 48 hours after spawning	Poorly known, larvae thought to be more common offshore than inshore	Sexual maturity attained at 1-3.5 years depending on species	One species (*C. ignobilis*) life span exceeds 15 years
Diet	N/A	No information available	Generally switch from planktivory to piscivory with increase in age	Predominantly piscivorous utilizing shallow-water reefs. The water-column is also utilized .
Distribution	Pelagic	Pelagic, more common in summer	Near-shore and estuarine waters	Throughout Indo-Pacific. Inhabit shallow coastal areas to deep slope (0-350m)
Water Column	Pelagic	Pelagic	Bentho-pelagic	Bentho-pelagic, utilize entire water-column but primarily associated with demersal habitat
Bottom Type	N/A	N/A	Wide variety of shallow-water reef and estuarine	Primary forage habitat is shallow to deep reef
Oceanic Features	Subject to advection by prevailing currents	Subject to advection by prevailing currents	N/A	N/A

27. Decapterus/Selar (scads, *opelu, akule*)

Egg and Larvae

The spawning of scads occurs in the pelagic environment. Depending on the species the ovaries of the female may contain from 30,000 to 200,000 eggs. The spawned eggs are spherical with a single oil globule, non-adhesive, and free floating (Yamaguchi 1953).

Juvenile

After hatching the larvae and juvenile fish remain in the pelagic environment where they frequently form large aggregating schools. Reports from fishermen have identified aggregations of juvenile scads as far as 80 nmi. offshore (Yamaguchi 1953). Juveniles enter the nearshore coastal waters in late fall and winter, where they grow rapidly over the next few months, usually attaining sexual maturity during the first year of life.

Larval and juvenile fish remain in offshore pelagic waters for the first several months of their life, after which they migrate to the nearshore adult habitat (0-100m).

Adults

Adults spawn in pelagic waters usually in proximity to their coastal habitat. Spawning appears to be seasonal from March through August, reaching a peak from May to July. These species feed in the water column and are mainly planktivorous, preying on zooplankton. Their diet consists of amphipods, crab megalops, fish larvae, pteropods, and copepods, however some species also feed on small fishes such as anchovies and holocentrids (Yamaguchi 1953). Adult opelu and akule inhabit nearshore waters around islands from shoreline depths to 100m.

Management Unit: Decapturus/Selar (scads)

	Egg	Larvae	Juvenile	Adult
Duration	No information	No information	migrate to nearshore waters ~ Six months after hatching	Relatively fast growing and short lived. Sexual maturity usually in first year of life
Diet	N/A	planktivorous	zooplanktivorous	primarily zooplanktivorous, with some piscivory
Distribution	circumtropical pelagic	circumtropical pelagic	circumtropical nearshore	circumtropical nearshore
Water Column	pelagic	pelagic	pelagic and nearshore reef in water column	nearshore reef in water column (neritic)
Bottom Type	N/A	N/A	N/A	N/A
Oceanic Features	Subject to advection by prevailing currents	Subject to advection by prevailing currents	offshore pelagic, migrate to nearshore waters in first year	nearshore waters

28. Caesionidae (fusiliers)

Fusiliers are planktivorous, schooling fishes. They have an elongate, fusiform body, a small terminal mouth with a very protrusible upper jaw, small conical teeth and a deeply forked tail. During the day, fusiliers swim actively in midwater around or near reefs in synchronomous formation, changing the formation to feed on zooplankton. They are particularly abundant along steep outer reef slopes and around deep lagoon pinnacles. They are often observed around cleaner stations, where some members of the aggregations pause to be cleaned by cleaner wrasses. They are not found in Hawaii. At least 10 species occur in Micronesia, and at least 5 species occur in Samoa.

The reproductive biology of caesionids has been examined in only a few species. They appear to be typified by early sexual maturity and high fecundity. They have a prolonged spawning season, but recruitment peaks once or twice a year. Fusiliers are dioecious and gonochoristic, with no significant difference in sex ratio. Spawning has been observed for *Caesio teres* (Bell and Colin 1986) and *Pterocaesio digramma* (Thresher 1984). These caesionids spawn in large groups around the full moon. They migrate to select areas on the reef at dusk and initiate spawning during slack water. In *C. teres*, spawning is preceded by periodic mass vertical ascents and descents to within about 1 m of the surface. During spawning they stay near the surface and subgroups within the mass swirl rapidly in circles and release gametes (Carpenter 1988).

During initial recruitment to a reef, juvenile caesionids generally remain close to the substrate and dart around coral heads and rocks to escape. At night, fusiliers shelter in crevices and under coral heads. Fusiliers often school in mixed species aggregations. They are primarily reef inhabitants, although they often range over soft bottoms in between reefs.

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Management Unit Species: Caesionidae (fusiliers)

	Egg	Larvae	Juvenile	Adult
Duration		weeks to months	reach maturity early	
Diet	N/A	various plankton	planktivores	planktivores
Distribution, general and seasonal	prolonged spawning season but tends to peak once or twice a year			tropical Indo-Pacific; None in Hawaii, at least 10 spp. in Micronesia, and 5 in Samoa
Location	spawning occurs at specific sites on a reef (Bell and Colin 1986)	offshore	similar to adults	abundant along steep outer reef slopes and around deep lagoon pinnacles
Water column	pelagic	pelagic	reef-associated; typically remain close to shelter	pelagic
Bottom type	N/A	N/A	coral or rock	coral, rock, but range over sand in travels from reef to reef
Oceanic features	subject to advection by ocean currents	subject to advection by ocean currents		

29. Haemulidae (sweetlips)

Haemulids are very similar to lutjanids but differ by having smaller mouths a bit lower on the head with small conical teeth and thickened lips, by having pharyngeal teeth and by lacking canine and palatine teeth. Some members of the sweetlip family are commonly called grunts because of the sound they can make by grinding the pharyngeal teeth and amplifying the noise with their gas bladder. Haemulids are primarily nocturnal feeders on benthic invertebrates. During the day they typically school under or near overhangs or tabular corals. Their general lethargy during the day and their schooling tendencies makes them easy targets for spearfishers. As a result, they have become scarce in waters near population centers such as Guam. Most species of *Plectorhinchus* change color dramatically with group. The striped juveniles of many species are similar and difficult to distinguish from other haemulid juveniles. Eleven species are recorded from Micronesian waters. None are recorded for the Hawaiian Islands. Three species are recorded from Samoan waters.

There is little information on haemulid reproduction, particularly in Indo-Pacific locations. Given their similarity to other roving benthic predators, such as groupers or snappers, the haemulids probably migrate to spawning sites on the outer reef slope for group spawning at dusk. Eggs are pelagic with a single oil droplet, and hatching time is approximately 24 hours. Duration of the planktonic stage for *Haemulon flavolineatum* is approximately 15 days, when the larvae settle to the bottom at a length of approximately 6 mm (McFarland 1980, Brothers and McFarland 1981). Juvenile grunts are commonly found in small groups on grass flats, near mangroves and in other inshore areas. Cummings et al. (1966) report sexual maturity of *H. album* at approximately 37.5 cm. Gaut and Munro (1983) found mean lengths at maturity for the Caribbean species *H. plumieri, H. flavolineatum, H. sciurus* and *H. album* of 22 cm FL, 12 cm FL or less, 15.5 cm FL 22 cm FL and 24 cm FL respectively.

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Management Unit Species: Haemulidae (sweetlips and grunts)

	Egg	Larvae	Juvenile	Adult
Duration	approximately 24 hrs	15 days to months	from 6 mm until 12–24 mm FL	
Diet	N/A	copepods, nauplii (Houde and Lovdal 1984)	similar to adult	nocturnal predators on benthic invertebrates, including crustaceans, mollusks, and fishes
Distribution, general and seasonal	likely spring spawning peak		similar to adult	no species recorded for Hawaii; tropical and temperate seas in marine and brackish waters worldwide; 11 Micronesian species
Location	probably outcroppings on outer reef slopes	offshore	sheltered inshore areas in lagoons, estuaries, mangroves as well as adult locations	close to patch reefs, lagoons,inshore and seaward reefs, channels, outer reef slopes
Water column	pelagic	pelagic	demersal and reef or mangrove-associated	demersal and reef-associated; 1–100m
Bottom type	N/A	N/A	sandy to muddy bottoms, coral, rocky ledges or table corals	sandy to muddy bottoms, coral, rocky ledges or table corals
Oceanic features	subject to advection by ocean currents	subject to advection by ocean currents		

30. Lethrinidae (emperors)

Egg and Larvae

Lethrinid eggs are pelagic, spherical ,colorless, and range in size from 0.63 to 0.83 mm. The eggs hatch within 21 to 40 hours after fertilization (Carpenter and Allen 1989). The larvae when hatched range in size from 1.3 to 1.7mm. Larval characteristics include unpigmented eyes, large yolk sac, variable body pigmentation and extensively developed head spination.

Juveniles and Adults

Juvenile and adult lethridids are found throughout the Indo-Pacific in tropical and sub-tropical waters. They are fairly long-lived ranging 7-27 years (Carpenter and Allen 1989). Although little is known of the biology of these species, they are known to inhabit the deeper waters of coral reefs and adjacent sandy areas. Some species also occur in shallow water habitats around coral reefs, sand flats, sea-grass beds and mangrove swamps (Carpenter and Allen 1985). Lethrinids appear to be carnivorous bottom-feeders. Their diet includes: crabs, sea-urchins, bivalves, gastropods, and fish (Walker 1978).

Based on the available data, lethrinids appear to be protogynous hermaphrodites (Young and Martin 1982). Spawning occurs throughout the year, and is preceded by localized migrations during crepuscular periods. Peak spawning occurs on or near the new moon. Spawning may occur at near the surface as well as near the bottom of reef slopes. Lethrinids may reach a maximum length of 70 cm. Males tend to attain a larger size than females.

Management Unit: Lethrinidae (emperors)

	Egg	Larvae	Juvenile	Adult
Duration	hatch 21 - 40 hours after spawning	No information	No information	7-27 Years
Diet	N/A	No information	No information	Carnivorous bottom-feeders
Distribution	Pelagic	Pelagic	Nearshore areas and shallow seamounts	Throughout Indo-Pacific. Inhabit shallow coastal areas to deep slope (0-350m)
Water Column	Pelagic	Pelagic	Benthic	Benthic
Bottom Type	N/A	N/A	Demersal Reef	Primary forage habitat shallow to deep reef feeding on the bottom
Oceanic Features	Subject to advection by prevailing currents	Subject to advection by prevailing currents	N/A	N/A

31. Lutjanidae (snappers)

Egg and Larvae

Lutjanid eggs are pelagic, spherical and 0.65-1.02 mm in diameter. Each egg contains a single oil globule which provides buoyancy during the pelagic phase. Incubation is between 17-27 hours depending on species and temperature. Newly hatched larvae of lutjanids in general are typical of those from fish with small pelagic eggs; the larvae have a large yolk sac, unpigmented eyes and no mouth. The yolk sac typically lasts 3-4 days, after which the mouth is fully formed and the eyes become pigmented (Leis 1987). The larvae are absent from surface waters during the day and migrate upward at night. Snapper larvae are thought to be planktonic and subject to advection by ocean current systems until benthic habitat suitable for metamorphosis is encountered (Munro 1987). The duration of the pelagic phase is thought to be at least 25 days (Leis 1987) and may be as long as 45 days.

Juveniles

Little information currently exists on larval development, settlement or early juvenile life history of deepwater snappers in Hawaii (Haight et al. 1993a). Little is known about the ecology of juveniles from time of settlement to their appearance in the adult fishery. Age at entry to the fishery for the principle fishery species in Hawaii is thought to be 2 to 3 years after settlement (Moffitt and Parrish 1996). In a three year study of fish settlement on artificial reefs adjacent to adult snapper habitat in Hawaii, no recruitment of juvenile snappers to the reefs was observed, although adults aggregated at times around the reef structures (Moffitt et al. 1989).

Studies on juveniles of one snapper species in Hawaii indicated juvenile *Pristipomoides filamentosus* first appear in the relatively shallow (60 - 100 m) nearshore areas at about 10 months of age (7 - 10 cm FL) during the fall and early winter months. The young fish remain in this habitat for the next 7 months until they reach 18 - 24 cm FL (Moffitt and Parrish 1996, Ellis et al 1992). *In situ* scuba observations of the juvenile habitat found it to be a relatively flat, soft sediment substrate devoid of relief (Parrish 1989).

Adults

Tropical snappers in general are slow growing, long lived and have low rates of natural mortality. Maximum ages exceed 10 years and von Bertalanffy growth coefficients (K) are usually in the range of 0.10 to 0.25 per year (Manooch 1987). Most ageing studies of tropical snappers have depended on the enumeration of regularly formed marks on calcareous structures. In Hawaii, Ralston and Miyamoto (1983) used daily growth increments deposited on the otoliths of immature *P. filamentosus* to determine its growth rate. The estimated growth coefficient of opakapaka is 0.145 per year, and asymptotic upper boundary on growth ($L\infty$) was 78 cm FL, which occurred at over 18 years of age.

Ralston (1987), in a comprehensive review of published reports on snapper growth and natural mortality, determined that for the 10 species studied, mortality and growth rates were highly correlated, with a mean M/K ratio of 2.0. Thus, if a value of K is available for a given species, its natural mortality rate can be estimated. Using an age-length probability matrix for opakapaka applied to length frequency samples, Ralston (1981) estimated the natural mortality rate for opakapaka in Hawaii to be 0.25, which when compared to the estimated K value for this species (0.145) is close to the value predicted by the M/K relationship derived for snappers in general.

Size at sexual maturity for lutjanids on average occurs at about 43 to 51% of L_∞ (Allen 1985). Size at maturity has been estimated for only two species in the MHI and two species in the NWHI. In the MHI, uku reaches sexual maturity at 47 cm fork length (FL), which is 46% of maximum size (L_∞). Onaga reaches sexual maturity at 61 cm FL (62% L_∞) (Everson et al. 1989). In the NWHI, ehu reaches maturity at about 30 cm FL (46% L_∞) and opakapaka reaches maturity at around 43 cm FL (48% L_∞) (Everson 1984, Kikkawa 1984, Grimes 1987).

Gonadal studies on four of the species in Hawaii indicate that spawning may occur serially over a protracted period but is at a maximum during the summer months, and peaks from July to September (Everson et al. 1989, Uchida and Uchiyama 1986). Estimated annual fecundity is 0.5 to 1.5 million eggs. The eggs are released into the water column.

Although snappers throughout the world are generally thought of as top level carnivores, several snapper species in the Pacific are known to incorporate significant amounts of zooplankton, often gelatinous urochordates, in their diets (Parrish 1987). Haight et al. (1993b) found zooplankton to be an important prey item in four of the commercially important snappers in Hawaii. The same study found that the six snapper species studied were either primarily zooplanktivorous or primarily piscivorous, with little overlap in diet composition between trophic guilds. A contributing factor in the distribution pattern of zooplanktivores may be that currents striking deepwater areas of high relief form localized zones of turbulent vertical water movement, increasing the availability of planktonic prey items (e.g. Brock and Chamberlain 1968). In an ecological study of the bottomfish resources of Johnston Atoll, Ralston et al. (1986) found *P. filamentosus* in much higher densities on the upcurrent versus downcurrent side of the atoll, and postulated that this was related to increased availability of allochthonous planktonic prey in the neritic upcurrent areas due to oceanic currents impacting the atoll.

Management Unit Lutjanidae (snappers)

	Egg	Larvae	Juvenile	Adult
Duration	Incubate 17-36 hours	Pelagic duration : 25-47 days	Reach sexual maturity in 2-3 years	Long-lived, slow growing. Age at entry to fishery at 2-3 years
Diet	N/A	No information available	Diet of one species includes crustaceans, cephalopods and small fish	Primarily demersal carnivores although some species are zooplanktivorous
Distribution	Widely distributed throughout management area	Widely distributed throughout management area	Throughout Indo-Pacific. Juveniles of some species Inhabit shallow reef areas not utilized by adults	Throughout Indo-Pacific. Inhabit shallow coastal coral reef areas to deep slope rocky habitats (0-400 m)
Water Column	Pelagic	Pelagic	Demersal	Demersal
Bottom Type	N/A	N/A	Wide variety of shallow-water reef and estuarine habitats	Primary forage habitat is shallow to deep reef and rocky substrate.
Oceanic Features	Subject to advection by prevailing currents	Subject to advection by prevailing currents	N/A	N/A

32. Mullidae (goatfishes)

Goatfish are important commercial fish that are highly esteemed as food. All have a characteristic pair of long barbels at the front of the chin, a moderately elongate body, two well-separated dorsal fins, a small mouth with a slightly protruding upper jaw and a forked tail. Goatfish use the barbels, which contain chemosensory organs, to probe sand or holes in the reef for benthic invertebrates or small fishes. The barbels are tucked between the lower portion of the gill covers when not in use. Some species are primarily nocturnal, others are diurnal and a few are active by day or night. Nocturnal species tend to hover in stationary aggregations or rest on coral ledges by day.

There are 10 native species of goatfish known from Hawaiian waters, and one accidental introduced species from the Marquesas, *Upeneus vittatus*. Two species, *Parupeneus porphyreus* and *P. chrysonemus*, are endemic to Hawaii. Fifteen species are recorded from Micronesia. Thirteen species are recorded from Samoa.

Goatfish have pelagic eggs, which are spherical, transparent and non-adhesive with a single oil droplet. Egg diameters range from 0.63 to 0.93 mm and hatch within 3 days. Goatfish in general have a long larval development. After settlement, juveniles take approximately 1 year to reach sexual maturity. Munro (1976) suggests that few live more than 3 years.

Schooling is common among the mullids. Group spawning and pair spawning have been documented for goatfishes. An aggregation of 300 to 400 individuals was observed spawning at 21 m depth off the coast of the US Virgin Islands (Colin and Clavijo 1978). Groups of fish made spawning rushes about 2 meters above the bottom before releasing gametes.

Holland et al. (1993) conducted a study of the movements, distribution and growth rates of *Mulloidichthys flavolineatus*by using tagging data. *M. flavolineatus* and *M. vanicolensis* were the most abundant mullids found in Hanalei Bay (Friedlander et al. 1997). *M. flavolineatus* ranked second in overall mean biomass at 211g/100m^2, with an overall mean numerical density of 1.1 individuals/100m^2. *M. vanicolensis* had higher numbers in patch reef habitat, but the larger fish were present in reef slope habitat, indicating partitioning of habitat by size. *Parupeneus cyclostomus* was the rarest and most mobile of the mullids found in Hanalei Bay, with an overall mean density of 0.01 individuals/100m^2 or 2.02 g/100m^2. The largest individuals were seen in deeper reef slope habitat. *P. cyclostomus* has a diet strongly dominated by fish, particularly fish that are diurnally active over reef and other hard substrata. It also eats lesser quantities of crabs, shrimps and stomatopods and trace amounts of other invertebrates. It typically probes sand or reef crevices to flush out small fish with its barbels. *P. cyclostomus* is inactive at night.

The diet of the Hawaiian endemic *P. porphyreus* encompasses a wide variety of benthic invertebrates such as crabs, shrimps, isopods, amphipods, ostracods, stomatopods, planktonic

crab megalops larvae and copepods, gastropods, foraminiferans and fish in order of decreasing importance. *P. porphyreus* shelters in areas of high relief and feeds over hard substrate and sandy areas nearby (Friedlander et al. 1997).

The breeding season for *P. porphyreus* shows peak spawning somewhere between December and July. Counts of nuclear rings on otoliths indicate a larval period of approximately 40–60 days. The juvenile phase involves rapid color changes, a lengthening of the gut and an external change in shape. Juveniles can sexually mature as early as 1.25 years. Fecundity was estimated as 11,000 to 26,00 eggs per spawn. Adults live 6 years or longer (Moffitt 1979).

Five goatfish species at Midway Island were generalized feeders, eating mostly small crustaceans, polychaetes and bivalve and opisthobranch molluscs (Sorden 1982). Sorden (1982) discusses similarities and differences among feeding preferences of the goatfish fauna at Midway.

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Management Unit Species: Mullidae (goatfishes)

	Egg	Larvae	Juvenile	Adult
Duration	3 days	relatively long, months?	approximately one year	3 years (Munro 1976)
Diet	N/A	planktivorous	benthic invertebrates such as crabs, shrimps, isopods, amphipods, ostracods, stomatopods, planktonic crab megalops larvae and copepods, gastropods, and foraminiferans; some species eat small fish	benthic invertebrates such as crabs, shrimps, isopods, amphipods, ostracods, stomatopods, planktonic crab megalops larvae and copepods, gastropods, and foraminiferans; some species eat small fish
Distribution, general and seasonal	spawning peaks in late spring and fall	most abundant in the open ocean, though still <25km from reefs	Atlantic, Indian and Pacific oceans, rarely in brackish waters	Atlantic, Indian and Pacific oceans, rarely in brackish waters; may have seasonal spawning aggregations at prominent reef features
Location	released several meters from the bottom	most abundant in the open ocean, though still <25km from reefs	pelagic for some species (Caldwell 1962), but coral reef and sand flat otherwise	coral reef or soft-bottom habitat
Water column	pelagic	pelagic	demersal	demersal
Bottom type	N/A	N/A	coral reef, rock, sand, mud, crevices, ledges	coral reef, rock, sand, mud, crevices, ledges
Oceanic features	subject to advection by ocean currents	subject to advection by ocean currents	unknown	spawning aggregations near channels with heavy tidal flow

33. Kyphosidae (rudderfishes)

Rudderfishes, or sea chubs, are shore fishes of rocky bottoms or coral reefs of exposed coasts. They have deep oval bodies, a continuous dorsal fin, a forked caudal fin and a small mouth with close-set incisiform teeth. They are benthic herbivores and the species of *Kyphosus* often occur in large groups that may overwhelm the defenses of territorial herbivorous fish, such as damselfishes and surgeonfishes. Juveniles often occur far out at sea beneath floating debris. Adults typically swim in schools several meters above the bottom, where they may feed on planktonic algae. Three species occur in Hawaii, Micronesia and Samoa: *Kyphosus bigibbus, K. cinerascens* and *K. vaigiensis*. Another species *Sectator ocyurus* has been reported in Hawaii but is rare and may be a waif from the tropical eastern Pacific.

Very little is known about reproduction in the kyphosids. The eggs are spherical, pelagic and 1.0–1.1 mm in diameter (Watson and Leis 1974). The larvae hatch at 2.4–2.9 mm. The largest pelagic specimen, a juvenile, examined by Leis and Rennis (1983) was 56 mm. Juvenile individuals may be carnivorous for a while before becoming herbivorous (Rimmer 1986).

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Management Unit Species: Kyphosidae (rudderfishes)

	Egg	Larvae	Juvenile	Adult
Duration		prejuveniles commonly collected far out at sea under floating debris		
Diet	N/A	zooplankton	may be carnivorous for a while, such as *Kyphosus cornelii* (Rimmer 1986)	herbivorous on benthic and planktonic algae
Distribution, general and seasonal				circumtropical; 3 species in Hawaii, Micronesia, and Samoa: *Kyphosus bigibbus, K. cinerascens*, and *K. vaigiensis*
Location			exposed seaward reefs	exposed seaward reefs
Water column	pelagic	pelagic	same as adults	benthic and pelagic, may school in the water column
Bottom type	N/A	N/A	rocky bottoms or coral reefs	rocky bottoms or coral reefs
Oceanic features	subject to advection by ocean currents	subject to advection by ocean currents		

34. Monodactylidae (monos)

Monos are a small family of highly compressed silvery fishes with small oblique mouths, brush-like teeth in the jaws, viliform teeth on the vomer and palatines, vestigial pelvic fins and a continuous unnotched dorsal fin. They occur primarily in estuarine habitats and can live in freshwater. No monos are recorded for the Hawaiian Islands. The family occurs off West Africa and in the Indo-Pacific, and one species, *Monadactylus argenteus*, occurs in Micronesia and Samoa. It is an active schooling fish that occurs primarily in estuaries but may venture over silty coastal reefs. It is valued as an aquarium fish.

M. argenteus spawns demersal, adhesive eggs, at least in freshwater (Breder and Rosen 1966). The eggs of *Psettus sebae*, a tropical Atlantic species, are small (0.6–0.7 mm), spherical and pelagic in seawater but demersal in freshwater (Akatsu et al. 1977). Larvae of *P. sebae* hatch at 1.8 mm. The largest size of a pelagic larval specimen of *M. argenteus* was 14.5 mm (Leis and Trnski 1989).

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Management Unit Species: Monodactylidae (monos)

	Egg	Larvae	Juvenile	Adult
Duration		from <1 mm to 14.5 mm		
Diet	N/A		probably similar to adults	small benthic and planktonic invertebrates
Distribution, general and seasonal	spring or summer spawning peak likely		similar to adults	West Africa and Indo-Pacific; not in Hawaii, *Monadactylus argenteus* only species in Micronesia
Location			similar to adults	primarily in estuaries, but may venture over silty coastal reefs
Water column	pelagic in seawater, demersal in freshwater	pelagic in seawater, demersal in freshwater	pelagic	pelagic
Bottom type			silt, mud, sand, coral	silt, mud, sand, coral
Oceanic features	pelagic larvae subject to dispersal by ocean currents	pelagic larvae subject to dispersal by ocean currents		

35. Ephippidae (batfishes, spadefishes)

Batfishes have deep, highly compressed bodies, a small terminal mouth with brushlike teeth, a continuous dorsal fin and small ctenoid scales extending to the basal portions of the median fins. They are schooling, semi-pelagic fishes often associated with reefs. Juveniles have very deep bodies and greatly elevated dorsal, anal and pelvic fins that shorten with age. Juveniles occur singly or in small groups among mangroves and in inner sheltered lagoons or reefs. Adults migrate to deeper channels and lagoons where they aggregate in small schools, although larger adults may be solitary. They are omnivores that feed on algae, invertebrates and small fishes. In Micronesian waters, 3 species occur: *Platax orbicularis, P. pinnatus* and *P. teira*. In Samoan waters, 2 species have been recorded.

There is little information on the spawning or egg characteristics of Indo-Pacific ephippidids, but there is some information for the Atlantic genus *Chaetodipterus*, which has pelagic eggs of about 1 mm diameter (Johnson 1984). Spawning for *C. faber* was observed near floating objects about 40 m offshore. Two small schools were present, but spawning occured between pairs (Chapman 1978). This observation suggests that ephippids migrate offshore to spawn. Spadefish larvae hatch in 24 hours and are about 2.5 mm long. By a length of 10 mm, the larvae are recognizable as spadefish and are ready to settle.

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Leis JM and T Trnski. 1989. The larvae of Indo-Pacific shorefishes. Honolulu: Univ of Hawaii Pr.

Management Unit Species: Ephippidae (batfishes, spadefishes)

	Egg	Larvae	Juvenile	Adult
Duration	24 hrs	hatch at 2.5 mm, ready to settle at 10 mm		
Diet	N/A		similar to adults	algae, invertebrates, small fishes
Distribution, general and seasonal	spring or summer spawning (Munro et al. 1973)		similar to adults	the family is found in tropical and temperate seas worldwide; the genus *Platax* is found in Micronesia, not in Hawaii
Location	offshore	offshore	mangroves, sheltered lagoons and reefs	deeper channels, lagoons, seaward reefs
Water column	pelagic	pelagic	semi-pelagic	semi-pelagic
Bottom type	N/A	N/A	sand, mud, silt, and coral reefs	reef-associated, but also mud and sand bottoms in mangroves and lagoons
Oceanic features	subject to advection by ocean currents	subject to advection by ocean currents		

36. Chaetodontidae (butterflyfishes)

Butterflyfishes are colorful, conspicuous fishes with deep, highly compressed, ovate bodies, small mouths and a band of brush-like teeth in the jaws. They have a single continuous dorsal fin with anterior interspinous membranes deeply incised and a caudal fin varying from slightly rounded to slightly emarginate. They are diurnal predators with diets that vary significantly between species. Many specialize on polyps of corals and other coelenterates. The corallivores tend to be territorial and limited to the shallower depth ranges of the corals, such as *Pocillopora meandrina*, upon which they feed. Others feed heavily on benthic algae and small benthic invertebrates. Some species, including those of *Hemitaurichthys*, are primarily zooplanktivores. The zooplankton feeders often occur in mid-water aggregations and range into relatively deep water. Most butterflyfishes are solitary or occur in pairs, but a few form aggregations. Butterflyfishes appear to be gonochorists, with sex remaining the same throughout life, and often form heterosexual pairs that stay together for many years and possibly their whole life.

Spawning generally occurs in pairs at the top of an ascent in which the male nudges the abdomen of the female. Eggs are planktonic and hatch within 2 days. The larval stage lasts from several weeks to a few months, with a distinctive late larval stage called the tholichthys larva when large bony plates cover the head and front of the body. Settlement occurs at night, and juveniles tend to occur in shallower, more sheltered habitats than adults. Coloration typically changes little with growth, although butterflyfish do exhibit slightly different, more subdued color patterns at night when they shelter in the reef. Because of their specialized feeding habits, butterflyfishes do not tend to do well in aquariums, although some of the generalists and planktivores are collected for the aquarium trade. The family is represented in Hawaiian waters by 24 species; *Chaetodon fremblii, C. miliaris,* and *C multicinctus* are endemic to Hawaii; and *C. tinkeri* is found only in Hawaii and the Marshall Islands. The family is represented in Micronesian waters by at least 40 species. It is represented in Samoan waters by 30 species. The yellow-crowned butterflyfish *C. flavocoronatus* is listed as a vulnerable species in Guam on the 1996 IUCN Red List.

Chaetodontid eggs are buoyant, transparent and spherical. They typically range from 0.6 to 0.74 mm in diameter and contain a single oil droplet. The eggs hatch in 1–2 days. The larvae typically have a preopercular spine and a bony sheath around the head. The tholichthys stage of development is unique to the butterflyfishes and is characterized by a series of thin transparent bony plates that completely encase the head of the larva and extend dorsally and ventrally to form bony spines. The plates remain until after the fish have settled on the bottom. The duration of the planktonic stage is not well studied, but Burgess (1978) suggests it is likely to be at least several months.

The Hawaiian endemic *C. miliaris* reaches reproductive maturity at a size of about 90 mm SL, or about 1 year old (Ralston 1976). Spawning occurs between December and April but peaks around the end of February or the beginning of March.

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Management Unit Species: Chaetodontidae (butterflyfishes)

	Egg	Larvae	Juvenile	Adult
Duration	2 days	several weeks to a few months	1–2 yrs; approximately one year for *C. miliaris* (Ralston 1976), two years for *C. rainfordi* (Fowler 1991); size at settlement for *Hemitaurichthys polylepis* is 60 mm (Burgess 1978)	10–25 yrs in captivity (Allen et al. 1998)
Diet	N/A	zooplankton	some are obligate corallivores (*C. trifascialis* and *C. trifasciatus*); some are planktivores; others consumea variety of benthic algae, small benthic invertebrates, fish eggs, coelenterate tentacles or polyps	some are obligate corallivores (*C. trifascialis* and *C. trifasciatus*); some are planktivores; others consumea variety of benthic algae, small benthic invertebrates, fish eggs, coelenterate tentacles or polyps
Distribution, general and seasonal	spawning peaks in late winter through early summer —January to March for *C. miliaris* in Hawaii (Ralston 1981), with another smaller peak in early fall for some species	typically more abundant in offshore waters in the summer months in Hawaii	primarily Indo-West-Pacific, but also tropical to temperate Atlantic, Pacific, and Indian Oceans; settlement of juvenile *C. lunula* and *C. multicinctus* peaked in Hawaii in May-July (Walsh 1987)	primarily Indo-West-Pacific, but also tropical to temperate Atlantic, Pacific, and Indian Oceans
Location	waters above coral reefs and nearshore waters	offshore waters	coral reef ecosystems	coral reef ecosystems
Water column	eggs released at the height of spawning rushes	pelagic	demersal and mid-water column; 1–100 m, as deep as 172 m	demersal and mid-water column; 1–100 m, as deep as 172 m
Bottom type	N/A	N/A	coral reef; obligate corallivores may be restricted to distributions of corals they feed upon- *C. trifascialis* and *Acropora* for example (Reese 1981)	coral reef; obligate corallivores may be restricted to distributions of corals they feed upon–*C. trifascialis* and *Acropora*, for example (Reese 1981)
Oceanic features	subject to dispersal by currents	subject to dispersal by currents		

37. Pomacanthidae (angelfishes)

Angelfishes are similar to butterflyfishes and at one time were grouped in the same family. They differ mainly in having a strong spine on the cheek at the corner of the preopercle, in the presence of strongly ctenoid scales and in lacking the distinctive chaetodontid tholichthys larval stage. They are diurnal, spectacularly colored and territorial. Many of the large species, including those of *Pomacanthus,* are primarily spongivores with a small amount of feeding on other soft-bodied invertebrates, algae and fish eggs. Smaller species such as those of *Centropyge* feed on benthic algae and detritus. Species of *Genicanthus* feed primarily on zooplankton but also a little on benthic invertebrates and algae. Juveniles of some species are cleaners of external parasites from larger fishes. Most, and possibly all, of the angelfishes are protogynous hermaphrodites that change from male to female and frequently have different color patterns depending on their sexual development. Males frequently maintain a harem of 2–5 females and defend a territory ranging from a few square meters for some species of *Centropyge* to well over 1 km for some *Pomacanthus* species. Angelfish spawn in pairs, typically near dusk, at the apex of a spawning rush after courtship and nuzzling by the male. Eggs hatch within 24 hours and undergo a pelagic larval stage of 3–4 weeks. They are popular aquarium fish. Six species are found in Hawaiian waters, and 4 of them are endemic: *Centropyge fisheri, C. potteri, Desmoholacanthus arcuatus* and *Genicanthus personatus* At least 26 species occur in Micronesia. At least 11 species occur in Samoa.

Pomacanthid eggs are small, spherical and nearly transparent and contain from one to several oil droplets. Egg diameter ranges from 0.6 to 1.05 mm depending on the species. Hatching occurs from 15 to 23 hours after release (Thresher 1984). Feeding by the larva begins within 2–3 days and settlement to the bottom occurs between 17 and days (Moe 1977, Allen et al. 1998). Juveniles seek shelter in reef crevices. Juveniles frequently exhibit dramatically different color patterns from adults and may inhabit shallower habitats. Juveniles of *Pomacanthus* may maintain cleaning stations on or near the reef (Brockmann and Hailman 1976). There is little information on the age at sexual maturity, but most angelfishes probably become mature at between 1 and 2 years of age (Allen et al. 1998).

Adult angelfishes require suitable shelter in the form of boulders, caves and coral crevices. Most species occur from 2 to 30 m depth, but a few, such as *C. narcosis*, are found over 100 m deep. Adults forage throughout territories that vary in size with the size of the species. Generally *Pomacanthus* are spongivores; *Genicanthus* are zooplanktivores, especially on pelagic tunicates; and *Centropyge* are herbivores. Small amounts of zoantharians, tunicates, gorgonians, fish and invertebrate eggs, hydroids and seagrasses may supplement the diet of any of the angelfish species. Hybridization is common amongst the angelfish species (Pyle and Randall 1994).

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Management Unit Species: Pomacanthidae (angelfishes)

	Egg	Larvae	Juvenile	Adult
Duration	12–24 hrs	17–39 days	1–2 yrs	10–26 yrs in captivity
Diet	N/A	plankton	diet similar to adults, although some species may be cleaners as juveniles	*Pomacanthus*-sponges; *Genicanthus* - zooplankton, especially pelagic tunicates; *Centropyge* - benthic algae; all may take small amounts of zoantharians, tunicates, gorgonians, fish and invertebrate eggs, hydroids, algae and seagrasses
Distribution, general and seasonal	spawning peak for *C. miliaris* in Hawaii from Jan. to Mar. (Ralston 1981)	more abundant in offshore samples	circumtropical, with greatest number of species in Indo-Pacific; seasonal peak of recruitment for Hawaii in the summer (Walsh 1987)	circumtropical, with greatest number of species in Indo-Pacific
Location	eggs released at apex of spawning rush of 3–9 m above the bottom	more abuundant in offshore samples	coral reef ecosystems	coral reef ecosystems
Water column	pelagic	pelagic	demersal and mid-water column, mostly 2–30 m but some species over 100 m deep	demersal and mid-water column, mostly 2–30 m but some species over 100 m deep
Bottom type	N/A	N/A	refugia on the reef such as cracks, crevices, boulders	home ranges encompass a wide variety of bottom types on coral reefs and flats; rubble/coral
Oceanic features	subject to advection by currents	subject to advection by currents		

38. *Genicanthus personatus* (masked angelfish)

The masked angelfish is endemic to the Hawaiian islands and is highly valued for the aquarium trade, despite doing very poorly in captivity. They are typically found on seaward reef slopes below 23 m deep. In the main Hawaiian Islands, they are seldom seen within safe diving depth limits, but, in the Northwestern Hawaiian Islands, they are more common in shallower water. The population starts at Necker Island and increases in density toward Midway, where it is common at diveable depths and probably extends into undiveable depths (Pyle, pers. comm.). They are often found near ledges and dropoffs and on bottoms or walls of coral reef, rock or sand and rubble.

First collected in 1972, the females of the species were described in Randall (1975) from 3 specimens collected off Oahu and one off the Kona coast of Hawaii. Almost all the specimens from the main Hawaiian Islands have been females, including individuals seen from submersibles greater than 100 m deep (Chave and Mundy 1994). Soon after the original description, 2 males were trawled from a depth of 51 m near Nihoa Island and described by Randall (1976). The stomach of one of the males was full of the green alga *Codium*, as well as planktonic organisms and fish eggs. Though members of *Genicanthus* are generally zooplanktivores, the guts of several *G. personatus* contained a majority of algae but also copepods, diatoms, fish eggs and sponge spicules (Howe 1993). Howe (1193) notes that the presence of oesophageal papillae may allow for a different feeding mode from other pomacanthids.

Like other members of the genus, *G. personatus* is sexually dichromatic. It most likely forms harems and is hermaphroditic. If like other angelfish species, it releases pelagic eggs at the end of a short spawning ascent, with eggs hatching within 12–24 hours and larvae remaining adrift for 17–39 days before settlement (Allen et al. 1998). In a study of the reproductive behaviour of another endemic Hawaiian angelfish, *Centropyge potteri*, Lobel (1978) found a peak in spawning from January to April and a peak in juvenile recruitment from May to July. Juvenile and adult angelfishes are highly dependent on the availability of shelter in the form of boulders, caves and coral crevices.

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Management Unit Species: *Genicanthus personatus* (masked angelfish)

	Egg	Larvae	Juvenile	Adult
Duration	angelfish in general: 12–24 hrs (Allen et al. 1998)	angelfish in general: 17–39 days (Allen et al. 1998)	angelfish in general: likely 1–2 yrs (Allen et al. 1998)	
Diet	N/A	likely small zooplankton	no information that it is different from adult	the genus is considered zooplanktivorous, but gut samples of *G. personatus* show a majority of algae, with some copepods, diatoms, fish eggs, and sponge spicules (Howe 1993, Randall 1976)
Distribution, general and seasonal	Lobel (1978) found a spawning peak from Jan to April for another endemic Hawaiian angelfish, *Centropyge potteri*		Lobel (1978) found a recruitment peak from May through July for another endemic Hawaiian angelfish, *Centropyge potteri*	endemic to Hawaii; rare in main Hawaiian Islands within diving depths, but more common shallower in Northwestern Hawaiian Islands
Location	typically released 3–9 m from the bottom after a spawning ascent	offshore waters	no information that it is different from adult	seaward reef slope, often near vertical discontinuities
Water column	pelagic	pelagic	demersal	demersal
Bottom type	N/A	N/A	coral reef, rock, sand and rubble	coral reef, rock, sand and rubble
Oceanic features	subject to advection by ocean currents	subject to advection by ocean currents	N/A	N/A

39. Pomacentridae (damselfishes)

The damselfishes are one of the most abundant fishes on coral reefs. They are seldom larger than 10–15 cm and are moderately deep-bodied, with a small mouth and conical or incisiform teeth. They have a continuous dorsal fin and a caudal fin that varies from truncate to lunate but is usually forked. Juveniles frequently have very different and brighter colors than adults. Males tend to have a distinct, darker color pattern during spawning times. Most damselfishes occur in shallow water on coral reefs or rocky substrata, wherever there is shelter. The species of *Chromis, Dascyllus, Lepidozygus, Amblyglyphidodon, Neopomacentrus* and *Pomachromis* are aggregating planktivores, which often form large schools in the water column. Most members of *Abudefduf, Chrysiptera* and *Pomacentrus* are omnivores that feed on benthic algae, small invertebrates or zooplankton. *Plectroglyphidodon johnstonianus* feeds on coral polyps. Other members of *Plectroglyphidodon*, as well as members of *Stegastes*, are aggressively territorial herbivores. Algal feeders frequently cultivate algal mats, which they weed of undesirable algae and aggressively defend from other reef inhabitants. Spawning for damselfishes usually occurs in the morning. The eggs, are elliptical and demersal and are guarded by the male until hatching. Predators on the eggs such as wrasses and butterflyfishes, quickly consume the eggs if the male is removed from the nest. In Hawaiian waters, there are 17 species of pomacentrids; 6 are endemic: *Abudefduf abdominalis, Chromis hanui, C. ovalis, C. verater, Dascyllus albisella* and *Plectroglyphidodon sindonis*. At least 89 species occur in Micronesian waters. At least 47 species occur in Samoan waters.

The anemonefishes, subfamily Amphiprioninae, live in a symbiotic relationship with large sea anemones. They are protandrous hermaphrodites; all females start out as males before sex reversal. *Amphiprion* and *Premnas* are unique among the damselfishes in forming permanent pair bonds (Fautin and Allen 1992). Spawning typically occurs near the time of a full moon most often during morning hours and involves the laying of several hundred adhesive eggs on a hard surface near the base of the anemone. Within the tropics, spawning occurs throughout the year although there may be seasonal peaks of activity. The male guards the eggs until hatching after about a week. A short planktonic larval stage lasts from 8 to16 days before settlement. New recruits must locate a suitable anemone, as anemonefish do not survive without a host. No anemonefish are found in Hawaii because of both the absence of host anemones and the short larval duration. Anemonefishes feed primarily on copepods, larval tunicates and filamentous algae. They have been recorded to live at least 6–10 years in nature (Fautin and Allen 1992).

Pomacentrid eggs are demersal, elliptical and adhesive by means of a cluster of fine threads at one end of the egg. Egg diameters range from 0.49 to 2.3 mm. Hatching occurs in 2–4 days for most species but up to 2 weeks for anemonefish eggs. The planktonic larval stage typically lasts 2–3 weeks but may be longer. Thresher, Colin and Bell (1989) found larval durations for the following families: *Amphiprion* and *Premnas*: 7–14 days; *Chromis* and *Dascyllus*: 17–47 days with most between 20 and 30 days; and genera in the subfamily

Pomacentrinae: 13–42 days. Size at settlement ranges from 7 to 15 mm, and several studies suggest that settlement occurs mainly at dusk and at night (Williams 1980, Nolan 1975).

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Management Unit Species: Pomacentridae (damselfishes)

	Egg	Larvae	Juvenile	Adult
Duration	2–4 days for most species, but up to 14 days for anemonefish	2–3 weeks for most species, but ranging from 7-47 days	1–2 years	6–8 years, but up to 10 years or more
Diet	N/A	zooplankton	planktivores: *Chromis, Dascyllus, Lepidozygus, Amblyglyphidodon, Neopomacentrus* and *Pomachromis*; omnivores: *Abudefduf, Chrysiptera* and *Pomacentrus*; herbivores: *Stegastes* and *Plectroglyphidodon*, except *P. johnstonianus* that feeds on corals	planktivores: *Chromis, Dascyllus, Lepidozygus, Amblyglyphidodon, Neopomacentrus* and *Pomachromis*; omnivores: *Abudefduf, Chrysiptera* and *Pomacentrus*; herbivores: *Stegastes* and *Plectroglyphidodon*, except *P. johnstonianus* that feeds on corals
Distribution, general and seasonal	peak spawning in Mar./Ap. and another in Sept./Oct. (Watson and Leis 1974)	more abundant in offshore waters	circumtropical and warm temperate with 84% of species in the Indo-West Pacific; peak in recruitment in spring or summer (Walsh 1987)	circumtropical and warm temperate with 84% of species in the Indo-West Pacific
Location	on hard substrate cleared and protected by the male	more abundant in offshore waters	coral reef-associated	coral reef-associated
Water column	demersal	pelagic	demersal and mid-water column, most within 0–20 m, but some deeper than 100 m	demersal and mid-water column, most within 0–20 m, but some deeper than 100 m
Bottom type	cleared surface of rock or coral	N/A	all hard substrate in coral reef habitats	all hard substrate in coral reef habitats
Oceanic features	N/A	subject to advection by ocean currents		

40. Labridae (wrasses)

Labridae is a large family, second only to Gobiidae for number of species in the Western Pacific. It is a very diverse family in size and body shape, with adult sizes ranging from less than 5 cm in *Wetmorella albofasciata* to greater than 229 cm in the humphead wrasse, *Cheilinus undulatus* (this species is rare and heavily fished in Guam and is treated as a separate management unit). Labrid body shapes vary from elongate and cigar-shaped in many species to deep and compressed in others (Myers 1991). Most wrasses are brilliantly and complexly colored, with juveniles frequently having a different color pattern from adults. Color changes may also be associated with protogynous hermaphroditism, sex reversal from female to male that has been described for many labrids and may be true for all species in the family (Randall 1996). Wrasses swim mainly with their pectoral fins, using their tail only when quick bursts are necessary. They have a terminal mouth usually with thick lips, protruding front canine teeth and nodular to molariform pharyngeal teeth. Scales are cycloid. Important summary documents are Randall (1996) and Myers (1991).

The wide variety of color phases in the labrids has created significant taxonomic confusion. Some new species have proven to be a different color phase of an existing species, resulting in a general shrinking of the number of species listed in the family. Still, the family has over 600 species (Hoover 1993). There are 96 known species of labrids in Micronesia (Myers 1991), 43 species in Hawaii (Randall 1996) and 68 species in American Samoa (Wass 1984).

Labrids are shallow-water fishes closely associated with coral reefs or rocky substrate, though some species of *Bodianus* occur deeper than 200 m (Smith 1986, Chave and Mundy 1994), and the razorfishes *Xyrichtys* and *Cymolutes* spp. occur on sand flats. Labrids are diurnal, and at night many bury into the sand, seek refuge in holes and cracks of the reef or lie motionless on the bottom. During the day, labrids keep close to coral or rocky cover, darting into refugia in the reef or burying themselves in the sand when danger approaches. Labrids can be found in virtually all coral reef habitats from inner lagoons and subtidal reef flats to deep seaward reefs (Myers 1991, Green 1996). Schooling behavior and excursions away from the reef into the water column are usually associated with reproduction (Thresher 1984). Many labrid species are solitary inhabitants of the reef, though many members of the family have large home ranges encompassing a wide variety of habitats (Green 1996). The geographic range of *Labridae* as a family are shallow, tropical and temperate seas of the Atlantic, Pacific and Indian Oceans. Labrids are found throughout shallow areas in the Western Pacific Region, including 96 known species in Micronesia (Myers 1991), and 43 species in Hawaii, 14 of them endemic (Randall 1996).

There is generally a dearth of information on the life history parameters of age, growth and mortality of many coral reef fishes, including labrids, and what information exists cannot realistically be applied to the whole family. Reef fish guides for Pacific coral reef fishes (Myers 1991, Hoover 1993, Randall 1996) include maximum sizes in the species description. Few correlations have been made between size and age for wrasses.

Sexual dimorphism is a characteristic of all labrids. Every species studied thus far has proven to be a protogynous hermaphrodite (Myers 1991, Randall 1996). Most species have a drab initial phase consisting of all females or a combination of females and non-sex-reversing males and a gaudier terminal phase consisting of males that were formerly females. Species vary as to the ratio of initial phase and terminal phase fishes (Thresher 1984). Spawning usually occurs along the outer edge of a patch reef or along the outer slope of more extensive reefs. Two types of spawning are characteristics of the labrids: aggregate spawning of large groups of a dozen to several hundred initial-phase males and females and pair spawning of a terminal-phase male and an initial-phase female
(Thresher 1984). Both types of spawning involve a sudden upward rush of the participants 0.1 to 2 m into the water column, where milt and eggs are released before the fish return to the bottom. The entire sequence often takes less than a second (Thresher 1984). Colin and Bell (1991) described polygonous haremic, lek-like and promiscuous mating systems for labrids in the Marshall Islands. Spawning season for many tropical wrasses is year-round, and some species perform spawning rituals daily. In Hawaii, the saddle wrasse *Thalassoma duperrey* had a peak in spawning from November to February (Ross 1983) and a peak in juvenile recruitment from January to March (Walsh 1987). Many species migrate to prominent coral or rock outcrops for spawning, including species of *Thalassoma*, *Halichoeres*, *Choereodon*, *Bodianus* and *Hemigymnus* (various references in Thresher 1984).

Fourteen species of wrasses are endemic to Hawaii: *Anampses chrysocephalus*, *A. cuvier*, *Bodianus sanguineus*, *Cirrhilabrus jordani*, *Coris ballieui*, *Coris flavovittata*, *Coris venusta*, *Cymolutes lecluse*, *Labroides phthirophagus*, *Macropharyngodon geoffroy*, *Stethojulis balteata*, *Thalassoma ballieui*, *T. duperrey* and *Xyrichtys umbrilatus* (Randall 1996). The Hawaiian population of another species, *Bodianus bilunulatus albotaeniatus*, is recognized as a subspecies (Randall 1996). No wrasse species are reported to be endemic to American Samoa (Wass 1984). There are no important species of introduced wrasses to the Western Pacific Region.

Schooling behavior is common among the wrasses, particularly group spawning aggregations and haremic systems of certain wrasse species. Aggregations of spawning labrids sampled by Robertson and Choat (1974) consisted of mostly males, although initial-phase females typically outnumber initial-phase males in the general population (Thresher 1984).

The majority of labrids are benthic carnivores, feeding on a wide variety of invertebrates or fishes, although some are planktivores, corallivores or cleaners.

The following carnivores feed on benthic invertebrates, including molluscs, crustaceans, polychaetes, sea urchins, brittle stars, tunicates and foraminiferans. Many species also feed on fishes or fish eggs.

Bodianus spp.	*Choerodon anchorago*
Pseudodax moluccanus	*Cheilinus spp.*

Wetmorella spp.
Cymolutes spp.
Xyrichtys spp.
Pterogogus spp.
Cheilio inermis
Gomphosus varius
Hemigymnus spp.
Macropharyngdon spp.
Stethojulis spp.
Epibulis insidiator
Novaculichthys spp.
Pseudocheilinus spp.
Anampses spp.
Coris spp.
Halichoeres spp.
Hologymnosus spp.
Pseudojuloides spp.
Thalassoma spp. (except *T. amblycephalum*)

The following small planktivore (usually < 100 mm) feed on zooplankton such as copepods, fish eggs, and larval fish and invertebrates in the water column.

Cirrhilabrus spp.
Pseudocoris yamashiroi
Paracheilinus spp.
Thalassoma amblycephalum

The following corallivores feed on live coral polyps.

Labropsis xanthonata (adults)
Diproctacanthus xanthurus (plus cleaning)
Labrichthys unilineatus

The following cleaners feed on external parasites or damaged tissue of other fishes. They are frequently territorial around a cleaning station, although some species roam larger areas to find fishes to clean. Larger fishes often travel long distances seeking the services of a cleaner, and removal of cleaners has led to abandonment of the area by larger fishes.

Labroides spp.
Labropsis xanthonata (juvenile)
Labropsis micronesica
Diproctacanthus xanthurus

Labrids are found in large numbers in a wide variety of habitats associated with reefs in the Western Pacific Region. Green (1996) measured the density of the 10 most abundant fish families in each of 5 coral reef habitat types in American Samoa. Labridae were the third most abundant fish family in the reef flat, shallow lagoon, reef crest and reef front at 20 m depth, with densities ranging from 719 to 1,123 fish per hectare. Wrasses were the fourth most abundant family on the reef front at 10 m depth with 858 fish per hectare (Table 11 in Green 1997). The great majority of Labridae are found in depths from 1 to 100 m of water, in close association with coral or rocky substrate, although species of *Bodianus*, *Polylepion* and *Suezichthys* were seen well below 150 m during submersible cruises on seamounts near Hawaii (Chave and Mundy 1994). Prominent outcroppings of rock or coral are important as sites for spawning aggregation in some species (Thresher 1984). Sandy areas are necessary for the sand-dwelling labrids, *Xyrichtys* spp. and *Cymolutes* spp.

Migration patterns have not been documented for the labrids. Many of the smaller species stay confined to very small areas of the reef, while larger species have bigger home ranges (Green 1996). Even very large species, such as *Cheilinus undulatus,* return to a favored hole or crevice to spend the night or to escape danger (Myers 1991).

In the main Hawaiian Islands, wrasses are a minor portion of the commercial catch, according to Division of Aquatic Resources catch statistics from 1991 to 1995. Two species are present in the top 25 inshore fish species by weight—4,159 lbs of *Bodianus bilunulatus* and 3,955 lbs of *Xyrichthys pavo* (Table 15 in Friedlander 1996). Some wrasse species are caught for the aquarium trade, including *Pseudocheilinus octotaenia, Cirrhilabrus jordani, Thalassoma* spp., *Anampses chrysocephalus, Macropharyngodon geoffroy* and *Novaculichthys taeniourus*, but wrasses are a small portion of the trade in numbers and value (Pyle, pers. comm). A report on commercial collection of aquarium fish by Forum Fisheries Agency countries— which did not include Hawaii, Guam or the Philippines but did include exporters from Belau, Christmas Island, Fiji, Kwajalein, Majuro, Pohnpei, Rarotonga, Tarawa and Australia—indicate that wrasses made up 7% of the catch by number of fish and 12% by value of catch, with an approximate selling price between US $3 and $15 per fish (Pyle 1993).

No fisheries target wrasses in the Northwestern Hawaiian Islands. Labrids do form a substantial component of coral reef systems in these areas (Hobson 1983, Parrish 1989, Randall et al. 1993, Demartini et al. 1994).

The coral reef fishery in American Samoa has two components: the shoreline subsistence and the boat-based artisanal fishery (Green 1997). Labrids comprise less than 3% of the reef fish catch throughout American Samoa (Dalzell et al. 1996) and were not listed in the catch composition of the shoreline fishery on Tutuila Island in 1991 (from Craig et al. 1993 in Green 1997). Green (1997) reports no commercial aquarium trade in American Samoa.

There is little information on the biological resources of the coral reefs in the federal waters surrounding Guam. Fisheries data is limited to unprocessed catch reports and anecdotal collection data (Myers 1996). Inshore, Labridae made up 7.3% of total landings by weight of the small-boat based spearfishing landings on Guam between 1985 and 1991 (Table 63 in Green 1997). In a study by Katnik (1982), wrasses composed 4.4% of the total catch weight on heavily fished reefs and 4.0% of total catch weight on lightly fished reefs. Similarly, Dalzell et al. (1996) reported that labrids composed 4.31% of the reef fish catch in Guam. Studies detailing overfishing of reefs near Guam are discussed in Green (1997).

There is very little information on the catch of wrasses in the Northern Marianas. For example, data collection in Saipan from 1992 to 1994 assigned 87–91% of annual landings to an unidentified reef fish category (Gourley 1997). Hamm et al. (1994, 1995, 1996) reported catches of 44, 346 and 206 lbs of wrasses in NMI reef-associated commercial fisheries in 1992, 1993 and 1994, respectively. As of 1997, NMI Division of Fish and Wildlife

regulations prohibited the commercial export of live fish for the aquarium trade (Gourley 1997).

Labrid eggs are pelagic, spherical, 0.45 to 1.2 mm in diameter and lightly pigmented if at all and usually contain a single oil droplet (Leis and Rennis 1983, Thresher 1984, Colin and Bell 1991). Colin and Bell (1991) measured oil globule diameter for 21 species of labrids in Enewetak Atoll and found a range of 0.10 to 0.24 mm. Colin and Bell documented spawning mostly on a reef bisecting a main channel with strong tidal currents but also on lagoon reefs and in *Halimeda* beds. Most labrids spawned at or slightly after high tide (Colins and Bell 1991), which is in agreement with similar findings for Indo-Pacific labrids (Ross 1983).

Larvae hatch at 1.5–2.7 mm and have a large yolk sac, unformed mouth and unpigmented eyes (Leis and Rennis 1983). Victor (1986) measured the duration of the larval phase of 24 species of wrasses in Hawaii and found a range of 29.5 days (*Anampses chrysocephalus*) to 89.2 days (*Thalassoma duperrey*), although he noted substantial variability within species, up to a standard deviation of 11 days for some wrasses. Victor (1986) and other authors (Miller 1973, Leis and Miller 1976) have noted that despite their abundance as adults in the nearshore fauna of coral reef habitats, labrid larvae are conspicuosly absent from nearshore samples and common in offshore samples. Some labrid larvae are routinely found in the open ocean (Leis and Rennis 1983).

Like adult wrasses, juvenile labrids inhabit a wide variety of habitats from shallow lagoon flats to deep reef slopes. Green (1996) reported that *Labroides dimidiatus* and *Thalassoma lunare* use deeper reef slope and reef base habitats as recruits and shallower habitats as adults. Examples of ontogenetic shifts in habitat use are not widely reported for the family, although relatively few studies have examined the topic.

Labrids are found in most any habitat associated with a coral reef, including rubble, sand, algae, seaweeds, rocks, flats, tidepools, crevices, caves, fringing reefs, patch reefs, lagoons and reef slopes (Myers 1991, Randall 1993). Most species of Labridae show similar patterns of habitat use as adults and recruits, aside from 2 species reported by Green (1996). Spatial and temporal patterns of habitat use by labrids, including descriptions of labrid assemblages distinct to each depth zone, are further reported in Green (1996).

A study of the fish population of Hanalei Bay, Kauai, found *Thalassoma duperrey* was the most numerous species in all habitat types except the deep slope (Friedlander et al. 1997). In the same study, 3 labrid species, *Bodianus biulunulatus*, *Coris flavovittata* and *Thalassoma ballieui,* were present in a creel survey of fishers in the bay. Sand-dwelling species, such as the razorfish *Xyrichtys pavo*, live in and forage over open sandy areas on crabs, shrimp and benthic molluscs (Friedlander et al. 1997). Their densities tend to decline with distance from the reef (Friedlander et al. 1997).

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Management Unit Species: Labridae (wrasses)

	Egg	Larvae	Juvenile	Adult
Duration	approximately 24 hours	29.5 to 89.2 days for 24 species in Hawaii (Victor 1986)		
Diet	N/A	likely small zooplankton	some species have ontogenetic shifts —*Labropsis xanthonata* from cleaner to corallivore, for example—but most have similar diets as adults	1) most are carnivores of benthic invertebrates and fishes; some are 2)corallivores, 3)planktivores, and 4)cleaners—see text for species list
Distribution, general and seasonal	year-round spawning common, although Miller (1973) and others have documented spring and fall peaks in spawning; *Thalassoma duperrey* has a winter spawning peak (Ross 1983)	more abundant in offshore samples	coral reef habitats throughout the Western Pacific; seasonal peak in recruitment for *T. duperrey* from January to May (Walsh 1987)	coral reef habitats throughout the Western Pacific
Location	released from <1 up to 5 m from the bottom	more abundant in offshore samples (Miller 1973, Leis and Miller 1976)	closely associated with reef substrate or sand flats; 1-200m	closely associated with reef substrate or sand flats; 1–200 m
Water column	pelagic	pelagic	demersal	demersal
Bottom type	N/A	N/A	wide variety from shallow lagoon sand flats to deep reef slopes (Green 1996)	wide variety from shallow lagoon sand flats to deep reef slopes (Green 1996)
Oceanic features	subject to ocean currents	subject to ocean currents		prominent points or outcroppings are important for spawning aggregations; gyres associated with these points may serve to take larvae temporarily away from reef predators (Johannes 1978)

41. *Cheilinus undulatus* (humphead wrasse)

Cheilinus undulatus is treated as a separate management unit because spear fishing has brought the species to very low population levels, particularly around Guam (Dalzell et al. 1996). Because the species is not present in Hawaii, a description follows from Micronesia (Myers 1991).

The humphead wrasse is among the largest of reef fishes. Adults develop a prominent bulbous hump on the forehead and amazingly thick fleshy lips. Adults occur along steep outer reef slopes, channel slopes, and occasionally on lagoon reefs, at depths of 2 to at least 60 m. They often have a home cave or crevice within which they sleep or enter when pursued. Juveniles occur in coral-rich areas of lagoon reefs, particularly among thickets of staghorn *Acropora* corals. The humphead wrasse is usually solitary, but occasionally occurs in pairs. It feeds primarily on mollusks and a wide variety of other well-armored invertebrates including crustaceans, echinoids, brittle stars, and starfish, as well as on fishes. It is one of the few predators of toxic animals such as the crown-of-thorns starfish, boxfishes, and sea hares. The thick fleshy lips appear to absorb sea urchin spines, and the pharyngeal teeth easily crush heavy-shelled gastropods like *Trochus* and *Turbo*. Much of its prey comes from sand or rubble.

The range of *Cheilinus undulatus* is Indo-Pacific: Red Sea to the Tuamotus, north to the Ryukyus, south to New Caledonia. Though rare, they can be found throughout Micronesia and also in American Samoa.

Humphead, or Napoleon, wrasse reach sizes of 229 cm TL and weights of 191 kg. Kitalong and Dalzell (1994) estimate growth and mortality parameters from length frequency data for humpheads in Belau. Studies of humphead wrasse otoliths from the Great Barrier Reef indicate an expected life span of about 25 years (in Dalzell et al. 1996). New research on the life history of *C. undulatus* indicates that it may grow and mature much faster than previously thought (C. Birkeland, pers. comm.).

Once an economically important species in Guam, *C. undulatus* is now rarely seen on the reefs, much less reported on the inshore survey catch results (Hensley and Sherwood 1993). Similar declines in the number of sightings are reported from Saipan (Green 1997). Spearfishing, particularly at night when wrasses are inactive near the reef surface or in caves, has significantly decreased the numbers of this very large reef fish. They are sought after despite accounts of ciguaterra poisoning (Myers 1991).

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Management Unit Species: *Cheilinus undulatus* (humphead wrasse)

	Egg	Larvae	Juvenile	Adult
Duration			research underway by Dr. Howard Choat	at least 25 years (in Dalzell et al. 1996)
Diet	N/A		likely to be similar to adult	carnivore; primarily on mollusks and a wide variety of well-armored invertebrates including crustaceans, echinoids, brittle stars, and starfish, as well as on fishes; also eats toxic animals such as crown-of-thorns starfish, boxfishes, and sea hares
Distribution, general and seasonal				Indo-Pacific, though not found in Hawaii
Location			coral-rich areas of lagoon reefs; among thickets of staghorn *Acropora* corals	steep outer reef slopes, channel slopes, and occasionally on lagoon reefs
Water column	pelagic	pelagic	demersal	demersal; 2 to at least 60 m depth
Bottom type	N/A	N/A	coral, sand, rubble	coral, sand, rubble
Oceanic features	subject to ocean currents	subject to ocean currents		

42. Scaridae (parrotfishes)

Parrotfishes get their name from the beak-like dentition and brightly colored appearance of mature adults. Like the wrasses from which they evolved, scarids are protogynous hermaphrodites that change color in relation to changes in growth and sex. Unlike wrasses, parrotfishes have a characteristic pharyngeal dentition, a digestive system lacking a true stomach but with a very long intestine, and a diet of mostly algae with some ingestion of live coral. Most scarids feed by scraping algae and bits of coral from the surface of coral rock, grinding the material with their pharyngeal mill into a slurry of calcium carbonate and algae, digesting the slurry and excreting grains of calcium carbonate "sand" that make up a large portion of the sediment on most coral reefs. A few species feed heavily on live coral, on large leafy algae or seagrasses or on sand to extract algae from between the grains. Parrotfishes are diurnal, sleeping under ledges or wedged against coral or rock at night, often surrounded by a mucus cocoon that may serve to mask their scent from detection by nocturnal predators. Small juveniles are frequently drab with white stripes. Some species are diandric, with both male and female juveniles, while others are monandric, with only females in the initial phase. Terminal males, usually formed from sex-reversal of a female, frequently maintain a harem of females, though they perform pair-spawning with each female individually. Initial phase males spawn in groups. Parrotfishes often occur in large, mixed-species schools which rove long distances while feeding on reefs. Some species are territorial and occur in small groups. Important summary documents are Myers (1991) and Randall (1996).

Scarids inhabit a wide variety of coral reef habitats including seagrass beds, coral-rich areas, sand patches, rubble or pavement fields, lagoons, reef flats and upper reef slopes (Myers 1991). They are prominent members in numbers and biomass of shallow reef environments. Scarids are chiefly distributed in tropical regions of the Indian, Atlantic and Pacific Oceans.

Among scarid species, adult sizes range from 110 to 1,000 mm SL, but most are between 200 to 500 mm. Warner and Downs (1977) suggested a maximum age of 6 years for *Scarus iserti*. Choat et al. (1996) found life spans ranging from 5 years (*S. psittacus*) to 20 years (*S. frenatus)*. Coutures (1994) used annular marks on scales to age *Bolbometopon muricatum* and found a life span of about 25 years.

Parrotfishes generally have complex socio-sexual systems based on protogynous hermaphroditism, drab initial phase coloration, gaudy terminal phase color patterns and dualistic reproduction. Males can either be primary, in which they are born male, or secondarily derived from females. Most species of *Scarus* are diandric. The relative proportion of primary males, terminal males and females vary widely between and within species.

Scarids spawn in both pairs and groups. Group spawning frequently occurs on the outer slope of the reef in areas with high current speeds. Pair spawnings are frequently observed at

the reef crest or reef slope at peak or falling tide. Scarids have been observed to undergo spawning migrations within lagoons and to the outer reef slope (Randall and Randall 1963, Yogo et al. 1980, Johannes 1981, Choat and Randall 1986, Colin and Bell 1991). Some species are diandric, forming schools and spawning in groups often after migration to specific sites, while others are monandric, at times being strongly site-attached with haremic, pair-spawning (Choat and Randall 1986).

A few species are territorial, but the majority are roving herbivores, with the size of the home range increasing with the size of the fish. Choat and Robertson (1975) found that smaller, less mobile scarids are usually associated with cover such as *Acropora* growth. Open areas with large amounts of grazing surface harbour larger, more mobile and school-forming scarids. Schooling behavior is common among the scarids, both for feeding and spawning.

Species endemic to Hawaii are *Calotomus zonarchus*, *Chlorurus perspicillatus*, *Scarus dubius*. Seven species of scarids can typically be found in Hawaii, 33 species in Micronesia, and 23 species in Samoa.

Most scarids are herbivores, although a few feed on live coral (most notably *Bolbometopon muricatum*) and a few have been reported to feed on newly exposed cryptic sponges (Bakus 1964, Dunlap and Pawlik 1996). The majority graze turf algae from hard substrata, some ingest algal filaments with sand grains, and some feed on seagrasses and leafy algae, such as *Padina*. Friedlander et al. (1997) found high counts of scarids in back reef and reef slope habitats of Hanalei Bay.

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Management Unit Species: Scaridae (parrotfishes)

	Egg	Larvae	Juvenile	Adult
Duration	25 hours	30–50 days	3–5 years (Sale 1991)	average as a family is 8–12 years, medium size-6–9 years, large size-20–25+years
Diet	N/A	copepods, nauplii, bivalve larvae (Houde and Lovdal 1984)	carniverous for 1 month, gradually becoming herbivorous (Horn 1989, Bellwood 1988)	algae—usually thin algal film on coral or rock, but some feed on seagrasses, macroalgae, or graze over sand; a few species feed on live coral
Distribution, general and seasonal	year round, but peak spawning may occur in the summer	higher concentrations in offshore water samples	abundant year round in many coral reef systems	abundant year round in many coral reef systems
Location	spawning aggregation sites frequently on the outer edge of the reef	0–100 m; peak density between 40–80 m in the Caribbean (Hess et al. 1986)	all coral reef habitats, plus seagrass beds, mangroves, lagoons	all coral reef habitats, plus seagrass beds, mangroves, lagoons
Water column	pelagic	pelagic	demersal	demersal
Bottom type	N/A	N/A	coral reef, sand patches, rubble, pavement	coral reef, sand patches, rubble, pavement
Oceanic features	advection by ocean currents	advection by ocean currents	seagrass beds and mangroves may be important nursery areas	channels with high relief habitat nearby are important spawning aggregation sites

43. *Bolbometopon muricatum* (bumphead parrotfish)

The bumphead is a very large parrotfish (to 120 cm and 75 kg) with a vertical head profile, a uniform dark green color except for the front of the head which is often light green to pink and a nodular outer surface to its beak. It typically occurs in schools on clear outer lagoon and seaward reefs at depths from 1 to 30 m. They are often located on reef crests and fronts. In unfished areas it may enter outer reef flats at low tide. In addition to algae, it feeds substantially on live coral, using its large foreheads to ram coral and break it into smaller pieces for ingestion. It is very wary in the daytime but sleeps in groups on the reef surface at night, making it an easy target for spearfishers. As a result, it has nearly disappeared from most of Guam's reefs and is rapidly declining in Belau. Johannes (1981) cites an example of bumpheads changing the location of their sleeping site away from the shallow reef flat to the deeper reef slope in Belau in response to increasing nighttime spearfishing. Its range is Indo-Pacific, although it is not found in the Hawaiian Islands.

B. muricatum on the Great Barrier Reef exhibits a gradual approach to the asymptotic length. On the Northern Great Barrier Reef, most schools are composed of fish 12–20 years old. The oldest bumphead *maximum age* identified is a 3- year-old fish with a standard length of 770 mm (Howard Choat, pers. comm.). Younger fishes appear to have different habitat requirements, as fish of SL less than 400 mm are not seen on outer reefs.

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Management Unit Species: *Bolbometopon muricatum* (bumphead parrotfish)

	Egg	Larvae	Juvenile	Adult
Duration	25 hours	30–50 days		20–25+years, up to 34 years
Diet	N/A		herbivore/coralivore	herbivore/ coralivore; eats a substantial amount of live coral; in Palau, stomachs were often full of sea urchins (Johannes 1981)
Distribution, general and seasonal	Spawning aggregations reported in barrier reef channels of Palau on the 8th and 9th days of the lunar month (Johannes 1981)			Indo-Pacific; not found in Hawaii
Location			fish < 400 mm not seen on outer reefs of the Great Barrier Reef	typically occurs in schools on clear outer lagoon and seaward reefs at depths of 1 to at least 30 m; may enter outer reef flats at low tide in unfished areas
Water column	pelagic	pelagic	demersal	demersal
Bottom type	N/A	N/A	coral reef, rubble, pavement	coral reef, rubble, pavement
Oceanic features	advection by ocean currents	advection by ocean currents		

44. Polynemidae (threadfins)

Threadfins are relatives of the mullets with silvery bodies, an inferior mouth with villiform teeth, two widely-spaced dorsal fins, a deeply forked caudal fin and moderately large scales. Thread-like lower pectoral rays are used as feelers and become relatively shorter with growth. Threadfins typically occur over shallow sandy to muddy bottoms, occasionally in fresh or brackish water. One species, *Polydactylus sexfilis,* occurs in Hawaii where it is highly valued as a food fish. The species, called *moi* in Hawaii, was historically reserved for royal people, or *alii*. It has become rare as a result of intense fishing pressure, and is currently being propagated in hatcheries for use in stock enhancement projects. The same species occurs in Micronesia. Two species occur in Samoa, *P. sexfilis* and *P. plebeius*. The family Polynemidae is distributed throughout the tropical Atlantic and Indo-Pacific Ocean.

P. sexfilis is a fast-growing species that inhabits turbid waters and can be found in large schools in sandy holes along rocky shoals and high energy surf zones. Spawning takes place for 3–6 days per month and has been observed in Hawaii from June to September, with a peak in July and August (Ostrowski and Molnar 1997). Spawning may be year-round in very warm locations. Spawning occurs inshore and eggs hatch offshore within 14–24 hours depending on water temperature (May 1979). Eggs are small, averaging 0.75 mm in diameter with a large oil globule.

Larvae are pelagic, but after metamorphosis they enter nearshore habitats such as surf zones, reefs and stream entrances (Ostrowski and Molnar 1997). Larvae and pre-settlement juveniles feed on zooplankton in the water column, mainly mysids, euphausiids, crab zoeae and amphipods.

Inshore juveniles have distinct dark vertical bars and feed on benthic crustaceans, mostly penaeid and caridean shrimps, as well as zooplankton. Young moi, from 150 to 250 mm long, are found from shoreline breakers to 100 m depth (Lowell 1971). Fishing for juvenile *P. sexfilis*, or *moilii*, has historically been an important recreational and subsistence seasonal fishery in Hawaii.

*P. sexfilis*is a protandrous hermaphrodite, with individuals first maturing as males within 5–7 months at a fork length of 20–29 cm. After mating at least once as a male, fish have a hermaphroditic stage of about 8 months when they have both male and female characteristics. By an age of about 1.5 years and a fork length of 30–40 cm, fish become mature females. The sexes are monomorphic.

Adults feed throughout the day on benthic crustaceans as well as fish. In Kaneohe Bay, adults could be found on reef faces, in the depths of the inner bay and in shallow (2–4 m) areas with muddy sand bottoms (Lowell 1971). When *moi* were more abundant in Hawaii, airplane spotters used to locate large schools and direct net fishers to the catch.

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Management Unit Species: Polynemidae (threadfins)

	Egg	Larvae	Juvenile	Adult
Duration	14–24 hours depending on the temperature	weeks to months	5–7 months	
Diet	N/A	zooplankton, mainly mysids, uphausiids, crab zoeae, and amphipods	benthic crustaceans (mainly penaeid and caridean shrimps) and zooplankton	benthic crustaceans (mainly penaeid and caridean shrimps) and fish
Distribution, general and seasonal	spawning 3–6 days per month from June to September in Hawaii, with a peak in July/August; may be year-round in very warm locations	largest numbers in late summer	largest numbers in late summer and fall in Hawaii	*Polydactylus sexfilis* only species in Hawaii, also found in Micronesia and Samoa; *P. plebeius* recorded in Samoa
Location	inshore	offshore	from shoreline breakers to offshore reefs; also near stream entrances in sheltered bays	sandy holes along rocky shoals and high energy surf zones
Water column	pelagic	pelagic	0–100 m depth	0–100 m depth
Bottom type	N/A	N/A	sand, mud, rock, coral reef	sand, mud, rock, coral reef
Oceanic features	subject to advection by ocean currents	subject to advection by ocean currents		

45. Sphyraenidae (barracudas)

The barracudas are a single genus of top-level carnivorous fishes that feed mainly on other fishes. They have a very elongate body, a large mouth with protruding pointed lower jaw, very large compressed teeth and two widely separated dorsal fins. They have small cycloid scales and a well-developed lateral line. Some species are primarily diurnal, while others are nocturnal. Species such as *Sphyraena helleri* school in large groups during the day but disperse at night to feed. *S. barracuda* is typically a solitary diurnal predator. In Hawaiian waters, these are the only 2 species positively recorded. In Micronesian waters, at least 6 species occur. In Samoan waters, at least 5 species occur.

Juvenile *S. barracuda* occur among mangroves and in shallow sheltered inner reef areas. Adults occur in a wide range of habitats ranging from murky inner harbors to the open sea. Ciguaterra is widely reported for large *S. barracuda*, and has caused deaths in the West Indies where it is now banned from sale. *S. forsteri, S. acutipinnis, S. novaehollandiae* and *S. obtusata* are all schooling barracudas that occur over lagoon and seaward reefs. *S. genie* is a larger schooling barracuda that frequently schools at the same sites on submarine terraces and is most often caught at night by trollers in Micronesia.

There is no evident external sexual dimorphism among sphyraenids, although males reach sexual maturity at a smaller size than females. Male *S. barracuda* reach maturity in 2 years, but females take about 4 years. Barracudas migrate to specific spawning areas, often in very large numbers at reef edges or in deeper water. Spawning typically takes place in warmer months, and may last extended periods of time in which individual females spawn repeatedly.

The eggs are pelagic, spherical, and range in diameter from 0.7–1.5 mm with a single clear or yellow oil droplet. Eggs hatch within 24–30 hours. Larvae begin to feed within 3 days on small copepods. Larger larvae voraciously feed on zooplankton and other fish larvae. Settlement typically occurs at a length of 18 mm but may be larger. *S. barracuda* larvae occasionally drift in the ocean for an indefinite period of time, usually associated with floating debris or algae, developing all the characteristics of juveniles and sometimes attaining large sizes before being delivered inshore. Newly settled juveniles are piscivorous.

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Management Unit Species: Sphyraenidae (barracudas)

	Egg	Larvae	Juvenile	Adult
Duration	24–30 hours for *S. pinguis*	the time it takes to grow from 1–2 mm to 18 mm	2 years for male *S. barracuda*, 4 years for females	
Diet	N/A	zooplankton, copepods, fish eggs	mostly fish	mostly fish
Distribution, general and seasonal	spring spawning aggregation sites may be important for some species	typically more abundant in offshore waters	circumtropical and subtropical	circumtropical and subtropical; seasonal spawning aggregations may be important for some species
Location	reef edge or interface of pelagic and coastal currents	coastal offshore waters	mangroves, shallow lagoons, estuaries	from shallow turbid inner harbors to reefs, as well as coastal offshore waters
Water column	pelagic	pelagic; within 0–100 m depth	from reef-associated to surface	from reef-associated to surface
Bottom type	N/A	N/A	mud, sand, reef	all bottom types
Oceanic features	subject to advection by currents	subject to advection by currents		

46. Pinguipedidae (sandperches)

The sandperches are represented in the Indo-Pacific by only one genus, *Parapercis*. The genus is characterized by an elongate, nearly cylindrical body, eyes on the top of the head and oriented upwards and a terminal protractile mouth. All are benthic carnivores of small invertebrates and fishes. They are usually found on rubble or sand bottoms near reefs, where they typically rest on the bottom by propping on well-separated pectoral fins. Adults are typically found in depths from 1 to 50 m, but some occur deeper. Most species are sexually dichromatic. Hermaphroditism has been demonstrated for some species and may be true for all. Males are territorial and haremic. Spawning occurs year round in the tropics, typically just before sunset. Eggs are pelagic and the larval period lasts for 1–2 months. In Hawaiian waters, 2 species occur. In Micronesia, 4 shallow water species occur. In Samoan waters, 3 species are recorded.

P. cylindrica males defend an area that includes 2–5 females who are defending smaller territories from each other. The male initiates courtship with one of the females about 40 minutes prior to sunset, and eventually the pair makes a short spawning ascent of 60–70 cm before releasing gametes. The eggs are spherical and pelagic, with a diameter ranging from 0.63 to 0.99 mm. Hatching occurs in 22–24 hours. Duration of the planktonic larval stage is estimated to be 1–2 months (Stroud 1981).

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Management Unit Species: Pinguipedidae (sandperches)

	Egg	Larvae	Juvenile	Adult
Duration	22–24 hours	1–2 months		
Diet	N/A	zooplankton	small invertebrates and fishes	small invertebrates and fishes
Distribution, general and seasonal	year-round spawning, but late spring/summer peak	year-round, with summer peak	one Indo-Pacific genus *Parapercis*	one Indo-Pacific genus *Parapercis*
Location	released near parents home; no evidence of spawning migrations	offshore of reefs and soft-bottom habitats	coral reefs and associated soft-bottom communities	coral reefs and associated soft-bottom communities
Water column	pelagic	pelagic, although Leis (1989) found them concentrated in the epibenthos over soft bottoms on the GBR	demersal; most within 1–50 m, but some deeper	demersal; most within 1–50 m, but some deeper
Bottom type	N/A	N/A	sand, mud, rubble and occasionally coral	sand, mud, rubble and occasionally coral
Oceanic features	subject to advection by ocean currents	subject to advection by ocean currents		

47. Blenniidae (blennies)

Blennies are small, elongate, agile, scaleless fishes with blunt heads and a long continuous dorsal fin. They are a large family of more than 300 species, most of which are bottom-dwelling territorial fishes that lay adhesive demersal eggs that are guarded by the male. The family may be divided into two subfamilies primarily based on dentition and diet. The sabretooth blennies, subfamily Salariinae, typically have small mouths and large fangs. They are carnivores and some feed on the scales, skin or mucus of larger fishes. Some species are mimics of cleaner wrasses or other blennies. They are active swimmers that rapidly approach larger fish, while other members of Salariinae are sedentary. The combtooth blennies, subfamily Blenniinae, typically have wide mouths, feeble teeth and feed on benthic algae. An exception is the leopard blenny *Exalias brevis*, which feeds primarily on coral polyps of *Acropora, Pocillopora, Seriatopora, Porites* and *Millepora*. Most combtooth blennies are sedentary inhabitants of rocky shorelines, reef flats or shallow seaward reefs. In Hawaiian waters, 14 species of blennies have been recorded; 7 are endemic: *Cirripectes obscurus, C. vanderbilti, Entomacrodus marmoratus, E. strasburgi, Istiblennius zebra, Plagiotremus ewaensis* and *P. goslinei*. The mangrove blenny *Omobranchus rotundiceps obliquus* was introduced to the Hawaiian and Line Islands, and the tasseled blenny *Pablennius thysanius* was probably introduced to Hawaii by ballast water. At least 59 species occur in Micronesia. At least 47 species occur in Samoa.

The blennies have very complex color patterns and are often well camouflaged to the surrounding habitat. Blennies tend to shelter in small holes in the reef or sand by backing into them tail-first. Some blennies, including those of the genera *Istiblennius* and *Entomacrodus*, live inshore on rocky bottom exposed to surge. They are called rockskippers for their ability to leap from pool to pool.

In addition to their unique feeding strategy, *Exalias brevis* has unusual reproductive characteristics. Males prepare a nesting site by clearing a patch of coral near a crevice. Females make the rounds of up to 10 different male's nests, depositing bright yellow eggs in each of them. Nests may contain more than one females eggs, and both males and females occasionally cannibalize eggs. Spawning occurs throughout the year with a peak from January to April.

The reproductive biology of blennies has been studied extensively. There are many variations, but all appear to produce relatively large demersal eggs which are deposited in or near a shelter hole and defended by the male. Eggs are characteristically flattened ovals, usually brightly colored, and about 1.0 mm in the longest dimension. Hatching typically occurs in 9–11 days. In the Red Sea species *M. nigrolineatus*, the larvae develop juvenile colors in 20 days and settle to the bottom by 30 days.

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Management Unit Species: Blenniidae (blennies)

	Egg	Larvae	Juvenile	Adult
Duration	9–11 days	20–30 days		
Diet	N/A	copepods, nauplii, bivalve larvae (Watson 1974, Houde and Lovdal 1984)	most graze on benthic algae; some feed on zooplankton; some prey on minute invertebrates such as foraminiferans, ostracods, copepods and gastropods; fangblennies of *Plagiotremus* eat mucus and skin tissue from fishes; at least one species, *Exallias brevis*, feeds on coral polyps	most graze on benthic algae; some feed on zooplankton; some prey on minute invertebrates such as foraminiferans, ostracods, copepods and gastropods; fangblennies of *Plagiotremus* eat mucus and skin tissue from fishes; at least one species, *Exallias brevis*, feeds on coral polyps
Distribution, general and seasonal			worldwide in tropical and temperate seas	worldwide in tropical and temperate seas
Location	near the adults shelter hole		rocky shorelines, coral reefs, reef flats, shallow seaward reefs, sand flats, lagoons	rocky shorelines, coral reefs, reef flats, shallow seaward reefs, sand flats, lagoons
Water column	demersal	pelagic	demersal; a few feed on zooplankton in the water column, and many of the fangtooths are active swimmers that pursue larger fish; many found in very shallow depths, and some rockskippers found above sealevel	demersal; a few feed on zooplankton in the water column, and many of the fangtooths are active swimmers that pursue larger fish; many found in very shallow depths, and some rockskippers found above sealevel
Bottom type	coral or rock	N/A	rock, coral reef, sand	rock, coral reef, sand
Oceanic features		subject to advection by ocean currents		

48. Gobiidae (gobies)

The gobies are the largest family of marine fishes, with about 1000 Indo-Pacific species and at least 1900 marine and freshwater species worldwide. They are typically small, elongate, blunt-headed fishes with a relatively large mouth with conical teeth, pelvic fins close together and usually fused to form a sucking disk, and two dorsal fins. Gobies are primarily shallow-water species. All are carnivorous and bottom-dwelling, although a few swim a short distance above the bottom to feed on plankton (*Ioglossus*, *Nemateleotris*). They inhabit a variety of habitats such as coral reef, sand, mud, rubble or seagrass. The majority of gobies occur on coral reefs, where they typically have unsurpassed diversity and abundance, but many occur in adjacent coastal and estuarine waters. Many live in close association with other animals such as sponges, gorgonians, and snapping shrimps. Several species have a symbiotic relationship with one or more species of Alpheid snapping shrimp in which the gobies share a burrow. The shrimp digs the burrow while one or more gobies keeps watch for predators. Nearly all gobies are gonochorists that lay a small mass of demersal eggs which are guarded by the male. A few have been shown to be protogynous hermaphrodites. There are 31 marine species of gobies in Hawaiian waters. Five of them are endemic to Hawaii: the noble goby *Priolepis eugenius*, the rimmed-scale goby *Priolepis limbatosquamis*, the Hawaiian shrimp goby *Psilogobius mainlandi*, plus two new species described recently in *Copeia*. In Micronesian waters, at least 159 species occur. At least 100 species are recorded for Samoan waters.

Most reef-associated gobies are sexually monomorphic, although gobies in other habitats do have color and size differences between the sexes. Protogynous hermaphroditism was documented for gobies of the genus *Paragobiodon*, in which the largest individual present was always male, the second largest was the functional female, and the smaller individuals were non-spawning females (Lassig 1977). In most cases gobies appear to spawn promiscuously with many individuals loosely organized into a social hierarchy or with individuals maintaining small contiguous territories, although pairing and apparent monogamy have been documented for a number of gobies, including Ioglossus spp. (Colin 1972), Gobodion spp. (Tyler 1971), and Valencienna spp. (Hiatt & Strasburg 1960), among others.

Gobies lay demersal adhesive eggs in a burrow, on the underside of a rock or shell, or in cavities within the body of a sponge. Males tend and guard the eggs, which are attached to the substrate by a tuft of adhesive filaments at one end. Most goby eggs are elongate, smoothly round-ended and range in length from 1.1 to 3.3 mm and in diameter from 0.5 to 1.0 mm, although the eggs of fresh water and anadramous species may be as large as 8 mm. Some species, such as those of *Elacatinus*, have distinctive protuberances from the eggs. Incubation typically lasts 5-6 days depending on temperature. The size at hatching ranges from less than 2 mm to 4mm. The majority of the gobies leave the plankton at a size less than 10 mm. The planktonic larval duration is known for a few species. Lassig (1976) estimated a duration of about 6 weeks for *Paragobiodon spp.* at Heron Island. Moe (1975)

reported a planktonic larval duration of from 18-40 days for *Gobiosoma oceanops*. Colin (1975) reported metamorphosis at 26 days for neon gobies, which grew quickly to subadult size in 3 months and spawned as soon as 5 months. He suggested neon gobies were "annual" fishes that mature quickly and may only live one or two years.

Species of *Amblyeleotris, Cryptocentroides, Cryptocentrus, Ctenogobiops, Vanderhorstia, Lotilia*, and *Mahidolia* live in burrows constructed by alpheid prawns. At least 20 species of gobies share burrows with at least 7 species of prawns in Micronesia. The gobies, either singly or in pairs, act as sentinels for the alpheid shrimps who maintain the burrows. The gobies benefit from the use of the burrow, and also from feeding on the invertebrates excavated by the shrimp. The shrimps benefit from having a wary sentinel with better eyesight to warn them of approaching danger.

Some gobies have specific habitat requirements. The gorgonian goby *Bryaninops amplus* is usually found on gorgonians. The whip coral goby *Bryaninops yongei* is usually found on the antipatharian seawhip *Cirrhipathes anguina*. The Hawaiian shrimp goby *Psilogobius mainlandi* lives in burrows built and maintained by the snapping shrimp *Alpheus rapax*. The translucent coral goby *Bryaninops erythrops* lives on certain branching forms of fire corals *Millepora* spp. and other branching or massive corals such as *Porites cylindrica* and *P. lutea*. The hovering goby *Bryaninops natans* occurs in groups that hover just above or within the branches of *Acropora* corals. Members of *Paragobiodon* and *Gobiodon* are obligate coral-dwellers. Mudskippers of the genus *Periophthalmus* are essentially amphibious and are typically found resting on mud, rocks, or mangrove roots.

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Management Unit Species: Gobiidae (gobies)

	Egg	Larvae	Juvenile	Adult
Duration	5-6 days	18-42 days	as soon as 5 months for neon gobies (Colin 1975)	smaller gobies may only live 1-2 years; others much longer
Diet	N/A	copepods, nauplii, tintinnids, mollusc larvae (Watson 1974, Houde and Lovdal 1984)	similar to adults	most are carnivorous on a wide variety of benthic invertebrates (copepods, amphipods, ostracods, nematodes, foraminiferans), fishes, and fish eggs; some semi-pelagic species are planktivorous
Distribution, general and seasonal				worldwide in tropical and temperate seas; 28 marine species of gobies in Hawaiian waters, with 3 endemic; at least 159 Micronesian species and at least 100 species in Samoa
Location			rocky shorelines, coral reefs, reef flats, shallow seaward reefs, sand flats, lagoons	rocky shorelines, coral reefs, reef flats, shallow seaward reefs, sand flats, lagoons
Water column	demersal	pelagic	same as adults	demersal; species of *Ioglossus* and *Nemateleotris* are semi-pelagic, hovering a short distance above the reef
Bottom type	coral, rock, sponge	N/A	coral reef, sand, mud, rubble or seagrass	coral reef, sand, mud, rubble or seagrass
Oceanic features		subject to advection by ocean currents		

49. *Zebrasoma flavescens* (yellow tang)

The yellow tang is a popular aquarium fish that is the top marine fish export from Hawaii, representing more than 75% of all animals caught statewide (Clark and Gulko 1999). They occur singly or in loose groups on coral-rich areas of lagoon and seaward reefs from below the surge zone to at least 46 m. Juveniles tend to hide among branches of finger coral, while adults graze near the shore in calm areas. They are diurnal herbivores of filamentous algae from hard surfaces. The genus is characterized by an unusually deep body with tall dorsal and anal fins and an elongate tubular snout. The yellow tang is moderately common at some locations in the Marianas, but is most abundant in Hawaii.

Group spawning (Lobel 1978) as well as pair spawning by territorial males that court passing females (in Thresher 1984) has been observed. Spawning occurs a few meters above the bottom or the depth of the spawning aggregation, usually at dusk. Pelagic eggs likely hatch within 1 to 2 days, and a pelagic larval stage lasts for up to a few months.

Z. flavescens tends to prefer the leeward sides of islands (Brock 1954), particularly areas of dense coral growth of *Pocillopora damicornis* and *Porites compressa*. It feeds on algae growing exposed on basalt and dead coral heads, as well as in crevices and interstices of the reef that it can reach with its long, thin snout (Jones 1968). The majority of yellow tang in Hawaii are collected off West Hawai'i, Kawaihae, Kona and Miloli'i (Clark and Gulko 1999).

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Management Unit Species: *Zebrasoma flavescens* (yellow tang)

	Egg	Larvae	Juvenile	Adult
Duration	approximately 24 hours	up to a few months		
Diet	N/A	various zooplankters	similar to adults	herbivores on filamentous algae
Distribution, general and seasonal	late winter, spring peak in spawning		highest recruitment in the summer, May to August, in Hawaii (Walsh 1987)	Pacific Plate; abundant only in Hawaii, found uncommonly at some locations in the Marianas; not recorded from Samoa
Location	eggs released after short spawning ascent from the bottom or the depth of a spawning aggregation	0-100m, larvae typically are more common in offshore waters than in water over reefs	often hide within the branches of finger coral	coral-rich areas of lagoon and seaward reefs from below the surge zone to at least 46 m; adults may feed very near the shore in calm areas
Water column	pelagic	pelagic	demersal and mid-water	demersal and mid-water
Bottom type	N/A	N/A	coral, rock, rubble, pavement	coral, rock, rubble, pavement
Oceanic features	subject to ocean currents	subject to ocean currents		

50. Zanclidae (Moorish idol)

This family consist of one species, *Zanclus cornutus*. It has a strongly compressed discoid body, tubular snout with a small mouth and many bristle-like teeth, and dorsal spines elongated into a whip-like filament. Moorish idols have a long larval stage and settle at a large size, >6cm SL for some individuals. As a result, they are ubiquitous in areas of hard substrate from turbid inner harbors to clear seaward reefs. They feed mainly on sponges, but will also take other invertebrates and algae. They usually are found in small groups of 2-5 individuals but may occur in large schools of well over 100 individuals. Their range is Indo-Pacific and tropical eastern Pacific, and they are found throughout the management area. They are a popular aquarium fish.

There is little information on Moorish idol reproduction, but they have been observed to spawn in pairs at dusk on outer reef slopes, producing pelagic eggs that are capable of long planktonic existence. Their wide distribution and length at settlement as large as 7.5cm are good indicators of long larval stages. The larval phase is similar to acunthurid larval phases.

Moorish idols inhabit all types of hard substrate in the tropical Pacific. They are present in very shallow habitats < 1m deep and have also been sighted as deep as 180m. They are diurnal predators that feed mainly on sponges, but also on small benthic crustaceans and algal film on rocks and coral.

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Management Unit Species: Zanclidae (Moorish idol)

	Egg	Larvae	Juvenile	Adult
Duration	unknown	relatively long; several months, ranging in size from a few millimeters to 7.5 cm		
Diet	N/A	zooplankton	mostly sponges, some small benthic crustaceans and algae	mostly sponges, some small benthic crustaceans and algae
Distribution, general and seasonal	little known	predominantly offshore	Indo-Pacific and tropical Eastern Pacific	Indo-Pacific and tropical Eastern Pacific
Location	released near the surface on outer reef slope	predominantly offshore	from turbid inshore harbors to clear outer reef slopes	from turbid inshore harbors to clear outer reef slopes
Water column	pelagic	pelagic	demersal	demersal
Bottom type	N/A	N/A	all hard substrates, including coral reef, rocks, rubble, reef flats, wrecks	all hard substrates including coral reef, rocks, rubble, reef flats, wrecks
Oceanic features				

51. Siganidae (rabbitfishes)

Siganids are small (from 20 -50 cm), essentially marine tropical Indo-West Pacific fishes. They have venomous dorsal, anal and pelvic spines. With a single row of flattened, close-set teeth, rabbitfishes feed primarily on algae and seagrasses, although some may occasionally feed on tunicates or sponges. Because of their herbivorous diet, most species live at depths less than 15 m, but some are trawled from as deep as 50m. Half the species live as pairs on coral reefs, the others usually gather in small schools. One species, *Siganus vermiculatus*, is almost exclusively estuarine; the rest move between estuaries, coral reefs, rocky shores, and other habitats. Rabbitfishes generally spawn on a lunar cycle with peak activity during the spring and early summer. Spawning occurs in pairs or groups on outgoing tides either at night or early in the morning. Juveniles of some species are estuarine. Rabbitfishes are highly esteemed foodfishes. Some of the colorful ones are popular aquarium fishes. None are found in Hawaii. Approximately 16 species are found in Micronesia, and at least 4 species in Samoa.

Spawning by rabbitfishes is typically preceded by a migration to specific and traditional spawning sites. The location varies from near mangrove stands (*S. lineatus*, Drew 1971), to shallow reef flats (*S. canaliculatus*, Manacop 1937, Johannes 1981), the outer reef crest (several spp. at Palau, Mcvey 1972; Johannes 1978), and even the deeper reef (*S. lineatus*, Johannes 1981). Sites are usually characterized by easy access to the ocean via channels, and large areas of sea grass flats nearby.

Reproduction in the schooling species has been studied in some detail, and in general the eggs are adhesive and demersal (with a few exceptions such as the pelagic eggs of *S. argenteus*); hatching occurs within 1-3 days and yolk sac absorption is completed in about 3 or 4 days (Lam 1974). Fecundity is high: 250,000-500,000 eggs per spawning season (Lam 1974, Gunderman et al. 1983). Larvae are pelagic and feed on phytoplankton and zooplankton. The duration of the larval stage is about 3 weeks in *S. fuscescens* (Hasse et al. 1977) and 3-4 weeks in *S. vermiculatus* (Gunderman et al. 1983). Popper et al. (1976) reported that siganid larvae follow a lunar rhythm in appearing on the reef, typically arriving inshore 3-5 days after a new moon. Fish are 15-20 cm long and sexually mature after one year. Judging by maximum size, some species survive from 2-4 years. *S. argenteus* is unique amongst the Siganidae in having a prejuvenile stage which is distinct from the larval and juvenile stages and is specially adapted for a pelagic life (Hubbs 1958). They can reach sizes of 6-8 cm SL before settling. Not surprisingly, *S. argenteus* has the widest distribution of all rabbitfishes.

The rabbitfishes vary widely in their habitat uses. The schooling species typically move between a wide range of habitats, whereas the pairing species tend to lead a sedentary existence among the branches of hard corals. Rabbitfishes are common on reef flats, around scattered small coral heads, and near grass flats. Gundermann et al. (1983) divided the siganids into two groups on the basis of habitat, behavioral characteristics and coloraton.

One group includes species (*S. corallinus, S. puellus*, and *Lo vulpinnus*) that live in pairs, have limited home-ranges on reefs and are brightly colored. The remaining group, including *S. rivulatus* and *S. canaliculatus*, form schools at some stage of their life cycle, may undertake substantial migrations, and assume a coloration similar to their preferred habitat.

Schools of juvenile *S. rostratus* and *S. spinus* swarm on the reef flats of Guam each year during April and May, and occasionally during June and October. Tsuda et al. (1976) studied the feeding and habitat requirements for these fish to determine the likelihood of mariculture of the rabbitfishes, which are highly esteemed for gastronomic and cultural reasons in Guam.

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Management Unit Species: Siganidae (rabbitfishes)

	Egg	Larvae	Juvenile	Adult
Duration	1-3 days	3-4 weeks	1 year	2-4 years
Diet	N/A	phytoplankton and zooplankton	herbivores	herbivores, though some may feed on tunicates and sponges; they will assume a carnivorous diet in captivity
Distribution, general and seasonal	spawning in Guam in April and May, and occasionally in June and October		some species estuarine as juveniles before moving offshore	throughout the shelf waters of the Indo-West Pacific, except for the Hawaiian and Easter Island provinces
Location	mangrove stands (*S. lineatus*, Drew 1971), to shallow reef flats (*S. canaliculatus*, Manacop 1937, Johannes 1981), the outer reef crest (several spp. at Palau, Mcvey 1972; Johannes 1978), and even the deeper reef (*S. lineatus*, Johannes 1981). Sites are usually characterized by easy access to the ocean via channels, and large areas of sea grass flats nearby	more abundant offshore	estuaries for some species	most wide-ranging over many habitats. *Siganus vermiculatus*, is almost exclusively estuarine; the rest tend to move between estuaries, seagrass beds, coral reefs, rocky shores
Water column	pelagic	pelagic	demersal or reef-associated	demersal or reef associated
Bottom type	N/A	N/A	silt, sand, and mud for estuarine species	some pair-forming species are sedentary in the branches of Acropora corals; most range over many bottom types
Oceanic features	ocean currents	ocean currents		

52. *Gymnosarda unicolor* (dogtooth tuna)

Very little is known about the biology of the dogtooth tuna (*Gymnosarda unicolor*), although it is widely distributed throughout much of the Indo-Pacific faunal region, from the Red Sea eastward to French Polynesia (Collette and Nauen 1983). This species is not found in the Hawaiian islands, although fishermen do refer to catches of the meso-pelagic snake mackerel (Gempylidae) as "dogtooths".

G. unicolor is an epipelagic species, usually found individually or in small schools of 6 or less (Lewis et al. 1983). Dogtooth tuna are found in deep lagoons and passes, shallow pinnacles and off outer reef slopes (Collette and Nauen 1983). It occurs in mid-water, from the surface to depths of approximately 100m, and has a preference for water temperatures ranging from 20-28 degrees Celsius.

G. unicolor is one of the few tuna species found primarily in association with coral reefs (Amesbury and Myers 1982) and probably occupies a niche similar to other reef-associated pelagic predators such as Spanish mackerel (*Scomberomorus* spp.) and queenfish (*Scomberoides* spp). Like the Spanish mackerels, large dogtooths can become ciguatoxic from preying on coral reef herbivores, which themselves have become toxic through ingestion of the dinoflagellate, *Gambierdiscus toxicus* (Myers 1991).

A positive correlation between size and depth has been observed in the distribution of this species based on limited information from Tuvalu, with larger individuals being found at greater depths (Haight 1998). This species reportedly reaches a maximum size of 150cm FL and 80kg (Lewis et al. 1983).

Observations from Fiji suggest that dogtooth tuna obtain sexual maturity at approximately 65 cm (Lewis et al. 1983), while Silas (1963) reported a partially spent 68.5 cm male dogtooth tuna from the Andaman Islands. Females outnumbered males by nearly 2:1 in Fiji, and all fish larger than 100cm were females, suggesting sexual dimorphism in this species (Lewis et al. 1983). Lewis et al. (1983) suggest that the vulnerrability of female dogtooth tuna to trolling declines as the fish approach spawning condition.

In Fiji, spawning reportedly occurs during the summer months - between October and March (Lewis et al. 1983). Dunstan (1961) observed spawning dogtooth tuna in Papua New Guinea during March, August and December, and various other authors (Silas 1963) have provided some evidence of summer spawning for this species. Okiyama and Ueyangi (1977) note that the larvae of dogtooth tuna occur over a wide area of the tropical and subtropical Pacific Ocean, between 10°N and 20°S, with concentrations along the shallow coastal waters of islands, such as the Caroline Islands, Solomon Islands and Vanuatu. Dogtooth larvae were collected in surface and subsurface tows, with greater numbers in the sub-surface tows at depths between 20-30m. Older larvae appear to make diurnal vertical migrations, rising to

the surface during the night. On the basis of larval occurrence throughout the year, Okiyama and Ueyangi (1977) postulate year round spawning in tropical areas.

There are no fisheries specifically directed at dogtooth tuna in the western Pacific region. The primary means of capture include pole and line, handlines and surface trolling (Severance 1998, pers. comm; Collette and Nauen 1983). Dogtooth tuna have been sold in local markets in American Samoa and the Northern Mariana Islands, but currently have little market value (Severance 1998, pers. comm.).

Dogtooth tuna are voracious predators, feeding on a variety of squids, reef herbivores such as tangs and unicorn fish (Acanthuridae), and small schooling pelagic species including fusiliers (*Caesio* spp) and roundscads (*Decapterus*) (Myers 1989).

Dogtooth tuna are unique among the family Scombridae in having such a close association with coral reefs, although they are also found around rocky reefs in higher latitudes such as in Korea and Japan (Myers 1989). Within the western Pacific region, waters on and adjacent to coral reefs down to a depth of about 100m should be designated EFH for this specis.

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Management Unit Species: Gymnosarda unicolor (dogtooth tuna)

	Egg	Larvae	Juvenile	Adult
Duration			sexually mature at approximately 65cm	unknown
Diet	N/A	unknown	unlikely to be different from adult	a variety of squids, reef herbivores such as tangs and unicornfish (Acanthuridae), and small schooling pelagic species such as fusiliers (*Caesio* spp)and roundscads (*Decapterus*)
Distribution, general and seasonal	unknown	tropical and subtropical Pacific Ocean between 10°N and 20°S, with greater concentrations along shallow coastal waters of islands such as the Caroline Isl., Solomon Isl. and Vanuatu	unlikely to be different from adult	widely distributed throughout much of Indo-Pacific, from the Red Sea eastward to French Polynesia. Not found in the Hawaiian islands
Location			unlikely to be different from adults	deep lagoons and passes, shallow pinnacles and off outer reef slopes
Water column	epipelagic	epipelagic; greater numbers in subsurface tows at depths between 20-30m	epipelagic	epipelagic; occurs in mid-water, from the surface to approximately 100m
Bottom type	N/A	N/A	N/A	N/A
Oceanic features	subject to advection by prevailing currents	subject to advection by prevailing currents	unknown	unknown

53. Bothidae/Soleidae/Pleuronectidae (flounder and soles)

Flatfishes have both eyes on one side of the body and a greatly compressed body suited for lying flat on the bottom. The eyes are situated on both sides of the head in the larvae, but migrate to one side as the larvae transforms into a benthic juvenile. The eyes migrate onto the left side for members of the family Bothidae, and onto the right side for members of the family Pleurnectidae and Soleidae. The side with no eyes settles on the bottom and remains unpigmented, while the top side can change color patterns to match the surrounding bottom. They are ambush carnivores of small fishes and crustaceans that live on silt, sand or gravel bottoms. They are important foodfishes worldwide, where they inhabit continental shelves of tropical and temperate seas. A few species are found on shallow coral reefs: in Hawaiian waters, there are 13 species of Bothidae but only 2 common shallow species, 2 species of the genus *Samariscus* that formerly were considered a part of Pleuronectidae but now are in their own family Samaridae, and 2 species of Soleidae. In Micronesian waters, there are at least 3 species of Bothidae, one species of Pleuronectidae, and at least 5 species of Soleidae found on shallow reefs. Two sole species, *Aseraggodes borehami* and *Aseraggodes theres*, are recently described species found only in the Hawaiian islands. Three species are recorded from Samoan waters.

Bothid eggs are pelagic, spherical, and small, with a diameter of 0.6-0.9mm. The larvae hatch at 1.6-2.6mm. Soleid eggs are pelagic, spherical and moderate in size, with a diameter of 0.9-18mm. The larvae range from 1.7 to 4.1mm at hatching. Larval pleuronectiform fish have symmetrical eyes, but many remain pelagic for some time after the eyes migrate. Some become quite large before settling, and often possess highly ornamented spines, elongate fin rays, or protruding guts as larval specializations (Leis & Trnski 1989). Larvae are found in the upper 100m of the water column.

Habitat for most flatfishes is soft bottoms such as sand, mud, or silt that are often found in association with coral reef habitats. Some species are found directly on the reef or within the reef framework. Many species are found in water deeper than 100m, but some are common in shallow habitats.

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Management Unit Species: Bothidae/Soleidae/Pleurnectidae (flounder and soles)

	Egg	Larvae	Juvenile	Adult
Duration		1.6 to 4.1mm at hatching		
Diet	N/A	the sole *Achirus lineatus* eats copepods, mollusc larvae, rotifers, dinoflagellates (Houde & Lovdal 1984); other species eat larvaceans, chaetognaths and copepods (Liew 1983)	similar to adult	ambush carnivores of fishes and invertebrates
Distribution, general and seasonal			similar to adult	tropical and temperate continental shelves worldwide; some species associated with coral reefs in the Indo-Pacific
Location	spawning aggregations not recorded	offshore waters	lagoons, caves, flats, reefs	lagoons, caves, flats, reefs
Water column	pelagic	pelagic; from 0-100m depth	demersal	demersal
Bottom type	N/A	N/A	similar to adult	soft bottoms such as sand, gravel, mud, and silt; some species found on reef surface or within reef framework
Oceanic features				

54. Balistidae/Monocanthidae (triggerfishes/filefishes)

The triggerfishes are named for an ability to lock their large, thickened first dorsal spine in an upright position, which can be released only by pressing down on the second dorsal spine (the trigger). They are deep-bodied fish with eyes high on the head, a long snout, a small terminal mouth, and tough skin with armor-like non-overlapping scales. Triggerfishes are usually solitary except when they form pairs at spawning time, although the black durgon *Melichthys niger* may form large aggregations. When alarmed, or at night, they wedge themselves into a hole in the reef or rocks by erecting the first dorsal spine and pelvic girdle. During the day, most are carnivores of a wide variety or benthic animals including crustaceans, mollusks, sea urchins, other echinoderms, coral, tunicates, and fishes. Some feed largely on benthic algae and zooplankton, including *M. niger* and *M. vidua*, while *Xanthichthys auromarginatus* and *X. mento* feed mainly on zooplankton. Eleven species are known from the Hawaiian islands. At least 20 species occur in Micronesia. At least 16 species occur in Samoa. Many species are collected for aquariums. The clown triggerfish *Balistoides conspicillum* is among the most highly prized aquarium fishes, although like most triggerfishes it is very aggressive to other fish in a tank and tends to eat all the invertebrates.

The filefishes are closely related to the triggerfishes, differing by having more compressed bodies, a longer and thinner first dorsal spine, a more pointed snout, a very small or absent second dorsal spine, and no third dorsal spine. Unlike the triggerfishes, many filefish are able to change their coloration to match their surroundings, and are frequently secretive. Some filefishes are sexually dimorphic, not in coloration so much as the size of the spines or setae posteriorly on the body. Filefishes are mostly omnivorous, feeding on a wide variety of benthic plant and animal life. Some species eat noxious sponges and stinging coelenterates that most fish avoid. Eight species occur in Hawaii, at least 17 in Micronesia, and at least 7 species occur in Samoa. Three species are endemic to Hawaii: the squaretail filefish *Cantherhines sandwichiensis*, the shy filefish *C. verecundus*, and the fantail filefish *Pervagor spilosoma*.

Sexual dimorphism is widespread, though not universal, in the triggerfishes. The male is typically more brightly colored and larger, as in *X. auromarginatus, X. mento, B. undulatus, B. vetula, Odonus niger, Pseudobalistes fuscus, Hemibalistes chrysopterus*, and *M. niger* (Berry & Baldwin 1966, Randall et al. 1978, Matsuura 1976, Breder & Rosen 1966, Aiken 1975, Fricke 1980). Sexual dimorphism is less common in the filefishes, in which males and females tend to be more drab. There is some evidence of lunar spawning periodicity for balistids. At Belau, the yellowmargin triggerfish *Pseudobalistes flavimarginatus* spawns in nests in sand-bottom channels within a few days before both new and full moons during the months of November, December, March, April, and May, if not throughout the year (Myers 1989). Balistids produce demersal eggs that may or may not be tended by a parent, usually the female. They are one of the, if not the only, reef fish families that have extensive maternal care. This could be related to a harem-based social structure that requires the male to vigorously defend his territory from other males. Balistid eggs are spherical, slightly over

0.5 mm in diameter, and translucent. Eggs are typically deposited in shallow pits excavated by the parents as an adhesive egg mass containing bits of sand and rubble. Triggerfish eggs hatch in as little as 12 hours and no more than 24 hours. Filefish eggs may take longer to hatch, up to 58 hours. The pelagic larval stage can last for quite a while, and some species reach a large size before settling to the bottom. Several species of Melichthys can reach as much as 144 mm before settling (Randall 1971, Randall & Klausewitz 1973). Prejuveniles are often associated with floating algae, and may be cryptically colored. Berry and Baldwin (1966) suggested that sexual maturity of *Sufflamen verres* and *Melichthys niger* occurs at approximately half maximum size, at an age of a year or more. Smaller filefishes may mature within a few months after hatching.

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Management Unit Species: Balistidae/Monacanthidae (triggerfishes/filefishes)

	Egg	Larvae	Juvenile	Adult
Duration	12-24 hours for triggerfish, up to 58 hours for filefish	several months, can grow up to 144 mm before settling (Randall & Klausewitz 1973)	one or more years	
Diet	N/A	various plankton	similar to adult	carnivores of a wide variety or benthic animals including crustaceans, mollusks, sea urchins, other echinoderms, coral, tunicates, and fishes. Some feed largely on benthic algae and zooplankton
Distribution, general and seasonal	At Belau, the yellowmargin triggerfish *Pseudobalistes flavimarginatus* spawns within a few days before both new and full moons during the months of November, December, March, April, and May, if not throughout the year (Myers 1989)		similar to adult	tropical and temperate seas worldwide; 11 species are known from the Hawaiian islands. At least 20 species occur in Micronesia. At least 16 species occur in Samoa.
Location	many spawn on sand or other soft-bottom habitats		Juvenile *B. conspicillum* usually occur in or near ledges and caves of steep dropoffs below 20m (Myers 1989)	lagoon and seaward reefs; many prefer steeply sloping areas with high coral cover and a lot of caves and crevices; zooplanktivores spend day in the water column
Water column	demersal	pelagic	demersal and pelagic	some species in very shallow water, 2-20m while others as deeper than 100m
Bottom type	sand, mud, rubble	N/A	similar to adults	coral reef, rock, sand
Oceanic features		subject to advection by ocean currents		

55. Ostraciidae (trunkfish)

The trunkfishes, or boxfishes, possess a bony carapace of polygonal plates that encase the head and body. The bony shell may be triangular, quadrangular, pentagonal, hexagonal, or nearly round in cross-section. Some species have stout spines projecting from the rough surface of the plates. The mouth is small and low with thick lips and a row of conical to incisiform teeth with rounded tips. Trunkfishes are slow swimming diurnal predators that feed on a wide variety of small sessile invertebrates, especially tunicates and sponges, and algae. Some species, and perhaps all, secrete a skin toxin when under stress. Some species, and perhaps all, are protogynous hermaphrodites. Sexual dichromatism is common in the family. The species studied thus far are haremic with males defending a large territory with non-territorial females and subordinate males. Spawning in pairs occurs at dusk, usually above a conspicuous outcrop. In Hawaiian waters, 6 species are recorded and the spotted boxfish *Ostracion meleagris camurum* is recognized as a subspecies. In Micronesian waters, 6 species are recorded. In Samoan waters, 3 species are recorded.

Leis (1978) described the eggs of Hawaiian ostraciids as slightly oblong, with less than 10 oil droplets, and a patch of "bumps" at one end. However, Mito (1962) described eggs from Japanese waters as 1.62-1.96mm in diameter with a single oil droplet. A western Atlantic species *Acanthostracion quadricornis* had spherical eggs, 1.4 to 1.6mm in diameter, that hatched in about 48 hours at 27.5°C. About 114 hours after hatching, it reaches a distinctive square armor-plated postlarval stage. Postlarvae and juveniles are commonly collected in grassbeds and other shallow areas and are rarely seen on the reef (Thresher 1984). Juveniles of *Ostracion*, on the other hand, are commonly seen on shallow reefs, especially in late summer.

The longhorn cowfish, *Lactoria cornuta*, occurs over sand and rubble bottoms of subtidal reef flats, lagoons, and bays to a depth of 50m. It feeds on polychaetes and other benthic invertebrates, often "blowing" sand off the bottom to expose the prey. The thornback cowfish *Lactoria fornasini* inhabits sandy areas with rubble, algae, or corals of clear outer lagoon and seaward reefs. The spotted trunkfish *Ostracion meleagris* occurs on clear lagoon and seaward reefs from the lower surge zone to 30m, where it feeds on didemnid tunicates as well as smaller amounts of polychaetes, algae, sponges, mollusks, and copepods. They are sexually dimorphic, with males taking a bright blue and yellow form upon sex-reversal from a female to male.

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Management Unit Species: Ostraciidae (trunkfishes)

	Egg	Larvae	Juvenile	Adult
Duration	48 hrs for A. quadricornis (Thresher 1984)	fairly short in general; 114 hrs in A. quadricornis in the Caribbean (Thresher 1984), but Moyer (1980) reported much older pelagic larvae, up to 90mm long		
Diet	N/A		similar to adults	small sessile invertebrates, especially didemnid tunicates and sponges, but also polychaetes, algae, sponges, mollusks, and copepods; also algae
Distribution, general and seasonal				
Location		offshore	grassbeds and other shallow areas	coral reefs, lagoon and seaward reefs
Water column	pelagic	pelagic	demersal and mid-water column	demersal and mid-water column, well defended from predators
Bottom type	N/A	N/A	similar to adults;	sandy areas with rubble, algae, or corals
Oceanic features	subject to advection by prevailing currents	subject to advection by prevailing currents		

56. Tetradontidae/Diodontidae (puffers/porcupinefishes)

Puffers are named for their ability to enlarge their bodies by drawing water into a highly distensible ventral diverticulum of the stomach. That feature, prickly skin, and a powerful toxin concentrated in their viscera, gonads, and skin helps them deter predators. Toxicity varies greatly with species, area, and season. Puffers have the teeth in their jaws fused to beak-like dental plates with a median suture. Most are slow swimmers that feed on a wide variety of algae and benthic invertebrates, including fleshy, calcareous or coralline algae and detritus, sponges, mollusks, tunicates, corals, zoanthid anemones, crabs, hermit crabs, tube worms, sea urchins, brittle stars, starfishes, hydroids, bryozoans and foraminifera. All species known to date lay demersal eggs. At least one species of Canthigaster, *C. valentini*, is haremic with males controlling a territory containing 1-7 females. The males spawn at mid-morning with a different female each day, and the eggs are deposited in a tuft of algae. Most puffers are solitary but a few form small aggregations. In Hawaiian waters, there are 14 species recorded, with 2 endemics: *Canthigaster jactator* and *Torquigener randalli*. In Micronesian waters, there are at least 17 species. In Samoan waters, 18 species are recorded.

Much of the information on puffer reproduction has been completed in temperate locations, but some reasonable assumptions can made about tropical species. Puffers lay demersal adhesive eggs, although courtship is often observed near the surface. The eggs are typically on their own after being deposited, and take approximately 4 days to hatch in *C. valentini* (Gladstone 1985). Newly hatched larvae range in size from 1.9 to 2.4mm. Settlement to the bottom can occur in a little over 30 days, but some species have a much longer pelagic existence.

Porcupinefishes are similar to puffers in many ways, but differ primarily in having prominent spines on the head and body. They also have larger eyes, broader pectoral fins, and lack a median suture on the dental plates. Hard, beak-like jaws allow them to crush the hard shells of mollusks or crustaceans, or tests of sea urchins. They appear to be nocturnal. Spawning has been observed in *Diodon holacanthus*, which spawns at the surface at dawn or dusk as pairs or groups of males with a single female. In Hawaiian waters, 3 species have been recorded. In Micronesian waters, 3 species are known, although one, *Diodon eydouxii*, is entirely pelagic. The juveniles of *D. hystrix* and *D. liturosus* are pelagic as well.

Porcupinefish in Hawaii have a peak in spawning in the late spring, with some spawning from January to September (Leis 1978). Courtship and spawning by *Diodon holacanthus* has been observed in a large public aquarium (Sakamoto & Suzuki 1978) and in the Gulf of California (Thresher 1984). Diodontid eggs are spherical, 1.62 to 2.1 mm in diameter, and may be demersal or pelagic. Hatching occurs in 4-5 days. Leis (1987) reported metamorphosis at a length of 3 mm and an age of 3 weeks to a postlarval stage similar in appearance to the adult. The duration of the larval stage may be several months. Very large prejuveniles (up to 86 mm for *D. holacanthus* and 180 mm for *D. hystrix*) are common in plankton tows.

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Management Unit Species: *Tetradontidae/Diodontidae* (Puffers/Porcupinefishes)

	Egg	Larvae	Juvenile	Adult
Duration	4-5 days	several months or longer	size at settlement of 180-191mm (Leis 1987)	
Diet	N/A	various zooplankton	similar to adult	wide variety of algae and benthic invertebrates, including fleshy, calcareous or coralline algae and detritus, sponges, mollusks, tunicates, corals, zoanthid anemones, crabs, hermit crabs, tube worms, sea urchins, brittle stars, starfishes, hydroids, bryozoans and foraminifera
Distribution, general and seasonal			same as adults	worldwide throughout tropical and temperate seas
Location	pelagic or demersal depending on species	pelagic	estuaries, mangroves, lagoons, coral reefs	estuaries, mangroves, lagoons, coral reefs
Water column	puffers are demersal spawners, porcupinefish may spawn pelagic or demersal eggs	pelagic; 0-100m	reef-associated and pelagic	reef-associated and pelagic
Bottom type	reef, sand, or algae tufts	N/A	sand, silt, coral, rock	sand, silt, coral, rock
Oceanic features		subject to advection by ocean currents		

B. EFH for Management Unit Species – Invertebrates

1. Cephalopods

General Description of the Taxon[1]

The cephalopods (Class Cephalopoda of the Phylum Mollusca) comprise a relatively small group of organisms that includes squid, octopods, cuttlefish, and nautilus. Although certain members of the class (e.g., the octopods) are for the most part bottom-dwellers, the majority are adapted for a free-swimming lifestyle. The head projects into a circle of large prehensile tentacles or arms, which are homologous to the anterior of the foot of other mollusks. The tentacles are used for various functions, including seizing prey, grasping the substrate, and for copulation and fertilization. Most cephalopods swim by jet propulsion, rapidly expelling water from the mantle cavity through a ventral tubular funnel. The funnel is highly mobile and can be directed either anteriorly or posteriorly. The force of water leaving the funnel propels the animal in the opposite direction, enabling both backward and forward swimming. Certain species of squid have attained the highest speed of movement through water observed for any marine invertebrate (up to 40 km per hour). (Barnes 1987; Nesis 1987). Within the class, only members of the genus *Nautilus* (in Subclass Nautiloidea) have a true external shell. All other cephalopods belong to the subclass Coleoidea, in which the shell is reduced and internal, or lacking altogether. In squids, for example, the shell is reduced to a long, flattened chitinous "pen" or gladius, while in cuttlefish the internal shell, the sepion, is thicker and calcareous. In certain genera—*Nautilus, Spirula,* and *Sepia*—the gas-filled chambers of the animals' shells allow for maintenance of neutral buoyancy within the water column. Many species exhibit diurnal vertical migration, moving upward to feed during the night and into deeper water during the day (Barnes 1987; Nesis 1987).

Reproduction and Life History

Cephalopods are dioecious, with a single gonad positioned at the posterior end of the body. Sperm are conducted through the vas deferens to a ciliated seminal vesicle, where the sperm are rolled together and encased in spermatophores. The spermatophores are then transported to a storage sac which opens into the mantle cavity. In females, the oviduct terminates in an oviductal gland. Octopods and some squid may have two oviducts.

Fertilization may occur within the mantle cavity or outside. One of the arms of the male is highly modified into a copulatory organ, the hectocotylus. During copulation, while the male grasps the female with the regular arms, the hectocotylus receives spermatophores from the funnel (opening of the vas deferens), or plucks them from the storage sac. The hectocotylus may be inserted into the mantle cavity, and spermatophores are deposited on the mantle wall of the female, near the openings of the oviducts. In *Octopus*, the hectocotylus is inserted into the genital duct. In some squid, the hectocotylus may be inserted into a seminal receptacle located in a fold beneath the mouth for deposition of spermatophores.

Eggs are discharged from the oviduct, then surrounded by a paired membrane or capsule. In some genera eggs may be surrounded by a gelatinous mass. In most cases, eggs are either attached by the female to a stable substrate, or shed into the seawater. Sepioids may attach the single eggs by means of a flexible threadlike stalk, which the female wraps around the blades of seagrasses or seaweeds (Pearse et al. 1987).

Embryonic development is considered "direct," that is, there is no trochophore or larval phase. However, newly-hatched cephalopods may remain planktonic for a time. In the octopods, those species in which hatchlings are less-developed may first go through a planktonic phase and then settle down to a benthic existence, while those species in which the newly-hatched offspring are well-developed may immediately take up a benthic lifestyle (Pearse et al. 1987). The degree of development at hatching may be related to the size of the egg, since Young and Harman (1989) noted that species with small eggs include a paralarval (planktonic) phase, while those with larger eggs, do not.

Most cephalopods are relatively short-lived (typically one- to two-year lifespan), dying after a single spawning, while certain members such as *Nautilus*, may live longer (up to twenty years; Barnes 1987).

Habitat and Ecological Requirements for Various Life History Stages

Substrate and Depth Preferences

Nautilus occur in waters down to 500 m depth, but generally occur at depths from 200-300m. The few observations made of nautiluses in the ocean suggest that they spend the day resting in coral crevices on deep reefs, attached by their tentacles, and swim out at night to feed (Pearse et al. 1987). They may rise to within 60-100m during nighttime (B. Carlson, Waikiki Aquarium, pers. comm., 27 Aug 99).

Cuttlefishes are generally found in shallow waters of seagrass beds and nearby reefs. Some species may bury themselves in the sand during the day, and emerge at night to hunt for the small fishes and crustaceans that are their preferred prey.

Octopods generally inhabit crevices in rocks or coral areas. In sandy areas, they may dig burrows or construct shelters built from scattered rocks.

Substrates utilized for the deposition of eggs may vary for different taxa, but it appears that there is some correlation with the habitats utilized for shelter by the species in question. Thus octopods may attach egg clusters within rocky recesses on the reef, while cuttlefish may attach their eggs to seaweeds or seagrasses.

The reef squid, *Sepioteuthis lessoniana*, uses corals and rocks of reef areas for egg-laying, and swims over the reef in shallow areas to feed. The reef cuttlefish, *Sepia latimanus,*

deposits its eggs deep among the branches of heads of finger coral (B. Carlson, pers. comm. 27 Aug 99).

Feeding

Within the cephalopod group are found a range of feeding habits and food preferences. Free-swimming squids typically hunt for fish, crustaceans, and other squids in open water. Cuttlefish swim near the bottom in shallow water, stir up sand with jets from their siphons, and feed on benthic and infaunal invertebrates, including crustaceans such as shrimps and crabs. Octopods venture out of their dens in search of food, and may swim and crawl more than 100m from their holes. Octopods often hunt by jumping to ambush their prey, which include principally crabs and shrimps. In Hawaii, one of the most common species, *Octopus cyanea*, forages during the day (hence the name "day squid"), while another *O. ornatus* (the "night squid"), forages after dark (Kay 1979). Squid bite and tear prey organisms with their jaws; cuttlefish first immobilize prey by injecting salivary toxins, and then chew their prey; while octopods, which also first paralyze their prey with salivary toxins, release enzymes that start to digest the tissue of the target prey prior to ingestion. It is thought that nautiluses scavenge on such food items as crab and lobster molts; it is not known whether they also prey on live organisms (B. Carlson, pers. comm. 27 Aug 99).

Economic Importance and Utilization of the Resource

Within the region, cephalopods, especially squid, cuttlefish, and octopus, have some economic importance as food items in the subsistence fishery. Octopus are a component of the incidental catch of the lobster-trap fishery in the Northwest Hawaiian Islands (NWHI; WPRFMC 25 May 99). In addition, shells of *Nautilus* may be used for ornamental purposes on a small scale, either by utilizing the whole or cut shell, or processing for production of mother-of-pearl. The meat is also occasionally sold in markets (Roper et al. 1984). The internal shells (cuttlebones) of sepioids may also have limited commercial value for use in the pet supply industry.

Occurrence of the Taxon Within WPRFMC Fishery Management Units (FMUs)

The following is an account of those cephalopod species reported in the literature that may occur on reef areas within the jurisdictional waters of WPRFMC.

American Samoa

On Tutuila Island, it was reported that octopus accounted for approximately five percent of the catch composition for the shoreline subsistence fishery (Craig et al. 1993).

Nautilus pompilius is known to occur in American Samoa. This may represent the easternmost extension of its range (B. Carlson, pers. comm. 27 Aug 99).

Commonwealth of Northern Mariana Islands (CNMI)

Octopus (*Octopus cyanea* and *O. ornatus*), squid (*Sepioteuthis lessoniana*), and cuttlefish (*Sepia latimanus*) are reef-associated species[3] commonly taken as food in the Marianas (Myers 1997 in Green October 1997). *Octopus cyanea* was identified as a species found on the reef slope at Rota, and targeted for capture in the local fishery (Smith et al 1989).

Guam

It is reported that on Guam, the octopus is the most sought-after unshelled mollusk, while squid and cuttlefish form a part of the incidental catch of the inshore fisheries (Hensley and Sherwood 1993). Octopus and squid are reported to contribute to the importance of mollusks as a food source (Amesbury et al. 1986 in Green October 1997). *Sepia latimanus* is reported from Guam (B. Carlson, pers. comm. 27 Aug 99). Presumably, other cephalopod species reported in the Northern Marianas (i.e., *Octopus cyanea, O. ornatus*, *Sepioteuthis lessoniana*) would be expected to occur in Guam, as well.

Hawaii (MHI and NWHI)

The following octopod species are known from Hawaiian waters: *Octopus cyanea, O. ornatus, Berrya hoylei* and *Scaeurgus patagiatus*. An additional three unnamed species are believed present (Young and Harman 1989). Octopus are a component of the incidental catch of the lobster-trap fishery in the Northwest Hawaiian Islands (WPRFMC 25 May 99). An unnamed species of octopus is known from Waianae, Oahu. It occupies burrows in sandy areas. The burrows have openings about the diameter of a thumb. It is not known whether the octopus digs the burrow, or simply occupies a burrow already dug by another animal (e.g., mantis shrimp). This octopus emerges from its burrow and mimics a flatfish (B. Carlson, pers. comm. 27 Aug 99).

While more than a dozen species of squids and cuttlefishes are recorded from Hawaiian waters (Matsumoto and Suzuki October 1988), most of these are pelagic. *Euprymna scolopes*, an endemic cuttlefish, is typically associated with a benthic existence in shallow-water areas. The species is common in the sand and mud flats of Kaneohe Bay, where it forages to feed on shrimp (*Leander debilis*) at depths of less than 0.5m (Kay 1979).

In Hawaii, *Sepioteuthis lessoniana,* the bigfin reef squid, was previously common, but may now be nearly extirpated. It had been known from Waianae, Oahu. A recent sighting of the species was made on Molokini Island, Maui (B. Carlson, pers. comm. 27 Aug 99).

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[1] The octopods are well-known reef-dwellers. The common names for *Sepioteuthis lessoniana* and *Sepia latimanus*, bigfin reef squid and reef cuttlefish, respectively, reflect their assocation with reef areas (Allen and Steene 1996).

Other Sites

No reports.

2. Tunicates

General Description of the Taxon

The tunicates, or sea squirts, are an unusual group of sessile marine organisms within the Phylum Chordata. While vertebrates make up the most conspicuous and well-known species in the phylum, species in two subphyla, the Urochordata and Cephalochordata, lack backbones. Nonetheless, they possess the three traits diagnostic for chordates--presence of a notochord, a dorsal hollow nerve cord, and pharyngeal clefts at some point in the life cycle. The Urochordata, which comprise the tunicates, are further divided into three classes, the Ascidiacea, the Larvacea, and the Thaliacea, the latter two being specialized planktonic forms (Abbott et al. 1977). The discussion in this section therefore refers to members of the Class Ascidiacea.

The ascidians are common marine invertebrates worldwide. Most inhabit shallow waters, where they attach to rocks, shells, pilings, or ship bottoms, or grow epizoically on other sessile organisms. Some forms anchor in sand or mud, though the species inhabiting sediments occur more generally in deeper waters.

The tunicate animal is sheathed in an outer covering, the tunic, that is distinctive for the group. The tunic in most cases contains cellulose, a rare instance of the substance being produced by an animal. Calcareous spicules may also be present. The consistency of the tunic varies from soft and gelatinous to fleshy, tough, leathery, cartilaginous, or fibrous. Tunicates are attached to the substrate at their proximal end, and have two openings at the opposite pole, the buccal and atrial siphons. The organisms filter plankton by drawing water into a pharyngeal "basket" through the buccal siphon (ICLARM 1998). The pharyngeal basket is the most prominent internal organ in most tunicates. Rows of perforations in the basket, the stigmata, are fringed with beating cilia that circulate water through the basket, with plankton filtered out in the process. A single tunicate a few centimeters long can filter about 173 liters of seawater in a 24-hour period (Barnes 1987). The filtered water is ultimately discharged through the atrial siphon. In addition to obtaining nutrition through filter-feeding, some tunicates possess within their tissues (in the tunic or cloacal region) endosymbiotic algae of the genus *Prochloron.* In certain ascidians, another algal endosymbiont, *Synechocystis,* occurs. This alga imparts a pink or red color to the appearance of the tunicate Monniot et al. 1991). Presumably, excess photosynthate produced by *Prochloron* or *Synechocystis* cells provides an accessory food source for the tunicate host.

While some of the largest species are solitary (or simple) ascidians, many are colonial. Colonies may be organized along several different lines. In the simplest colonies (e.g., *Perophora*), the bodies of individual zooids are almost completely separated but are connected by a stolon. In other types, the stolons are short, and the individuals form tuftlike groups (e.g., *Clavelina*). In the most specialized colonial types (e.g., *Botryllus*), individual animals are minute, and completely embedded in a common tunic. The buccal siphons of

each zooid open separately to the environment. The atrial siphons may also, but in many cases the apertures of the atrial siphons open into a common cloacal chamber, which has one large opening in the middle of the colony (Barnes 1987; Abbott et al. 1977).

Reproduction and Life History

Patterns of sexual reproduction vary from one family to another, and sometimes from one genus to another, within the class. For the most part, solitary and colonial ascidians are simultaneous hermaphrodites (Abbott et al. 1977). The degree to which self-fertilization occurs is not well known. Typically, solitary ascidians release both eggs and sperm into open water, where fertilization occurs. The embryo develops into a non-feeding, swimming larva, or "tadpole." It is in the tadpole phase (which superficially resemble a typical frog tadpole) that the notochord and dorsal nerve cord, which characterize these organisms as chordates, are present. However, these features are lost during metamorphosis, and are absent in the adult phase. Colonial forms are ovoviviparous: sperm are shed to the sea, but not eggs. Fertilization in these types occurs within the oviduct or peribranchial cavity of the female parent, and the tadpole larvae emerge swimming, following development inside the parent body (Monniot et al. 1991). The larvae are completely encased in a tunic, and the buccal and atrial siphons are not functional. Thus the larvae are unable to feed; their prime function is to quickly find a suitable substrate to settle on. Therefore, tadpole larvae may only swim for a few minutes to a few days (Pearse et al. 1987). Following settlement, metamorphosis to the adult phase generally entails resorption of the tail and other larval structures, 180-degree rotation of the body to its adult posture, opening of the siphons, development of the brancial sac, and formation of the adult nervous system (Monniot et al. 1991).

In addition to sexual reproduction, the tunicates can reproduce asexually by budding. Budding individuals, or blastozooids, originate in different parts of the ascidian body, depending on the species. Individuals produced by primary buds are eventually freed from the parent colony (Barnes 1987). In addition to budding, colonial forms may undergo continuous divisions into smaller units termed cormomeres. The division entails rapid and dynamic movement of the colonies over the substrate. In addition to accomplishing the actual physical separation of the colony fragments, it is thought that this form of division may serve some other purposes as well, including maximizing periphery to area (which may improve efficiency of feeding or growth), excluding competitors by the dynamic movement involved; and mingling clones to facilitate cross-fertilzation (Ryland et al., 1984).

Typically, tunicates may live for 1-3 years, but some colonies may have a somewhat longer life span (Barnes 1987).

Habitat and Ecological Factors

Finding a stable substrate is critical for the survival of settling tunicates. Thus, inert surfaces of rocks, corals or pilings may be preferable to the less durable surfaces of seaweeds, mangrove roots, or other sessile invertebrates (soft corals, sponges, other tunicates), though

all of these may provide surfaces for tunicates to grow on. Many tunicates (especially the more delicate soft-bodied forms) also show a marked preference for growth in protected pockets or crevices, as opposed to exposed areas of the reef crest or face, where they would be subject to extreme variations in water movement, and possibly, greater predation by grazing animals. When they do occur in such places, tunicates are often covered by epibionts that may afford some camouflage and physical protection (Monniot et al. 1991).

Light and color of the substrate may be physical cues that influence larval settling, with darker, less illuminated surfaces being the preferred substrates. However, some forms, especially didemnids containing the endosymbiotic alga, *Prochloron,* can grow as high up as the intertidal zone, where light is most intense (Ryland et al. 1984). In addition, it is believed that certain chemicals may trigger initiation of various processes, including spawning, metamorphosis, larval attraction, and repulsion of predators or epibionts. For example, chemicals exuded by parent zooids may cause larvae to settle nearby, increasing the likelihood that larvae will find a suitable settlement substrate (Monniot et al. 1991).

As filter-feeders, tunicates are dependent upon the availability of adequate suspended food particles in the water column. Tunicate growth on outer reef slopes may be relatively more limited than within enclosed bays or lagoons, since phytoplankton may be less abundant there. Ovoviviparous colonial types are better suited to growth on outer slopes than are solitary forms, since larvae are protected during development and the free-swimming stage is very brief. By contrast, within lagoons, both solitary and colonial types are fairly abundant. Solitary forms seem to dominate in colonizing newly-available surfaces in disturbed areas (for example, in harbors), but typically species diversity in such settings is low (Monniot et al. 1991). Dominance of the solitary forms may be due to the fact that their larvae are released in greater numbers, and spend a longer time in the free-swimming phase, than larvae of colonial types.

Tunicates are not selective about the types of particles that are ingested in filter-feeding, and in waters with a high sediment load, silt and other mineral particles may accumulate in the pharyngeal basket and the digestive tract. If excessive, the silt may clog the pharynx and suffocate the animal.

Economic Importance

With minor exceptions,[4] ascidians are not presently utilized for any economic purposes. However, over the last twenty years or so, considerable research efforts have been directed at isolating and identifying compounds from tunicates that may have some cytotoxic activity, and thus some future medical value. For example, didemnines extracted from *Tridemnum solidum* are effective anti-cancer agents and may also have anti-viral properties (Monniot et al. 1991). Alkaloids and peptides, derivatives of amino acids, have also been isolated from

[4] In some countries, certain larger species are consumed as a food item.

tunicates. Some of these have antimicrobial properties (Lee et al., 1997; Zhao et al., 1997). Other proteinaceous compounds derived from tunicates may play a role in mediating responses in the immune system (Pancer et al., 1997; Pancer et al., 1993). *Lissoclinum bistratum*, a tunicate from New Caledonia that contains within its tissues endosymbiotic *Prochloron* algae, has been the source of polyethers that have strong effects on the nervous system. It remains to be determined whether the embedded *Prochloron* algal cells, rather than the tissues of the tunicate animal itself, are the source of these compounds (Monniot et al., 1991). It is speculated that in life, tunicates may utilize cytotoxic compounds to ward off predators or repel epibionts (Muller et al., 1994).

The ascidians are important members of the community of marine fouling organisms. The solitary tunicates seem to be especially opportunistic in colonizing freshly-exposed surfaces of pilings, docks, other harbor structures, and boat hulls. Ascidians and other fouling organisms interfere with boat operations and normal function such equipment as cooling water intakes. On hulls, fouling organisms cause additional drag of vessels as they move through the water. Significant effort and money are spent in developing effective means for deterring the growth of fouling organisms, and for eliminating them from boat hulls and other structures. Recently, great concern has developed about the transoceanic transport of tunicate species to areas where they are not indigenous, typically by attachment to boat hulls or being carried in bilge water. Introduction of exotic species transported in this manner can be disruptive of the balance of species in natural communities.[5] Among the Hawaiian species discussed by Abbott (1977), many are potential fouling organisms, with *Polyclinum constellatum, Diplosoma listerianum, Ciona intestinalis, Corella minuta, Ascidia sydneiensis Phallusia nigra, Symplegma oceania, Polyandrocarpa zorritensis, Styela canopus, Herdmania momus* being the most prevalent.

While ascidians typically will settle only on dead parts of coral, once established they may overgrow and smother adjacent living coral tissue (Monniot et al. 1991). The encrusting colonial tunicate, *Diplosoma similis,* has an extremely wide range in the tropical Western Pacific, and is known to overgrow large areas of living *Acropora* coral and the coralline alga, *Hydrolithon* (Littler and Littler 1995). This can cause indirect economic consequences, since such overgrowth of living coral areas can reduce the productivity of the reef, reducing the potential for fisheries.

Occurrence of the Taxon Within WPRFMC Fishery Management Units (FMUs)

Little information is available on occurrence of ascidians in the Pacific Islands. Data from the few citations located are presented here.

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[5] Biological Resources Division, US Geological Service, Nonindigenous Tunicate Information Website.

American Samoa

No reports.

Commonwealth of Northern Mariana Islands (CNMI)

Abbott et al. (1977) mention that *Polyclinum vasculosum*, has been reported widely in the Pacific, including from the Marianas.

Guam

The ascidian fauna of Guam is not well-known. As the result of some recent surveys, work is in progress to more accurately assess and describe the fauna (pers. comm. Gretchen Lambert, California State University, Fullerton 19 Aug 99).

Hawaii (MHI and NWHI)

Eldredge and Miller (1995) report a total of 45 species from Hawaii, but give no firm indications about how many might be endemic or introduced species. Abbott et al. (1977) report species from Hawaii in the following families: Polyclinidae (4 species); Polycitoridae (4); Didemnidae (11); Cionidae (1); Perophoridae (4); Corellidae (1); Ascidiidae (6); Styelidae (10); Pyuridae (3). All the growth forms discussed above are represented, and these taxa occupy a corresponding range of substrates. *Diplosoma similis,* the species that overgrows live reefs, is among the tunicates reported from Hawaii.

Other Sites

No reports.

3. Bryozoans

General Description of the Taxon

The Phylum Bryozoa is a taxonomically problematic group. While authorities have variously regarded them as including (Ehrenberg [1831]) or excluding (Hyman [1959]) the Entoprocta (a group of sessile organisms that superficially resemble hydroids), the Bryozoa as considered here refer only to the Ectoprocta. This group is comprised of colonial, sessile animals, with the vast majority occurring in marine environments. They have formed an important component of the fossil record since the Ordovician period. Though widespread on tropical reefs, bryozoans are often not recognized because they occur in mixed associations with algae, hydroids, sponges, and tunicates, especially on older portions of coral reefs (Soule et al. 1987).

The Bryozoa comprise the largest of four phyla of invertebrates that possess a lophophore. The lophophore is a fold of the body wall that encircles the mouth and bears numerous ciliated tentacles. Through the movement of the cilia, a water current is generated that drives plankton into the mouth of the bryozoan animal. The individual animals of the colony, or zooids, have a large coelom and a "U"-shaped digestive tract, with the anus opening to the outside of the lophophore tentacle circle (hence, "Ectoprocta"). Organs for gas exchange, circulation, and excretion are absent, probably owing mostly to the small size of the animals, which would allow for direct exchange of nutrients and wastes.

The phylum is divided into three classes, with Class Gymnolaemata containing most of the living marine species. Other marine types are contained within the order Cyclostomata in Class Stenolaemata (Ryland 1970). While some Bryozoa occur at great depths, the majority are found in shallower coastal waters, where they grow attached to rocks, corals, shells, other animals, wood (e.g., mangrove roots), or algae. Growth habit may be stoloniferous, foliose, branching, or encrusting. Large colonies may consist of more than two million individual zooids, and may reach up to 24 cm in height for erect species, and up to 50 cm diameter for encrusting forms (Barnes 1987). While various species are recognized on a gross level by their growth habit, to some degree, growth form is mediated by environmental conditions, so that within any given taxon, a range of variation in the form of the colony may occur (Soule et al. 1987).

The Gymnolaemata are divided into two distinct orders. The Ctenostomata, or ctenostomes, contain stoloniferous or compact colonies in which the exoskeleton is membranous, chitinous, or gelatinous. Usually, the terminal aperture of the zooid is open (i.e., lacks an operculum). In contrast, the Cheilostomata, or cheilostomes, have boxlike calcareous walls. A hinged, moveable operculum covers the aperture of the zooid in most cheilostome species. The operculum opens when the lophophore is extended for feeding, and shuts when the animal withdraws into the calcareous chamber of the zooecium (the colonial skeleton). Specially modified zooids are the avicularia, with movable jaw-like parts that serve to repel

predators, and vibracula, with setae or bristles that are used to prevent accumulations of silt. The marine Stenolaemata, the cyclostomes, are considered more primitive in organization than the Gymnolaemata (Ryland 1970). In the cyclostomes, the zooids are tubular and calcified, and the orifice is distally or anteriorly located, without an operculum (Barnes 1987).

Reproduction and Life History

The reproductive process in the Gymnolaemata is representative for the majority of marine species. Most marine bryozoans are hermaphroditic. However, the details of this arrangement may vary, with individual bryozoans being sequentially or simultaneously hermaphroditic, or unisexual. In some cases, permanently unisexual colonies may form (Soule et al. 1987). Sperm are shed through terminal pores of two or more tentacles of the lophophore, and released into seawater. Sperm are captured in the currents generated by the action of the lophophores of other nearby zooids. Fertilization between zooids of the same colony is probably common, but sufficient cross-fertilization likely occurs between colonies to assure outbreeding. In certain non-brooding species, fertilized eggs are shed directly into the seawater. Eggs of other species may be brooded in the coelomic cavity, or outside it. One specialized structure for brooding is a hood-like outgrowth of the body wall and coelom called the ovicell. In many species, the developing embryo receives its nutrition from a contained yolk, but in others, placenta-like connections to the ovicell from the mother zooid may provide food material.

For the Cyclostomata, specialized individuals, the gonozooids, may be modified for reproduction, or the colony may form a centralized chamber as a brooding structure (Soule 1987).

Bilateral cleavage leads to the development of a larva that has a locomotory ciliated girdle, or corona, an anterior tuft of long cilia, and a posterior adhesive sac. In certain genera of non-brooding bryozoans (e.g., *Membranipora*) a specialized feeding larva, the cyphonautes larva, develops. These are the only larvae that possess a functional digestive tract, and feed during the larval stage, a phase which may last several months. In brooding species, larvae are non-feeding, and the larval phase lasts only for a brief period before settlement.

During settling, the vibratile plume, a sensory tuft of cilia, is used in selecting a suitable site for attachment. The adhesive sac is everted and attaches the larva to the selected site. After settlement, the larva undergoes a marked metamorposis to form the ancestrula, the first zooid. Subsequent zooids in the colony are formed by asexual budding. The zooids formed by budding can themselves bud in various arrangements, giving rise to the form that characterizes each species (Meglitsch and Schram 1991).

Habitat and Ecological Requirements for Various Life History Stages

Substrate Preferences and Other Physical Parameters

Rather than being a primary structural reef-builder, bryozoans generally function as "hidden encrusters" that grow on the undersides of coral heads, rock ledges, and rubble, and may also partially fill cavities deep within the reef (Cuffey 1972). In this capacity, to a limited degree, bryozoans may reinforce the structural strength and stability of the reef.

A correlation has been noted between growth form and the depth at which various types occur (Ryland 1970). Generally, encrusting forms may be associated with intertidal areas or other sites subject to strong waves. Such forms would also be more resistant to grazing by predators. Less sturdy types, including erect branching and foliose forms, are found in areas not subject to strong surge or heavy pressure from grazing predators. For example, reticulate to fenestrate reteporids are typically confined to deeper, more stable marine habitats (Dade and Honkalehto 1986).

On modern tropical reefs, encrusting cheilostomes are the most abundant and diversified bryozoans. Encrusting cheilostomes comprise from 50 to 70 percent of the colonies observed in various reef environments in Kaneohe Bay (Dade and Honkalehto 1986). It appears that in depths below 5 to 7 m, bryozoans become more abundant and more diverse than in shallower areas (Cuffey 1972). In surveys conducted to depths of approximately 20 m in Kaneohe Bay (Dade and Honkalehto 1986), a similar trend was observed toward conditions that appear to favor more abundant and diverse growth in deeper water. Among the possible contributing factors cited were environmental stability (e.g., less water movement, fewer grazers); availability of substrate (as competition with corals and encrusting algae decreases); and decrease in ambient light.

It is known that bryozoan larvae actively search for suitable substrates for settlement. It has been observed that bryozoan larvae are able to persist in the plankton for many days longer than expected when conditions are not favorable for settling (Soule et al. 1987). Different species settle variously on rocks, shells, corals, or algae. The length of time over which larvae settle for a given species within a given area is thought to be dependent on a number of environmental factors, including day length and temperature. Day length may be both a direct influencing factor, and an indirect influence, since phytoplankton, presumed to be the preferred food source for many bryozoans, would be available in larger quantities during days with longer daylight hours. In Hawaii, larvae of *Bugula neritina* settled almost year-round (March to December). This also may indicate that *B. neritina* has an extended spawning season in Hawaii (Ryland 1970).

In many species, larvae first exhibit a positive phototropic reaction, but then become negatively phototropic before metamorphosis, eventually settling in dark places on the reef, such as the undersides of stones or flat coral plates (Soule et al. 1987). Generally, high light intensity environments do not support the growth of bryozoans (Soule et al. 1987). Empirical

observation suggests that heavily-silted environments generally deter successful settlement; few bryozoans are found growing in areas where rapid deposition of fine sediments occurs, or where water is frequently muddy or turbid (Soule et al. 1987).

Strong correlations were observed between various growth form groups and their position on the reef. So-called lagoon reef areas (fringing and patch reefs, 1-8m depth) were dominated by encrusting cheilostomes (*Celleporaria vagens*, *Rynchozoon* sp., *Coscinopsis fusca, Cleidochasma* sp.) and mat-like, tuft-like, and disk-like cheilostomes, as well as lichenoporid and tubuliporid cyclostomes. The barrier reef coral-algal flat breaker zone (1-2.5m depth) portion of the study site was dominated by the encrusting cheilostomes, *Thallamoporella stapifera* and *Rhynchozoon* sp. The ocean slope bench (15-20m depth) provided habitat for a wider variety of species, including encrusting cheilostomes (especially *Steginoporella magnilabris, Parasmittina parsevaliformis,* and *Schizoporella decorata*), as well as an assortment of reteporid cheilostomes, tuft-like cheilostomes, and lichenoporid and tubuliporid cyclostomes.

Idmidronea, a genus of highly-branched cyclostomatous bryozoans, is reported to occur on the surface of living corals and sponges in Hawaii (Gossliner et al. 1996).

Reteporellina and *Reteporella* sp. occur in areas with fairly strong currents at 10-20m depth (Gossliner et al. 1996).

Another interesting occurrence is the association of bryozoans with black corals (*Antipathes dichotoma*) growing at around 50m depth in the Auau Channel off Maui. About thirty species were found attached to the bases of the corals, and to mollusks attached to the lower coral branches. *Haloporella vaganas* and *Reteporellina denticulata* were the most common members of these assemblages (Soule et al. 1986).

In another study, encrusting and erect cheilostome bryozoans were found to grow on an artificial reef positioned in 20m of water in Kaneohe Bay, Oahu. Bryozoans grew rapidly on introduced substrates after two months. Two encrusting species, *Celloporaria vagans* and *Thalamoporella* spp., competed vigorously for space on an artificial substrate (Bailey-Brock 1987). In a similar manner, fouling organisms also appear to opportunistically colonize available surfaces. Thirteen species[6] were found to occur regularly on harbor and bay structures and boat hulls around Oahu (Soule et al. 1987).

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[6] *Aetea recta, Bowerbankia gracilis, B. imbricata, Bugula stolonifera, B. neritina, Hippopodina feegeensis, Savignyella lafonti, Schizoporella unicornis, Zoobotryon verticillatum, Scrupocellaria sinuosa, Cryptosula pallasiana, Tryptostega venusta,* and *Watersipora edmondsoni.*

Feeding

Bryozoans are suspension-feeders that capture plankton from the water. Gut contents show the presence of diatoms, detritus, bacteria, silicoflagellates, peridinians, coccolithophores, algal cysts, and flagellates. Unicellular algal cultures (*Dunaliella tertiolecta* and *Gymnodinium simplex)* have been used to successfully rear bryozoans in the laboratory (Soule et al. 1987).

While not an obvious food source for other animals, bryozoans are utilized by a variety of grazers, including echinoids, labrid fishes, and nudibranchs (Soule et al. 1987).

Economic Significance

Despite their widespread occurrence, bryozoans are generally not directly utilized for any applied purposes. However, they are being thoroughly investigated for the presence of biochemically active compounds that may ultimately prove useful for treatment of disease. Bryostatin 1, a compound isolated from a common marine bryozoan, is currently being tested as an anti-cancer drug.[7] Bryozoans are recognized for producing a range of other compounds, particularly alkaloids, that may ultimately be shown to have pharmaceutical applications (Van Alstyne and Paul 1988).

Many bryozoan species also have economic importance because of their action as fouling organisms. Bryozoa, along with other common sessile invertebrates and algae, attach to boat hulls, making their movement in the water less efficient. Among the common bryozoan fouling species in warm-water areas are *Bugula neritina, Schizoporella errata, Watersipora subovoidea,* and *Zoobotryon verticillatum* (Ryland 1970). These and other species can also clog industrial water intakes and conduits. Significant effort and money are spent in developing effective means for deterring the growth of fouling organisms, and for eliminating them from boat hulls and other structures. The growth of fouling organisms, besides being of economic significance, also has ecological implications--species growing on ship hulls are readily transported great distances beyond their natural range, and may be introduced into new areas, thus having an impact on the natural balance of species in established ecosystems.

Occurrence of the Taxon Within WPRFMC Fishery Management Units (FMUs)

American Samoa

No reports.

Commonwealth of Northern Mariana Islands (CNMI)

No reports.

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[7] U. of California, Berkeley: Bryozoan Internet website.

Guam

No reports.

Hawaii (MHI and NWHI)

Surveys in Kaneohe Bay (Dade and Honkalehto 1986) yielded a total of 57 species of ectoproct bryozoans, including 45 cheilostomes, 13 cyclostomes, and 1 ctenostome. Many of these are cosmopolitan, capable of being dispersed over great distances, often by rafting on algae, logs, or artificial substrates. However, owing to the isolation of the archipelago, significant speciation has occurred, with the result that of the species recorded in Kaneohe Bay, 23 percent were believed to be endemic to Hawaii. It is estimated that over 150 species of bryozoans occur in Hawaii, however the total number of endemic species for Hawaii is not known (Eldredge and Miller 1985).

Other Sites

With the exception of Hawaii, little published information is available for the other U.S. Pacific Islands. Because the shallow sublittoral bryozoan fauna for the Indo-Pacific is not well known, it is difficult at present to establish with any certainty the degree of endemism of specific taxa within any given island or archipelago (Soule et al. 1987).

4. Crustaceans

Introduction

The arthropod subphylum Crustacea is one of the most diverse and widespread groups of invertebrates. Within the subphylum, the Class Malacostraca contains such familiar types as mantis shrimps, lobsters, crabs, and shrimp, as well as less conspicuous, but ecologically important organisms, the isopods and amphipods.

Crustaceans cannot grow as many other animals do, because the hard exoskeleton does not stretch. Therefore, they periodically shed the outer skeleton, grow rapidly for a period of time, then re-grow a new exoskelteton. The molting process involves many complex physiological changes, including reduction of the lime content in the exoskeleton to weaken it prior to molting; rapid absorption of water after molting to expand the body size; and redeposition of lime to again strengthen the exoskeleton (Tinker 1965). During molting, the animal is in a weakened and vulnerable condition, and must seek shelter to avoid being preyed upon by other animals. Thus the molting process strongly influences the habitat requirements of these animals.

The malacostracan body is typically composed of 14 segments, plus the telson, with the first 8 segments forming the thorax and the last 6, the abdomen. The thorax may or may not be covered by a carapace. All segments bear appendages, with the first antennae usually being biramous, the exopodite (outer branch) of the second antennae often in the form of a flattened scale, and the mandibles usually bearing palps. In the primitive condition, the thoracic appendages are similar, with the endopodite (inner branch) being more developed for use in crawling or grasping. In most species, the first one, two, or three pairs of thoracic legs have been turned forward and modified to form maxillipeds. The anterior abdominal legs are similar, and are called pleopods. They are used for swimming, burrowing, ventilating, gas exchange, and carrying eggs in females. In males, the first one or two pleopods are modified to form copulatory organs. The sixth abdominal appendages, or uropods, are flattened, and together with the telson, form a tail fan used in escape swimming.

The present discussion is confined to those larger forms that are of concern from a management standpoint. These belong to the order Stomatopoda (mantis shrimps), and order Decapoda (shrimps, lobsters, and crabs). As part of Amendment 10 to the *Crustacean Fisheries Management Plan,* (WPRFMC September 1998) background information has been presented, and EFH has already been defined, for certain economically-important decapod taxa (i.e., spiny lobsters, *Panulirus marginatus* and *P. penicillatus*, and kona crab, *Ranina ranina*). The present discussion will provide further information on other decapod taxa, and summarize the information contained in Amendment 10 on lobsters and Kona crab.

Stomatopoda (Mantis Shrimps)

Description

Several hundred marine species constitute the order Stomatopoda, the mantis shrimps. These organisms live in rock or coral crevices or in burrows excavated in sand. They are dorsoventrally flattened with a small, shield-like carapace and a large segmented abdomen that widens toward the posterior end. Characteristic of the group is the possession of a highly developed, powerful pair of second-segment raptorial appendages that are used either for spearing or smashing prey.

Reproduction and Life History

In stomatopods, as many as 50,000 eggs (e.g., genus *Squilla*) are joined together by an adhesive secretion to form a globular mass. The mass is held by the female in small subchelate appendages and constantly turned and cleaned. The female does not feed while brooding. Depending on the species, the egg mass may be left in the burrow, or the female may carry the egg mass with the thoracic legs (Meglitsch and Schram 1991). The eggs hatch into zoea larvae that have carapaces that are much larger than in the adult, relative to total body size. The larvae may appear in very large numbers in the plankton community in tropical waters. Two types of larvae are recognized, an erichthus and an alima. The larvae pass through a prolonged phase during which the last three thoracic somites have no appendages, a feature also observed in zoea larvae of decapods (Meglitsch and Schram 1991). The planktonic larval phase lasts for up to three months (Barnes 1987).

Habitat and Ecological Requirements for Various Life History Stages

Most stomatopods live in pockets or crevices on the reef, or in burrows in sand. They may dig their own burrows or occupy burrows excavated by other animals. A variety of mechanisms are used to close the burrow entrance for protection; the animal may plug the hole with its telson, or gather shells and other debris to close the entrance at night, and block it during the day with the raptorial appendages.

Mantis shrimps may leave the burrows to feed, either crawling or swimming over the bottom. Some types ("spearers," e.g., *Lysiosquilla maculata*) are equipped with raptorial appendages that have sharp barbs that pierce soft-bodied prey animals, such as shrimps or

fishes. In others ("smashers" such as *Gonodactylus* spp.) the raptorial appendages have a sharp, heavy heel that can crack the shells of crabs, snails, and clams.

Economic Importance

Mantis shrimps are part of the incidental catch of subsistence fisheries, and may be captured in crab nets that are placed near their burrows (Tinker 1965). Their use as a food source is generally limited. Some species, especially brightly-colored ones (e.g., *Gonodactylus* sp.), may have some minor value in the aquarium trade (?-confirm). Limited use is made of the ivory-like raptorial appendages of some species in the small-scale manufacture of jewelry (Tinker 1965).

Occurrence of the Taxon Within WPRFMC Fishery Management Units

American Samoa

No reports.

Commonwealth of Northern Mariana Islands (CNMI)

Two stomatopods found in the Northern Marianas, *Mesacturus dicrurus* and *Gonodactylus* sp., were reported by Hamano (1994). Both species, in the Gonodactylidae, occur in rocky intertidal areas.

Guam

Lysiosquilla spp. (Green October 1997) and *Mesacturus dicrurus* (Gonodactylidae; Hamano 1994) are known from Guam. *Mesacturus dicrurus* is associated with rocky intertidal environments (Hamano 1994).

Gossliner et al. (1996) report on the following species:

Gonodactylellus affinis (Stomatopodidae), a species that is highly polymorphic in color, occurs here, usually below 20m depth. By contrast, *Gonodactylus chiragra* is an inhabitant of shallow intertidal reef flats and rocky outcrops, and forages in low tide in a few centimeters of water. *Gonodactylaceus mutatus* occurs on reef flats to 5m depth, and also forages at extreme low tide. *Mesacturoides spinosocarinatus* may be found at depths ranging from 5 to 50 m. The animals stay close to their burrows, but dart about nearby. *Pseudosquilla ciliata* burrows in sand and gravel on reefs and sand flats, to 30m depth.

Hawaii (MHI and NWHI)

Eldredge and Miller (1995) list a total of approximately 17 stomatopods from Hawaii. Of these, 11 are considered endemic.

Lysiosquilla maculata and *Squilla (Oratosquilla) oratoria* are reported to occur in Hawaii. Both are found in mud-bottom areas suitable for burrows (Tinker 1965).

Gossliner et al. (1996) report the occurrence of the following Hawaiian species:

Odontodactylus brevirostris is found in burrows of small rubble pieces at 10-50m depth. *O. scyallarus* is a night-feeding carnivore that preys on crustaceans, worms, mollusks, fish. It is found on sand and rubble bottoms to 70m. *Oratosquilla oratoria,* another nocturnal species, is reported in muddy estuaries and on reefs, in U-shaped burrows up to 1m long. *Pseudosquilla ciliata* burrows in sand and gravel on reefs and sand flats, and is found to 30m depth.

Other Sites

A single specimen of *Pseudosquilla ciliata* was encountered at Palmyra Island (Edmondson 1923).

Decapoda: Shrimps, Lobsters, and Crabs

Introduction

With approximately 10,000 species, decapods represent about one fourth of all known crustaceans (Barnes 1987). They are among the most diverse and successful crustacean groups, having exploited virtually all available niches in the marine habitat, as well as having developed specialized strategies for nutrition and reproduction.

The generalized decapod life cycle is characterized by the nauplius and protozoea stages being passed inside the egg. However, some primitive forms (e.g., penaeids) pass the earlier developmental stages outside of the egg. Transition from protozoea to the next stage (zoea) involves the addition of thoracic limbs and dependence on the thoracic appendages for locomotion. The carapace fuses to the thorax, and pleopods and stalked eyes appear. The zoea is typically the stage at which the larva emerges from the egg. From the zoea phase, further transformations occur, making the postlarval or juvenile phase more closely resemble the adult (Meglitsch and Schram 1991).

In the adult phase, decapods are distinguished by having the first three pairs of thoracic appendages modified into maxillipeds. The remaining five pairs are the legs. The first or second pair of legs may be chelipeds (pincer-like claws) that are used for seizing prey or for defense (Barnes 1987).

Decapods exhibit a wide range of feeding behaviors, but most combine predation with scavenging, with large invertebrates being typical prey items (Barnes 1987). Others may be detritus or filter feeders. The form of the body, especially the appendages, is often modified

for more effective functioning in acquiring food. Thus, box crabs such as *Calappa calappa* have powerful chelae used to crush mollusks; sand-burrowing mole crabs (e.g., *Emerita pacifica*) use long fringed antennae to filter plankton and detritus; and banded coral shrimp (*Stenopus hispidus*) use thin pincers to delicately pick ectoparasites from the scales of fishes' bodies (Gossliner et al. 1996).

Shrimps: Infraorders Penaeidea, Stenopodidea, Caridea

General Description and Morpohology

The shrimps are found in several different decapod infraorders, and this taxonomic disunity reflects the wide range of forms and lifestyles that are represented in this large but artificial grouping. The penaeids are considered the most primitive decapods, while other types, such as the alpheids and palaemonids, represent more advanced forms. The features that generally characterize shrimps are bodies that are laterally compressed or more or less cylindrical, with well-developed abdomens, and a cephalothorax that often has a keel-shaped, serrated rostrum. Legs are usually slender, and chelipeds may be present or absent. The exoskeleton is usually relatively thin and flexible (Barnes 1987).

Reproduction and Life History

In most shrimps, copulation takes place with the adults pair oriented at right angles to each other. The male uses the modified first and second pair of pleopods to transfer a spermatophore to a median receptacle between the thoracic legs of the female. The penaeids are the only decapod group in which eggs are shed directly into the water and hatch as naupliar or metanaupliar larvae. In all other decapods, females carry the eggs on the pleopods, and hatching takes place at the protozoea or zoea stage (Barnes 1987). The various larval schemes in decapods are summarized in Table A.

Habitat and Ecological Requirements for Various Life History Stages

Most shrimps are bottom-dwellers. Thoracic appendages are used for crawling, while pleopods are used for swimming, and also to fan sediments during excavation of burrows. Many penaeids construct burrows in sand or other soft-bottom material, or simply bury themselves in sediment during daytime, emerging at night to feed (Gossliner et al. 1996). Other types, such as snapping or pistol shrimp (Alpheidae), live in holes and crevices beneath rocks and coral rubble, or may construct burrows. Certain alpheids are also closely associated with corals, especially in the genus *Pocillopora* (Hayashi et al. 1994; see notes in section IV.C.4.e, below) Other genera also may live inside or in close association with a variety of other living organisms, including sponges, tunicates, mollusks, corals, echinoderms, or anemones.

Many of the commensal associations between shrimps and other organisms are quite specialized. The "cleaner shrimps," an artificial grouping of species distributed among several families, play an important role in reef ecology by reducing ectoparasites on reef fishes. Through complex behavioral cues and signals, the fishes approach well-defined "cleaning stations" on the reef and allow the shrimps to climb over their bodies and even insert their chelipeds into the gill region to pick off parasites. Anemone shrimps in the genus *Periclimenes* may also clean fish, and spend most of their time living among the stinging tentacles of sea anemones. Many snapping shrimps of the family Alpheidae typically share their burrows in a close relationship with fish of the family Gobiidae, presumably to the mutual benefit of both partners.

Occurrence of the Taxon Within WPRFMC Fishery Management Units

American Samoa

No reports.

Commonwealth of Northern Mariana Islands (CNMI)

Hayashi et al (1994) surveyed the crustacean fauna on Anatahan, Sarigan, Guguan, Alamagan, Pagan, Agrihan, Asuncion, Maug (East, West and North), and Uracas. Their collections were made at depths ranging from 3-14 meters. The findings included reports of the following species of shrimps:

Stenopodidae:

Stenopus hispidus (found in the rocky subtidal zone; known from a wide geographic range where it occurs from the intertidal to depths of 210m); Rhyncocinetidae: *Rhyncocinetes* sp.; Palaemonidae: *Brachycarpus biunguiculatus, Harpiliopsis beaupresii* (on coral), *H.depressa, Ichnopontonia lophos, Jocaste japonica, Onycocaris quadratophthalma* (on *Pocillopora* coral), *Palaemonella spinulata*; Alpheidae: *Alpheopsis* sp., *Alpheus bidens, A.* cf. *crinitus, A. frontalis* (under boulders), *A. lottini* (in somewhat deeper water [14 m]on *Pocillopora*), *A. obesomanus, A. pacificus, A. pearcyi, Athanas areteformis* (on *Pocillopora*), *Automate dolicognatha, Metalpheus rostratipes* (on *Pocillopora*), *Racilius compressus, Syalpheus charon* (on *Pocillopora*), *S. paraneomeris* (on *Pocillopora*), *S. tumidomanus* (on *Pocillopora*); Hippolytidae: *Hippolyte edmondsoni* (on algae; known otherwise only from Oahu, Hawaii)

Guam

Several species of snapping shrimp (Alpheidae) were found in Guam. One species, *Alpheus obesomanus*, occupied extensive tunnels in *Millepora platyphylla* colonies; up to 95 percent of the colonies surveyed had shrimp tunnels. Another species, *A. idiocheles*, occupied sub-

hemispherical pockets, called "galleries," in an intertidal erosion bench. Each gallery typically was inhabited by a male-female pair (Kropp 1987).

Hawaii (MHI and NWHI)

Eldredge and Miller (1995) indicate that there are approximately 200 species of marine shrimps in Hawaii; of these, 4 stenopodids are believed to be endemic. Endemism of other types has not been established with certainty.

Tinker (1965) reports the following species of interest: *Stenopus hispidus* (Stenopodidae), the banded cleaner shrimp, is or pan-tropical distribution. It is typically found in holes in the reef. The harlequin shrimp, *Hymenocera picta* (Gnathophyllidae), is found from Hawaii eastward to the Red Sea. This species, relatively uncommon in Hawaii, is occasionally found in quiet inshore waters on the reef.

Gossliner et al. (1996) report the following shrimps from Hawaii:

Stenopodidae:
Stenopus hispidus, *S. pyrosonotus* (cleaner shrimp found in crevices to 15 m depth; eggs are light blue color); Pontoniidae: *Periclimenes soror* (on sea stars), *P. imperator* (on nudibranch [*Hexabranchus*], holothurians [*Stichopus, Bohadschia, Synapta*], and sea star [*Gomophia*]), *Pontonides unciger* (mimics polyps of black coral [*Cirripathes*] on which it lives), *Stegopontonia commensalis* (on sea urchin spines); *Lysmata amboinensis* (cleaner shrimp); Hippolytidae: *Parhippolyte uveae* (in anchialine ponds), *Saron marmoratus* (nocturnal in protected lagoons); Gnathophyllidae: *Gnathophylloides mineri* (on sea urchins), *Gnathophyllum americanum* (associated with echinoderms), *Hymenocera picta* (preys on sea stars); Rhinchocinetidae:*Rhinchocinetes rugulosus.*

Hayashi et al (1994) indicate that the following species are known from Hawaii:

Palaemonidae:
Brachycarpus biunguiculatus; Alpheidae: *Alpheus pearcyi, Metalpheus rostratipes, Syalpheus paraneomeris*; Hippolytidae: *Hippolyte edmondsoni* (on algae; known only from, Oahu, Hawaii and CNMI).

Other Sites

For each of the following families of shrimps, Edmondson (1923) lists the following number of species (in parentheses) represented at Palmyra Atoll and/or Fanning Island:[8] Alpheidae

[8] Family name nomenclature is updated.

(10); Hippolytidae (1); Gnathophyllidae (2); Palaemonidae (5); Stenopodidae (1); Sergestidae (1).

Lobsters, Spiny Lobsters, Slipper Lobsters: Infraorders Astacidea, Palinura

General Description and Morpohology

Lobsters are heavy-bodied decapods that generally inhabit holes and crevices of rocky and coralline bottoms. They have extended abdomens that bear a full complement of appendages, and the carapace is always longer than it is broad. The infraorder Astacidea includes large-clawed lobsters, while the Palinura include the spiny lobsters (Palinuridae), slipper lobsters (Scyllaridae), and coral lobsters (Synaxidae)(Barnes 1987; Pitcher 1993). Spiny lobsters are non-clawed, decapod crustaceans with slender walking legs of roughly equal size (Uchida 1986, FAO 1991). In spiny lobsters, the carapace is large and spiny. Two horns and antennae project forward of the eyes and the abdomen terminates in a flexible tailfan (FAO 1991). The slipper lobster, while in many respects quite similar to the spiny lobster, has its second antennae modified into broad, platelike structures (Pearse et al.1987). The body is more flattened dorsiventally than the body of spiny lobsters. Large-clawed, or true lobsters are more widespread and abundant in temperate areas, but of limited occurrence in the tropical and sub-tropical Western Pacific. They differ from palinurids in having large, heavy chelipeds.

Reproduction and Life History

The developmental history of the spiny lobster is covered at length in Amendment 10 of the *Crustacean Fisheries Management Plan,* (WPRFMC September 1998). Key points are excerpted here.

Spiny lobsters (*Panulirus* sp.) are dioecious (Uchida 1986). Generally, the different species within the genus have the same reproductive behavior and life cycle (Pitcher 1993). The male spiny lobster deposits a spermatophore or sperm packet on the female's abdomen (WPRFMC 1983, Uchida 1986). The fertilization of the eggs occurs externally (Uchida 1986a). The female lobster scratches and breaks the mass, releasing the spermatozoa (WPRFMC 1983). Simultaneously, ova are released from the female's oviduct and are then fertilized and attached to the setae of the female's pleopods (WPRFMC 1983, Pitcher 1993). At this point the female lobster is ovigerous, or "berried" (WPRFMC 1983).

The fertilized eggs hatch into leaf-like zoea larvae (the phyllosoma larvae) after 30–40 days (MacDonald 1986, Uchida 1986), and enter a planktonic phase (WPRFMC 1983). The duration of this planktonic phase varies, depending on the species and geographic region, and may last from 6 months to 1 year from the time of hatching (WPRFMC 1983, MacDonald 1986). There are 11 dissimilar morphological stages of development that the phyllosoma larvae pass through before they transform into the postlarval puelurus phase (Johnson 1986,

MacDonald 1986). The relatively long pelagic phase for palinurid larvae results in very wide dispersal; palinurid larvae are transported up to 2,000 miles by prevailing ocean currents (Johnston 1973, MacDonald 1986).

There is a lack of published data pertaining to the preferred depth distribution of phyllosoma larvae in Hawaii. However, the depth distribution of phyllosoma larvae of other species of *Panulirus* common in the Indo-Pacific region has been documented. Newly hatched larvae of the western rock lobster (*P. cygnus*) are typically found within 60 m of the surface. Later stages of the phyllosoma larvae are found at depths between 80–120 m. *P. cygnus* undergoes a diurnal vertical migration, ascending to the surface at night, descending to lower depths during the day, the authors add. Research has shown that early phyllosoma larvae display a photopositive reaction to dim light. In the Gulf of Mexico, the depth to which *Panulirus* larvae descend is restricted by the depth of the thermocline (Phillips and Sastry 1980).

The puelurus stage for spiny lobster lasts 6 months or less (WPRFMC 1983). The pueruli are free-swimming and actively return to shallow, nearshore waters in preparation for settlement (WPRFMC 1983, MacDonald 1986). MacDonald and Stimson (1980) found pueruli settlement to occur at approximately 1 cm in length.

MacDonald (1986) states that after settlement the pueruli molt and transform into post-pueruli, a transitional phase between the pelagic phyllosoma phase and the juvenile stage. Pitcher (1993) states that the post-pueruli of *Panulirus penicillatus* have been observed inhabiting the same "high-energy reef-front habitat" as adults of the species. Yoshimura and Yamakawa (1988) conclude that small holes in rocks, boulders and algae provide important habitat for the newly settled pueruli and juvenile lobsters.

The other palinuroids (coral and slipper lobsters) also have the unique phyllasoma larval phase (Pitcher 1993). Johnston (1973) reports that the phyllosoma phase of some species of slipper lobster (genus *Scyllarides)* is somewhat shorter than that of the spiny lobster.

Habitat and Ecological Requirements

Adult spiny lobsters are typically found on rocky substrate in well-protected areas, in crevices and under rocks (Pitcher 1993, FAO 1991), down to a depth of around 110m (Brock 1973). Unlike many other species of *Panulirus*, the juveniles and adults of *P. marginatus* are not found in separate habitat apart from one another (MacDonald and Stimson 1980, Pitcher 1993, Parrish and Polovina 1994). Juvenile *P. marginatus* recruit directly to adult habitat; they do not utilize separate shallow water nursery habitat apart from the adults as do many Palinurid lobsters (MacDonald and Stimson 1980, Parrish and Polovina 1994). Juvenile and adult *P. marginatus* do utilize shelter differently from one another (MacDonald and Stimson 1980). Similarly, juvenile and adult *P. pencillatus* also share the same habitat (Pitcher 1993).

In the NWHI, *P. marginatus* is found seaward of the reefs and within the lagoons and atolls of the islands (WPRFMC 1983). Uchida (1986) reports that *P. penicillatus* rarely occur in the commercial catches of the NWHI lobster fishery. In the NWHI, *P. pencillatus* is found inhabiting shallow waters (<18 m) (Uchida and Tagami 1984).

In the NWHI, the relative proportion of slipper lobsters to spiny lobsters varies between banks; several banks produce relatively higher catch rates of slipper lobster than total spiny lobster (Uchida 1986; Clarke et al. 1987, WPRFMC 1986). The slipper lobster is taken in deeper waters than the spiny lobster (Clarke et al., 1987, WPRFMC 1986). Uchida (1986) reports that the highest catch rates for slipper lobster in the NWHI occur between the depths of 20–55 m.

Pitcher (1993) observes that, in the southwestern Pacific, spiny lobsters are typically found in association with coral reefs. Coral reefs provide shelter as well as a diverse and abundant supply of food items, he notes. Pitcher also states that in this region, *P. pencillatus* inhabits the rocky shelters in the windward surf zones of oceanic reefs, an observation also noted by Kanciruk (1980). Other species of *Panulirus* show more general patterns of habitat utilization, Pitcher continues. At night, *P. penicillatus* moves on to reef flat to forage, Pitcher continues. Spiny lobsters are nocturnal predators (FAO 1991).

P. marginatus is typically found on rocky substrate in well-protected areas such as crevices and under rocks (FAO 1991). During the day, spiny lobsters are found in dens or crevices in the company of one or more other lobsters (WPRFMC 1983). MacDonald and Stimson (1980), studying the population biology of spiny lobsters at Kure Atoll in the NWHI, found that 57% of the dens examined were inhabited by solitary lobsters. The remaining 43% were occupied by more than one lobster, with adult and juvenile lobsters of both sexes often found sharing the same dens. However, the authors note, adult and juvenile spiny lobsters exhibit distinctly different den occupancy patterns, with juveniles (less than 6 cm in carapace length) typically in multiple occupancy dens with other lobsters. Adult and juvenile spiny lobsters are not segregated by geographic area or habitat type at Kure Atoll, MacDonald and Stimson observe. They found that juvenile spiny lobsters do not utilize separate nursery habitats apart from the adult lobsters. The larval spiny lobster puerulus recruits directly to the adult habitat (Parrish and Polovina 1994). This is in contrast to the juveniles of other species of spiny lobsters that tend to reside in shallow water and migrate to deeper, offshore waters as they mature (MacDonald and Stimson 1980).

There are limited data available concerning growth rates, reproductive potentials and natural mortality rates at the various life history stages (WPRFMC 1983). The relationships between egg production, larval settlement, and stock recruitment are poorly understood (WPRFMC 1983).

Occurrence of the Taxon Within WPRFMC Fishery Management Units

American Samoa

The only species of *Panulirus* reported from American Samoa is *P. penicillatus* (Pitcher 1993).

Commonwealth of Northern Mariana Islands (CNMI)

P. penicillatus is the most common species of the genus encountered in the CNMI. *P. longipes* and *P. versicolor* are also found in significant numbers. Regulations prohibit capture of individuals less than 76 mm carapace length and of egg-bearing females (Pitcher 1993).

Guam

P. penicillatus is the most common species of spiny lobster on Guam, and is caught by islanders spearfishing at night. *P. longipes* and *P. ornatus* are also caught occasionally. Regulations are in effect that protect small (<0.45 kg) lobsters (Pitcher 1993).

Of the several hundred species of crustaceans that likely occur on Guam, lobsters of various types are among the most sought-after by local fishermen. They include spiny lobsters (*Panulirus longipes, P. ornatus, P. penicillatus,* and *P. versicolor*); a homarid; and a slipper lobster (*Scyllarus squamosus*)(Green October 1997).

Hawaii (MHI and NWHI)

Eldredge and Miller (1995) state that 13 palinurids occur in Hawaii, with 2 endemic species.

Tinker (1965) indicates that *Justitia longimanus* and *Enoplometapus occidentalis* are seldom found in Hawaii. They usually occur in depths greater than 30 m. He characterizes *Panulirus penicillatus* as an omnivorous species that eats algae and animal prey. It is nocturnal and hides during the day.

Scillarus timidus is a rare species of slipper lobster that has been found in Hawaii at a depth below 30m. *Scillarides squammosus* inhabits rocky areas of the reef. It is another nocturnal species that hides during the day ad feeds on the reef at night. This species is much prized by fishermen and divers. According to Tinker (1965), the body of *Parribacus antarcticus* is too small and flat to be of much interest as a food item.

Two species of slipper lobster, the ridgeback slipper lobster (*Scyllarides haanii*) and the Chinese slipper lobster (*Parribacus antarcticus*) are caught in low numbers incidental to the

targeted fishery for *Panulirus marginatus* and *Scyllarides squamosus* in the NWHI . The traps are typically set at depths of 20-70m (Polovina 1993).

Gossliner et al. (1996) report the following lobster species from Hawaii:

Palinuridae:
Enoplometopus debelius (in caves and crevices of reef faces), *E. occidentalis* (in caves and crevices of reef faces), *Hoplometopus holthuisi* (in caves and crevices of reef faces); *Justitia longimanus* (found in caves at outer reef edge, to 35 m depth; feeds at night), *Palinurellus wieneckii* (of interest for the aquarium trade), *Panulirus marginatus* (endemic species), *P. penicillatus*; Scyllaridae: *Arctides regalis* (endemic species occurring in caves), *Parribacus antarcticus, Scyllarides haanii.*

Other Sites

Panulirus marginatus has been reported from Wake Island (pers. comm., Mark Minten), and Johnston Atoll (Brock 1973). *Parribacus antarcticus* was record at Palmyra Atoll in the 19th century (Edmondson 1923).

Crabs (True Crabs and Hermit Crabs): Infraorders Brachyura and Anomura

Description

The Brachyura, the so-called true crabs, are one of the largest and most successful groups of decapods. The body form is short and wide, and the abdomen is flexed to fit tightly beneath the cephalothorax. Uropods are generally lacking. Pleopods are retained in females for brooding of eggs, and in males only the anterior two pairs of copulatory pleopods are present. The carapace is typically wider than long. The broad body form, while allowing for crawling in the forward direction, is better suited for sideways movement. Most crabs are poor swimmers, but in the Portunidae (swimming crabs), the last pair of legs are modified into broad paddles, enabling them to swim rapidly (Barnes 1987).

The Anomura contain the hermit crabs and several other interesting groups, such as the Porcellanidae (porcelain crabs). In the Anomura, the fifth pair of legs is reduced. However, the abdomen is not reduced (as in brachyurans) and uropods are generally present. The anomuran superfamily Pagurolidea, the hermit crabs, have adapted to living the majority of their adult life with their abdomens protected in abandoned shells of gastropods. In these types, the abdomen is modified to fit inside the spiral chamber of the gastrpopod shell. The porcelain crabs, often found in commensal relationships with sea anemones, resemble true crabs in having symmetrical, flexed abdomens, but the abdomens are longer than in typical brachyurans (Barnes 1987).

Reproduction and Life History

When brachyurans copulate, the female lies under the male facing in the same position, or with ventral surfaces opposed. The male inserts the first pair of pleopods into the openings on the female's abdomen. Fertilization is internal. The abdomen, which is normally in a tightly flexed position, is lifted to a considerable degree to permit brooding. The egg mass, often orange in color is called a sponge. Eggs hatch out into a zoea larval stage, easily recognized by the presence of a long rostral spine, and sometimes a pair of lateral spines that project from the posterior of the carapace. The postlarval megalops is also quite distinctive, already possessing the flexed abdomen and the full complement of appendages found in the adult (Barnes 1987).

Hermit crabs partially emerge from their gastropod shell shelters to mate. The mating pair appress their ventral surfaces, and eggs and spermatophores are released simultaneously. Eggs hatch into a zoea larval phase, and metamorphose into glaucothoë postlarvae (Barnes 1987).

The kona crab, *Ranina ranina*, is one brachyuran species for which EFH has already been established under Amendment 10 of the *Crustacean Fisheries Management Plan,* (WPRFMC September 1998). A summary of the basic life history is presented here.

Ranina ranina, the kona crab, has a wide range, being found from the Hawaiian Islands south to Polynesia and westward across the tropical Pacific through Micronesia and Melanesia, as far north as Japan and Taiwan, and reaching across the Indian Ocean as far east as the coast of Africa (Tinker). In the NWHI, it occurs from Kure Atoll to Nihoa at depths of 24 to 115 m (Uchida, 1986; Edmonson, 1946). *R. ranina* is also found in the main Hawaiian Islands (MHI).

It is believed that female kona crabs reach sexual maturity somewhere between 54.3 and 63 mm CL. Uchida (1986) reports that 60% of male kona crabs ≥60 mm were sexually mature. Kona crabs are dioecious and display sexual dimorphism. The males tend to grow to a larger size (Uchida, 1986). The sex ratio of males to females has been found to be skewed in favor of males (Fielding and Haley, 1976; Onizuka, 1972).

This species spawns at least twice during the spawning season (Uchida, 1986). The female kona crab usually spawns a second time approximately nine days after the first batch of eggs hatch. Fertilization of the eggs occurs externally. The fertilized eggs adhere to the females' numerous setae (Uchida, 1986). In the MHI, ovigerous females have been found to occur only from May to September (Uchida, 1986; Fielding and Haley, 1976). There are insufficient data available to define the exact spawning season in the NWHI (Uchida, 1986).

A small, directed fishery for kona crabs exists in the MHI. While there is no directed fishery for kona crabs in the NWHI, it is taken incidentally in the spiny lobster fishery. The principal gear used in the fishery is the kona crab net. *R. ranaina* is also taken in lobster traps. In the MHI from 1961 to 1979 the average total landings for kona crab averaged 13,519 kg.

Kona crab eggs are spherical and orange. They hatch at approximately 29 days after fertilization (Uchida, 1986). About 5 days prior to hatching the eggs change from an orange to brown color at the onset of the eyed stage (Uchida, 1986).

Little is known about the plankton larval stage of kona crabs. The first molt occurs at 7-8 days after hatching, the second molt about seven days later (Uchida, 1986).

There is no information available concerning the distribution or habitat utilization patterns of juvenile kona crabs.

Adult kona crabs are found inhabiting sandy bottom habitat at depths between 24 to 115 m. Kona crabs are opportunistic carnivores that feed throughout the day. The species buries itself in the sand where it lies in waits for prey or food particles (Uchida, 1986).

The WPRFC has designated EFH for the juvenile and adult life stages of *Ranina ranina* as the shoreline to a depth of 100 m. EFH for this species larval stage is designated as the water column from the shoreline to the outer limit of the EEZ down to 150 m.

Habitat and Ecological Requirements

Crabs exhibit an astonishing array of structural and behavioral adaptations that enable them to occupy a wide range of niches within the coral reef habitat and associated environs. They may bury themselves in high littoral sands, occupy crevices or burrows among subtidal rocks and coral heads, or live on the surfaces of marine plants or other invertebrates. Their commensal associations include living in the mantle cavities of bivalves (pea crabs, Pinnotheridae); living among the tentacles of sea cucumbers (sea cucumber crab, Portunidae), attaching varied invertebrates to their carapaces for camouflage (sponge crabs, Dromiidae; decorator crabs, Majidae); or holding anemones in their chelipeds for defense (boxer crabs, genus *Lybia*). Additional ecological and habitat notes, where available, are provided in Section IV.C.4.e., below.

Occurrence of the Taxon Within WPRFMC Fishery Management Units

American Samoa

A number of crabs that cause gall formation in corals are reported from Samoa. For example, Eldredge and Kropp (1981) discuss the occurrence of the crab, *Cymo* sp., that causes galls in *Acropora hyacinthus* growing at 1-5m depth. *Calcinus herbstii*, a coral-inhabiting hermit crab, is also known from Samoa (Edmondson 1923).

Gossliner et al. (1996) report several species of crabs from American Samoa, including *Emerita pacifica,* the mole crab (Hippidae); *Cryptodromia* cf. *coronata* (Dromiidae), a sponge decorator that places live sponge on its carapace; and a coral crab, *Trapezia wardi* (Xanthidae).

Commonwealth of Northern Mariana Islands (CNMI)

Asakura et al. (1994) collected 27 species of anomurans in the Northern Marianas. Among these was the coconut crab, *Birgus latro* (Coenobitidae). Its distribution includes most islands of the Marianas, including Guam, Saipan and Tinian.

Takeda et al. (1994) reported on the results of collections of crustaceans made during a survey of the remote islands of the Northern Marianas in 1992. The majority of the collections were from the rocky intertidal and high subtidal zones. Subtidal collections were from the 3m depth zone, usually on coral. The following families and genera of crabs, and number of species (in parentheses) were recorded:

Dromiidae: Cryptodromia (1); Dynomenidae: Dynomene (1); Majidae: Menaethius (1), Perinea (1), Tiarinia (1); Parthenopidae: Daira (1); Atelecyclidae: Kraussia (1); Portunidae: Charybdis (1), Thalamita (2); Xanthidae: Chlorodiaella (1), Forestia (1), Lachnopus (1), Leptodius (1), Liomera (1), Lophozozymus (1), Lybia (1), Macromedaeus (1), Paraxanthias

(1), Phymodius (1), Pilodius (2), Pseudoliomera (4), Xanthias (2); Menippidae: Dacryopilumnus (1), Epixanthus (1), Eriphia (1), Lydia (1), Ozius (1), Pseudozius (1); Pilumnidae: Nanopilumnus (1), Parapilumnus (1); Trapeziidae: Domecia (2), Tetralia (2), Trapezia (9); Ocypodidae: Ocypode (2); Grapsidae: Grapsus (2), Geograpsus (3), Pachygrapsus (2), Cyclograpsus (1), Plagusia (1), Percnon (1); Gecarcinidae: Cardisoma (1).

Guam

Several crabs (*Carpilius maculatus, Etisus dentatus, E. utilis, Calappa calappa* and *C. hepatica*) are among the species of shellfish sought by local fishermen (Green October 1997).

Hawaii (MHI and NWHI)

Eldredge and Miller (1995) state that nearly 200 species of crabs occur in Hawaii. Data concerning endemism is limited.

In a partial listing, Gossliner et al. (1996) indicate the following species found in Hawaii:

Anomura: *Aniculus maximus* (occurring in water up to 35m deep), *Dardanus gemmatus* (in waters to 15 m deep), *D. megistos;* Hippidae: *Emerita pacifica* (mole crab; sits submerged in sand and filter-feeds in intertidal wave zone); Calappidae: *Calappa calappa* (mollusks are principal diet), *C. hepatica* (mollusks are principal diet); Raninidae: *Ranina ranina* (found in sandy substrates); Dromiidae: *Dromia dormia* (carries sponge held over carapace by rear legs for camouflage); Majidae: *Huenia heraldica* (in 30m-deep waters with gorgonians), *Schizophrys aspera* (to 15m depth); Portunidae (swimming crabs): *Charybdis erythrodactyla* (feeds at night in waters 5-10m deep), *C. hawaiiensis* (on reef face at 10-20m depth), *Lissocarcinus laevis* (on anemones and soft corals; Xanthidae: *Carpilius maculatus* (in rocky areas 3-35m deep), *Etisus dentatus* (molluscivore found in waters to 15m deep), *Lybia edmondsoni* (endemic species; holds anemones in chelipeds), *Lophozozymus incisus* (occupies crevices on reef slopes), *Polydectus cupulifer* (camouflages with yellow anemones), *Trapezia wardi, Zosymus aeneas* (with poisonous flesh); Grapsidae: *Plagusia depressa, Percnon planissimum* (intertidal to subtidal)

Calcinus herbstii, a coral-inhabiting hermit crab, is the most common hermit crab on Oahu reefs (Edmondson 1923).

Other Sites

Edmondson (1923) reported 9 brachyuran families and 5 anomuran families from Palmyra Atoll and Fanning Island. Among the notable taxa reported are the following: *Carpilius maculatus* (dark-finger coral crab); 5 species of *Trapezia*; *Lissocarcinus orbicularis,* a swimming portunid crab; *Calappa spinosissima,* a box crab; *Petrolisthes speciosa,* a

porcellanid crab; *Calcinus herbstii*, a coral-inhabiting hermit crab also found at Wake Island, Samoa, and Hawaii.

Calappa hepatica (Calappidae) and *Brachycarpus biunguiculatus* (Palaemonidae) are among the species found at Wake Island (Gossliner et al. 1996; Hayashi et al. 1994).

Table II.B.1. Summary of post-embryonic development and larval types in Decapoda.[9]

Group	Postembryonic Development	Larvae
Suborder Dendrobranchiata		
Family Penaeidae	slightly metamorphic	nauplius > protozoea > mysis (zoea) > mastigopus (postlarva)
Family Sergestidae	metamorphic	nauplius > elaphocaris (protozoea) > acanthosoma (zoea) >mastigopus (postlarva)
Suborder Pleocyemata		
Infraorder Caridea	metamorphic	protozoea > zoea > parva (postlarva)
Infraorder Stenopodidea	metamorphic	protozoea > zoea > parva (postlarva)
Infraorder Palinura	metamorphic	phyllosoma (zoea) > puerulus, nisto, or pseudibaccus (postlarva)
Infraorder Astacidea	slightly metamorphic	mysis (zoea) > postlarva
Infraorder Anomura	metamorphic	zoea > glaucothoë [in pagurids], or grimothea (postlarva)
Infraorder Brachyura	metamorphic	zoea > megalopa (postlarva)

[9] After Waterman and Chace (T. H. Waterman [ed.]: Physiology of Crustacea, Vol. 1) *in* Barnes 1987.

Table II.B.2: Habitat description for Cephalopods (Class Cephalopoda).

	Egg	Larvae	Juvenile	Adult
Duration		N/A (no larval phase)	unknown	in many cases, cephalopods die shortly after spawning; 1-2 year life span is typical (e.g., 12-15 months after settling from planktonic juvenile phase in *Octopus cyanea*); *Nautilus* may live up to 10 years
Diet	yolk	N/A	in *Nautilus*, eggs hatch directly to juvenile phase; juveniles believed to start immediately scavenging and grazing	generally predators on fishes, shrimps, crabs and mollusks; *Nautilus* may scavenge upon crab and lobster molts
Distribution	•*Nautilus* may have a single annual egg laying season, peaking around October; a few (10-15) large (mean 29mm) eggs are produced by each female •*Euprymna scolopes* may have two reproductive periods per year •in other taxa (e.g., *Octopus cyanea*) no seasonality noted	N/A	*Euprymna scolopes* goes through a short (<1 week) planktonic juvenile phase	nautiloids may migrate into deeper waters in daytime, rise to shallower reef flats at night to feed
Location	octopods attach eggs to rocky recesses on the reef reef cuttlefish deposits eggs among branches of finger coral; other cuttlefish may attach eggs to seagrasses; *Euprymna scolopes* attaches eggs to dead coral reef squid attach eggs to rocks and coral *Nautilus* attaches egg capsules to hard substrate	N/A		*Octopus* spp. in American Samoa, CNMI, Guam, NWHI, MHI *Nautilus pompilius* is found in American Samoa, perhaps the easternmnost extension of its range reef squid and cuttlefish in CNMI, Guam *Euprymna scolopes* cuttlefish endemic to Hawaii *Sepioteuthis lessoniana* believed nearly extirpated in Hawaii
Water Column		N/A	in octopod species with smaller, less developed eggs, juveniles may be planktonic and then settle to benthic existence; other octopod species may not have planktonic phase juveniles of other cephalopods generally have a planktonic phase	interidal, high subtidal (e.g., octopods, *Euprymna*); mesopelagic (squids, cuttlefishes); 60-500m (nautiloids) nautiloids may migrate into deeper waters in daytime, rise to shallower reef flats at night to feed
Bottom Type		N/A		octopods mostly in holes and crevices in rocky or coral areas, but some types in burrows in sand; squid and cuttlefish over reefs or seagrass areas; *Euprymna scolopes* burrows in sand on shallow sand and mud flats
Oceanic Features	N/A	N/A		some reef-associated squids semi-pelagic

Table II.B.3: Habitat description for Tunicates (Class Ascideacea).

	Egg	Larvae	Juvenile	Adult
Duration	solitary forms release eggs to the water; in colonial forms, fertilization is internal and larvae, not eggs are released	"tadpole" larvae are non-feeding, and thus short-lived; larval phase may last from several minutes to a few days	rapid transition from larval to adult zooid phase, with no marked juvenile phase	typically 1-3 year life span
Diet	N/A	nutrition derived from yolk sac; some forms have endosymbionts that may contribute photosynthate product to the ascidian host as a food source	N/A	adults filter-feed non-selectively on phytoplankton and other suspended food particles and nutrients
Distribution	egg production occurs year-round	in some species studied (e.g., *Diplosoma similis*), larvae are released year-round		wide range of species known from most locations in the region; many species dispersed as fouling organisms transported on boat hulls
Location	eggs may be found in peribranchial cavity during embryonic development; in solitary forms, fertilization and subsequent development occurs outside the parent body	in colonial forms, larvae are typically held in the peribranchial cavity, or may be in a brood pouch or the basal test	N/A	range from high-light and high-energy environments (especially those forms with photosynthetic endosymbionts), to protected deeper-water areas
Water Column	N/A	larvae generally in same depth range as adults, approx. 0-100 m (or deeper); larvae in *Diplosoma similis* first swim up to enter layers with faster current, then swim down to settle on substrate	N/A	intertidal to 120 m depth or greater
Bottom Type	N/A	attach to dead corals, seaweeds, mangrove roots, other sessile invertebrates; favor attachment to darker surfaces with lower illumination	N/A	dead corals, seaweeds, mangrove roots, other sessile invertebrates; may also overgrow live coral
Oceanic Features	N/A	larvae in *Diplosoma similis* first swim up to enter layers with faster current, then swim down to settle on substrate	N/A	N/A (sessile attached organisms)

Table II.B.4: Habitat description for Bryozoans (Phylum Bryozoa or Ectoprocta).

	Egg	Larvae	Juvenile	Adult
Duration	approximately two weeks from fertilization to development and release of larva	two types: ●non-feeding coronate larvae: planktonic for a few hours ●feeding (cyphonautes) larvae develop in those forms that shed eggs directly to the sea (e.g., in *Membranipora*): cyphonautes may last several months	no distinct juvenile phase; following adhesion of larva to substrate, all larval organs undergo histolysis within approx. one hour from the onset of metamorphosis, forming ancestrula (first zooid of colony)	large colonies may add 2-4 cm growth annually and believed to live for ten years or more
Diet	in some species, developing embryo receives its nutrition from a contained yolk, but in others, placenta-like connections to the ovicell from the mother zooid may provide food material	cyphonautes larvae are planktotrophic; "non-feeding" types may take up dissolved organic nutrients (e.g., amino acids)		selective suspension-feeders that consume diatoms, bacteria, flagellates, and phytoplankton
Distribution				adult colonies may be transported as fouling organisms on ships' hulls; various species found throughout all sites in the region
Location	eggs may variously be: ●small sized, fertilized at the time of discharge into seawater (e.g., *Membranipora*); ●larger, brooded internally in coelomic cavity during embryonic development; ●brooded in specialized ovicells	may develop internal or external to parent zooid		usually found on shaded surfaces (e.g., undersides of coral tables)
Water Column		larvae are initially positively phototropic, and move upward in water column; later become negatively phototropic and move toward shaded areas (e.g., under stones or coral plates) prior to settlement		benthic sessile organisms occurring from intertidal to abyssal depths, but majority associated with substrates at 20-80m depth; preference for clear water free of suspended silt and sediment
Bottom Type		larvae highly selective in choosing attachment site; usually settle on rock, dead coral, seaweeds or wood		adults attached to rock, dead coral, seaweeds or wood
Oceanic Features		January thermal boundaries (e.g. 27 degree C isotherm may act as filtering mechanisms that determine larval distribution		steady water currents essential for successful filter-feeding function; however, waves may be destructive of delicate erect, branching or foliose colonies

Table II.B.5: Habitat description for Crustaceans (Class Malacostraca [in part]).[10]

	Egg	Larvae	Juvenile	Adult
Duration	30-40 days in lobster; 29 days in kona crab	•zoea larvae last up to 3 months in stomatopods •in penaeids, eggs hatch to the nauplius or metanauplius stage, last for a few weeks •in spiny lobster phyllosomae may last approx. 6 months to 1 year (shorter in other lobsters), metamorphose into pueruli which last 6 months, and after settling, post pueruli •brachyurans and anomurans hatch to zoea phase, develop into megalops and glaucothöe postlarvae, respectively	up to six years (in coconut crab)	most species several years; up to 50 years in coconut crab
Diet	N/A	generally planktivorous		various, but typically carnivorous or omnivorous predators or scavengers, with preferred food items being mollusks, other crustaceans, and small fish; some taxa are specialized cleaners that feed on ectoparasites, while others are filter feeders
Distribution	in spiny lobster spawning continuous throughout the year, with individual females spawning up to 4 times each year, producing up to 0.5 million eggs each spawning; other species may have more defined spawning seasons			all major groups known or assumed to be well-represented at all locations in the region (e.g., around 2,000 species of crabs are known from the region)
Location	in penaeid shrimps, eggs are shed directly to the water; in other decapod groups and in stomatopods eggs carried on the pleopods of the female			
Water Column		in lobsters, newly-hatched larvae may occur in upper 60m, but later larval stages may occur in deeper water (80-120m)		•stomatopods are generally subtidal from 5-70m depth •coral associated shrimps generally found in depths from 3-15m but may be found much deeper •lobsters generally occur in depths between 20-55m, but may occur to at least 110m •crabs may be terrestrial, intertidal, or subtidal to depths of at least 115m

[8] The MUS as defined here includes mantis shrimp (Order Stomatopoda), as well as shrimps, lobsters, and crabs (various taxa within the Order Decapoda). The taxa not already addressed under Amendment 10 of the *Crustacean Fisheries Management Plan* (which covers spiny lobsters and kona crab) are the primary emphasis here.

	Egg	Larvae	Juvenile	Adult
Bottom Type			juvenile spiny lobsters occupy habitat similar to that of adults	•stomatopods typically in burrows, either in sand or rubble •shrimp may stay buried in sand or live in pockets in coral or among rubble •lobsters typically in subtidal holes or crevices on reefs •crabs may occupy mud or sand bottom, corals, or rocky areas
Oceanic Features		palinurid larvae may be transported up to 2,000 miles by prevailing ocean currents		while some taxa are pelagic, these are generally not reef-associated

Table II.B.5: Economic importance of invertebrates.

FMU	Economic Importance				Distribution					
	Food	Ornamental	Bio-prospecting	Fouling Organism	AS	CNMI	GU	MHI	NWHI	Other
CEPHALOPODS:										
octopus	●	L			●	●	●	● R	● R	A
squid and cuttlefish	●				A	●	●	●	A	A
nautilus	L	●			●					
TUNICATES			●	●	A	●	●	●	●	●
BRYOZOANS			●	●	A	A	A	●	A	A
CRUSTACEANS:										
stomatopods	L	L			A	● R[11]	●	●	A	●
shrimps	●	●			A	● R[1]	●	●	●	●
lobsters	●	L			●	● R	●R	●R	●R	●
crabs	●	L			●	● R[1]	● R[12]	● R[13]	● R	●

L = Limited Use

A = Assumed to be Present; R = Regulated

[11] all invertebrates regulated (for export)

[12] coconut crab

[13] blue crab, Samoan crab

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Persons Contacted

Dr. Lucius Eldredge, Bernice P. Bishop Museum, Pacific Science Association

Dr. Gretchen Lambert, California State University, Fullerton

Dr. Bruce Carlson, Waikiki Aquarium

C. EFH for Management Unit Species – Sessile Benthos

The concept of essential fish habitat (EFH) is of obvious value when used as a tool to protect individual fisheries. It is defined as that habitat necessary for their various stages of managed species life histories to perpetuate. To consider the sessile benthos (SB) as required by the Interim Final Rule (IFR) for EFH, the concept must be qualified. This is because it is applied to broad groups of organisms, many of which form the habitat upon which all other species depend. Due to the large numbers of species of coral, algae and other sessile benthos (450 spp algae; 99 Scleractinia and 150 spp. of the other groups considered in Hawaii (Eldredge and Miller, 1995) and a total of approximately 1200 spp of the combined groups in the total AFPI), the concept loses definition and becomes too generalized to be of value. The vast numbers of SB do not represent a managed fishery. This is particularly the case when considering the benthos of coral and algae.

The fauna and flora, generally, lack mobility in the adult stages with the intermediate stages are transported in the water column until settlement. Once they have settled they largely become habitat. They are instrumental in the ecosystems primary production and are largely responsible for supporting the higher trophic levels, many with predator-prey relationships. The high degree of symbiosis begins with the zooxanthellate associations and encompasses a wide degree of associations involving all groups of the fauna and flora. Much of the physical relief of the reef is the result of the living environment as is the deposition of the coral reef itself. An overly simplistic assessment of the habitat requirements for the sessile benthos are suitable substrate, water quality and light. This, however, negates the history of the substrate development and the myriad of biological interactions, which qualify as a coral reef. Due to these considerations, the species and their fundamental roles in the ecosystem define the EFH as the coral reefs themselves. As such, all coral reefs in the AFPI should be designated EFH for the sessile benthos. This is because all of the coral reef associated fisheries for which the Magnuson-Stevens Fisheries Conservation and Management Act was designed to protect and conserve depend on the coral reef ecosystem.

As there is no fisheries extraction of the sessile benthos in the AFPI, the objective of the concept discussion shifts to the life history characteristics of the fauna and flora of the coral reef environment. It is the life history stages of the selected benthic groups that comprise the discussion of their importance in the EFH description. It is important in the consideration of the management unit species (MUS).

Life histories and habitat requirements rely on an understanding that the coral reef is a variable and dynamic entity. The composition of the reefs responds to environmental parameters such as temperature, dilution and sedimentation. Regionally, their composition varies in response to temperature by virtue of latitude, current regimes and events brought on by unique climatic events such as El Nino hot spots. Such major discontinuities in taxa occurrence such as the absence of the genus *Acropora* in Hawaii or reef cementing coralline alga in extra-tropical areas, require that we consider reefs on a regional basis, as well as, locally. The history of a particular area is as important as short-term community cycles and is often seen to be decadal in time frame, and most probably represents longer cycles. The fossil record of reefs shows a process of progressive change in the nature of reefs. Current concern for global warming and the effects of some of the hotspots may require this to be added to the equation, when human induced impacts are considered.

The interconnectivity of the coral reef, in terms of potential recruitment, provide us with an understanding of the reef environment that is at once very robust and able to restore itself after the most destructive natural events. The coral reef is fragile, in that, if the composition of a reef is changed then the effect is likely to be manifest down current as well. A chronic change in the environmental parameters of an area is likely to result in a permanent change in the community composition. In summary, EFHs are not a useful concept for the numerous sessile benthos at the species level but rather a conformation of the importance of the many non-commercial species that comprise the coral reef ecosystem. In developing this as an operational framework, Conservation of these broad groups may be accomplished in two ways. 1) It may be appropriate to establish criteria for the amount of reef that is allowed to be affected by development, fishing practices or tourism. This quantity would be established in relation to the amount of area of unaffected reef, within the range of the ocean currents that would allow restoration or maintenance of this area through recruitment. 2) Equally useful is the concept of the *management unit species (MUS)* in making the description of the ecosystem more manageable with better resolution in its definition. Here generic assemblages or their interactions are considered entities, which allow a more categorical method of management.

The Management Unit Species (MUS): An Ecosystem Approach

The concept of the management unit species (MUS) is a useful concept when considering a resource composed of species or higher taxa who share the same habitat, have the same trophic ecology or respond to changing environmental variables in a predictable way. Coral reef zonation, as the result of an environmental regime, reflects a natural MUS organization. Whether through tolerance or requirement, benthos is sorted into a zonation with respect to the proximity to land, depth or wave action. Impacts which add nutrients, as the result of some human activity, to a naturally low-nutrient coral reef and the community changes from being micro-algal and coral dominated, to being macro-algal and with a great reduction in the hard coral component. In the case of increases in sediments and freshwater, there is a reduction in species numbers in both groups to those which are resistant to such effects. Tidal influences of periodic exposure, ponded waters or exposure to wave action have a dramatic effect in conditioning species compliments.

The MUS may be defined in relation to the environmental variables, be it natural or induced. With respect to this, taxonomic classification does not conform to groupings by environmental tolerances. As a result, a wide range of taxonomic groups is considered depending on the type of organism. This section describes these groups as general taxonomic entities. Depending on the availability of information or scale of consideration, in an operational sense, the appropriate taxonomic level should be used. As an example, *Porites/Favid* assemblages are characteristic of areas of periodic flooding. *Acropora* assemblages and a micro-algal assemblage are characteristic of normal seawater salinity with clear, flowing aerated water. Add wave action to this and the coral assemblages become reduced in diversity and morphology characterized by robust or encrusting forms. Coralline alga dominated. The dynamic potential inherent in coral reef communities becomes apparent with a change in the environment as the result of some change in a natural parameter resulting from development or terrestrial activity.

In conforming to the MUS approach, using the general taxonomic groupings of sessile benthos was considered for designations of the MUS. Within these groups species can be clumped based on

selection by environmental parameters. Suggested divisions are the hard and soft coral and the micro and macro-alga. Other benthic groups of reef associated organisms (*Porifera, Actinaria, Hydroidea, Gorgonacea and Zooanthidea*), generally, are less dominate in reef communities and more liable to conform, in terms of abundance, to the dominance exhibited by the primary groupings. In terms of the reef community composition, these more minor groups are largely coral or algal associated with the type and abundance of coral or alga conditioning their occurrence. It is useful to consider the light limited environments of depth or caves where the groups such as the *Gorgonacea* and *Porifera* may be dominant.

It would be in error not to emphasize considering the regionality of such a framework. The Caribbean and Florida seaboard are very different than the Indo-Pacific. Within the Indo-Pacific, species occurrence, generally, winnows from west to east and is limited when approaching the temperate boundaries. As a result, geographic locations may vary in terms of their species complements. This gives rise to variability in dominance but does not change the relationship within the four major groupings. The species within the groupings become less consequential, varying in dominance depending on the region.

Habitat Areas of Particular Concern (HAPC)

Habitat areas of particular concern for the benthos of coral reefs may include a variety of situations. These may be the same as those which give rise to marine protected areas or where a conservation area has been set aside to protect organisms which may have been depleted through fishery harvest. Particular concern may be for an area where coastal development has adversely impacted near shore areas. With respect to this, it may be that areas within ocean current range should be protected to conserve areas which are unprotectable due to a requirement for subsistence fishing, recreational usage, damage done by circumstances of coastal development or activities inland such as agriculture. It may be that an area is of concern due to the long history of research at a particular site or area and the encroachment of development (e.g. Pago Pago Harbor, American Samoa). Reserves, national parks, wildlife refuges and other protected areas are existing operational areas of particular concern.

1. Algae

Algal Life Cycles

Both sexual and asexual reproduction are widespread in algae, and the predominance of one or the other is mainly linked to the class of algae in question (Cyanobacteria, Chlorophyta, Phaeophyta or Rhodophyta) and the predominant geographical and environmental conditions affecting the algal populations (Bold and Wynne, 1985). Unicellular algae reproduce mainly asexually, while multicellular algae have asexual or sexual life cycles of varying complexity. Sexual life cycles are classified into four basic types, according to the site of meiosis or reduction-division of the algal genome (table I). By far the most common type is the sporic life cycle, in which a usually diploid sporophyte stage alternates with a usually haploid gametophyte stage. The recurring sequence of these two stages is called alternation of generations, which can be either isomorphic (when both generations are morphologically similar) or heteromorphic (where one generation can differ markedly in morphology from the other).

Table II.C.1: Classification of sexual algal life cycles (after South and Whittick, 1987)

Life cycle type	Site of meiosis	Main algal groups concerned
Zygotic	zygote	Unicellular algae (Chrysophyceae)
Sporic	sporangia	Rhodophyta, Phaeophyta, Chlorophyta
Gametic	gametangia	Chlorophyta
Somatic	thallus cells	Chlorophyta, Rhodophyta

Cyanophyta

In the Cyanophyta, reproduction is primarily by the production of asexual spores, which are released into the environment and grow into new individuals. These spores can be produced by budding from the free ends of the filaments, or by the fission of large vegetative cells within the thallus.

Phaeophyta

In most members of the Phaeophyta, sexual reproduction is sporic, with the alternation of a haploid gametophyte generation with a diploid sporophyte generation; both generations may or may not be morphologically similar. Spores are usually numerous and motile, being produced in unilocular sporangia.

Chlorophyta

The Chlorophyta life cycle is variable, but a typical case can be demonstrated in the common genera *Ulva*, where zoospores are produced in the thallus which are released and fuse to produce a new individual.

Rhodophyta

Most members of the Rhodophyta exhibit a sporic life cycle, a majority of which are of the triphasic *Polysiphonia*-type. The gametophytes and the tetrasporophyte are often isomorphic (although in some algae the tetrasporophyte can be crustose and alternate with large fleshy gametophytes). The Carposporophyte is reduced, and attached to the female gametophyte. The gametes are non-motile.

Distribution patterns of algae amongst the American Flag Pacific Islands (AFPI) (with nomenclature updated (following taxonomy in Silva *et al.* 1996), from available literature; excludes varietal status of species). The attached AFPI algae distribution table lists 815 taxa of marine algae, statistically broken down as follows:

Table II.C.2: Algae distribution in the American Affiliated Pacific Islands (AFPI)

AFPI locality	Cyanophyta	Chlorophyta	Phaeophyta	Rhodophyta	Total
American Samoa	15	31	14	68	128
Baker Is.	1	6	3	6	16
Howland Is.	0	5	1	3	9
Jarvis Is. [1]	-	-	-	-	-
Palmyra Is.	19	39	11	64	133
Kingman Reef [1]	-	-	-	-	-
Johnston Atoll	19	24	9	40	92
Hawaii [2]	3	48	29	343	423
NWHI	0	43	32	121	196
Wake Island	2	8	10	3	23
CNMI	5	55	20	57	137
Guam	16	58	29	98	201
Total	52	142	70	333	

[1] no data available at this time

[2] Abbott (1995) estimates the total Hawaiian flora at about 400 species

Comments

Because the reported distribution is related to the sampling effort in each particular locality, the comparisons are largely artificial at this stage. For instance, the Guam and North West Hawaiian floras are fairly well-known, while the Jarvis Is., Kingman Reef, Wake Is, Baker and Howland Islands floras are seriously under-collected or unknown. For the Hawaiian flora, there is a large amount of as yet unpublished material which will drastically increase the number of known species in the near future (Abbott 1995).

The most comparable groups of algae are the Phaeophyta and Chlorophyta, because they are mostly intertidal in habitat and thus most easily collected and inventoried, and there is a relatively constant number of common species across the AFPI islands for the better investigated localities.

Distribution Among Islands

From an examination of the species distribution table, the most commonly reported species (those which occur in 50% or more of the localities under study) for the islands of the AFPI are as follows, according to class:

Table II.C.3: Most commonly reported species for the islands of the AFPI

Class	Most common species	Typical reef habitat
Cyanophyta	*Lyngbya majuscula*	inner reef flat
	Schizothrix calcicola	inner reef flat
Chlorophyta	*Boodlea spp.*	inner / outer reef flat
	Bryopsis pennata	inner reef flat / lagoon
	Caulerpa racemosa	inner / outer reef flat
	Caulerpa serrulata	inner reef flat / lagoon
	Dictyosphaeria spp.	inner reef flat / lagoon
	Halimeda discoidea	inner reef flat
	Halimeda opuntia	inner reef flat
	Neomeris annulata	inner reef flat
	Ventricaria ventricosa	reef flat / outer reef slope
Phaeophyta	*Dictyota friabilis*	reef flat
	Feldmannia indica	reef flat
	Hincksia breviarticulata	reef crest / exposed shoreline
	Lobophora variegata	reef flat / lagoon
	Sphacelaria spp.	reef flat / epiphytic
	Turbinaria ornata	reef flat / bommies in lagoon
Rhodophyta	*Amphiroa fragilissima*	inner reef flat
	Asparagopsis taxiformis	reef crest / outer reef slope
	Centroceras clavulatum	reef flat / epiphytic
	Gelidiopsis intricata	inner reef flat / lagoon
	Gelidium pusillum	inner reef flat
	Hydrolithon reinboldii	reef crest
	Hypnea esperi	inner reef flat
	Jania capillacea	reef flat
	Martensia fragilis	outer reef slope
	Neogoniolithon brassica-florida	reef crest
	Polysiphonia spp.	reef flat
	Porolithon onkodes	reef crest
	Portieria hornemanni	outer reef slope

Habitat distribution of the common algal species in the AFPI (After N' Yeurt, 1999)

The Flora of Fringing Reefs

In shallow, calm fringing areas where sediment accumulations are predominant, green and brown algae are most abundant with the most characteristic species being *Caulerpa spp.*, *Chlorodesmis fastigiata*, *Halimeda spp.*, *Neomeris spp.*, *Ventricaria ventricosa* and *Boodlea spp.* for the greens, and *Padina spp.* and *Dictyota spp.* for the browns. Common red algae include *Galaxaura* spp. and *Laurencia* spp. When water depth and movement are more important, hard substrata (coral colonies and rubble) are more numerous and ubiquitous species such as *Turbinaria spp.* and *Sargassum spp.* thrive. In very exposed places, the marine scenery is generally rocky or limited to small shelves below the border road. The violent wave action increases sea spray and enables the rise of certain species notably the two brown algae *Chnoospora minima* and *Hincksia breviarticulata*. On this type

of shelf we generally find the flora of external reef shelves described later, confined to a few square meters owing to the intensity of the hydrodynamic factors such as wave action.

The Flora of the Barrier Reef

On barrier reefs, coral bommies are generally dominant, between which are spread out well sorted-out sediments. The pavement of the lagoon floor is visible in areas of strong hydrodynamism. Water level rarely exceeds 2.5 m. The flora is essentially one of hard substrata, and species exist in close link with the coral colonies, resulting in a mosaic pattern of species distribution. The summit of coral bommies skimming the water surface are generally colonised by the large brown algae *Turbinaria ornata* and *Sargassum spp.*, that form an elevated layer under which grow species such as *Amansia sp.*, and coralline algae. In areas where grazing by herbivores is more important, the bommies are covered by a fine tuft where a great number of discrete species belonging to the Ceramiaceae and Rhodomelaceae intermingle. In areas where hydrodynamism is more important, the encrusting coralline algae form pinkish, yellowish and bluish blotches on the upper parts of the substratum.

At the base of bommies, it is common to see large bunches of brown algae such as *Dictyota bartayresiana*, intermingled to the spread-out thalli of *Halimeda opuntia* and tufts of the red algae *Galaxaura fasciculata* and *G. filamentosa*. Most crevices are colonised by *Ventricaria ventricosa*, *Valonia fastigiata*, and *Dictyosphaeria spp.* Finally, where direct sunlight does not reach, live a range of encrusting coralline algae whose pink, violet and purple hues mingle with the soft green colours of *Halimeda spp.* and *Caulerpa spp.*

The Flora of the Outer Reef Flats

It is probably the richest and most diversified flora of the reef complex. On high islands, it is represented by a belt of the brown algae *Turbinaria ornata* and *Sargassum spp.*. We find in particular the erect and stiff tufts of *Laurencia spp. and Gelidiella spp.*, to which are attached the little bright green balls of *Chlorodesmis fastigiata*, or the light pink hemispherical cushions of the articulated Corallinaceae *Amphiroa spp.* and the opportunistic *Jania spp.* It is here that the encrusting calcified algae form the most important growths, with notably *Hydrolithon* spp. However, it is on the reef flats of atolls that Corallinaceae formations are the most exuberant. They form a compact pad of a beautiful brick-red colour, and in very exposed places even construct spectacular corbellings several tens of centimetres thick. The dominant species is *Hydrolithon onkodes* with a rather smooth texture. On atolls, large brown algae are absent and the fleshy species are limited to yellowish-brown rosettes of *Lobophora variegata* and *Turbinaria spp.*

The Flora of the Lagoons of Atolls

The sandy bottoms of the lagoons are often in deeper parts, covered with a mucous film rich in bacteria or of a carpet of Cyanobacteria where mingle tufts of filamentous red algae such as *Polysiphonia*, *Ceramium*. The hard substrata are always much richer in various green algae such as *Caulerpa* and *Halimeda*. Bommies in the lagoon offer a habitat for green genera such as *Cladophoropsis spp.* and very large varieties of *Dictyosphaeria cavernosa*.

The Flora of the Outer Reef Slope

It extends beyond 10 meters depth. The red algae are most abundant and diversified. It is the main area of encrusting coralline algae (mainly in the atolls), but also of elegant and fleshy forms such as *Gibsmithia hawaiiensis* and *Asparagopsis taxiformis*. As one goes deeper, coralline algae become the dominant species, although occasionally species of the green algal genus *Halimeda* and the brown algal genus *Lobophora* have been found up to depths of 130 metres (Littler *et al.* 1985) while the green alga *Caulerpa bikinensis* has been reported beyond depths of 70 metres (Meinesz *et al.* 1981).

The Ecological Role of Algae in the Coral Reef Ecosystem

Benthic algae are a very important, yet often overlooked component of any reef biome. Marine plants are responsible for the primary productivity of the reef ecosystem, owing to their photosynthetic ability which inputs solar-derived energy into the reef community. This energy is made available to other reef organisms in a variety of forms, ranging from direct input (grazing by hervibores; symbiotic relationships with invertebrates and fungi) or indirectly by the breaking down of plant products and detrital residues after death.

Algae play an important role in organic and inorganic material cycles within the reef community, by being able to retain and uptake key elements such as nitrogen and carbon. The primary role of marine algae in the carbon and nutrient cycles of coral reef ecosystems cannot be underestimated and has been the focus of much research (Dahl 1974; Wanders 1976; Hillis-Colinvaux 1980; Payri 1988; Charpy and Charpy-Roubaud 1990; Charpy-Roubaud and Sournia 1990; Charpy-Roubaud *et al.* 1990, Charpy *et al.* 1992; Gattuso *et al.* 1996).

Calcified (*Halimeda* and *Amphiroa spp.*) and crustose coralline algae play a major but easily overlooked role in coral reef construction and consolidation, and contribute a major part of reef carbonate sediments (Payri 1988). These organisms lay down calcium carbonate as calcite, which is much stronger than the brittle aragonite produced by corals, thus cementing and consolidating the reef structure. In particular, coralline algae are of primary importance in constructing the algal ridge that is characteristic of exposed Indo-Pacific reefs, which prevent oceanic waves from striking and eroding coastal areas (Nunn 1993; Keats 1996). At the other extreme, penetrating or boring algae such as Cyanophyta are important contributors to bioerosion and breakdown of dead reef structures (Littler and Littler 1994).

Marine macroalgae contribute significantly to organism interrelationships in reef ecosystems, either by the production of chemical or structural by-products on which other organisms depend, the providing of protective micro-habitats for other species of algae or marine invertebrates, or by offering surfaces promoting the settlement and growth of other algal species or the larvae of some herbivorous invertebrates such as abalone (Dahl 1974; Keats 1996). Symbiosis is also an important aspect of algal interrelationships in reef communities, with hermatypic corals relying on photosynthetic zooxanthellae for food. Marine plants thus offer a remarkable potential as experimenting organisms in the elucidation of the complex chemical and biological interactions that make up the fragile, closed ecosystems of tropical coral reefs (Littler and Littler 1994).

The Effects of Human Activities on Coral Reefs, in Relation to Algae

The impact of human habitation, and activities linked to industries and waste processing and disposal have proven negative impacts on coral reef ecology. An "healthy ecosystem" is a self-regulating unit where ecological productivity and capacity is maintained, with a diversity of flora and fauna present (Federal Register 1997: 66551). Some reef organisms are very sensitive to disruptions, and can act as timely indicators of changes in the natural balance of the ecosystem. For instance, the absence of *Acropora* coral on the backreef areas could indicate polluted waters with high levels of siltation, a situation reported from the stressed Aua Reef on Tutuila Island, American Samoa (Dahl and Lamberts 1977). The green algae *Enteromorpha* spp. and *Ulva* spp. thrive in high-nutrient areas, acting as bio-indicators of organic pollution linked to sewage outfalls, and also accumulate heavy metals present in industrial effluents (Tabudravu 1996). Dredging and increasing reclamation of coastal mangrove for industrial and urban use further contribute to siltation of the lagoon and the destruction of algal habitats and marine nursery areas. In this respect, algae can be classified as essential fish habitats (EFH) as they are direct contributors to the well-being and protection of fish species, both as a source of food and offering protection to larvae and small fish species. Overfishing in the lagoon reduces the number of herbivorous fishes, destroying the fragile equilibrium between reef organisms, while the input of excess nutrients via sewage and domestic effluents into the lagoon contributes to algal blooms. This can lead to the ecosystem shifting from coral dominance to algal dominance, and abnormal blooms of turf algae have been known to overgrow and kill healthy coral (Dahl 1974; Littler and Littler 1994) while >red tide= dinoflagellate blooms lead to anoxic conditions killing a wide range of marine organisms (Horiguchi and Sotto 1994). Increased chemical pollution of the lagoon could also lead to a bloom of reef-destroying organisms such as the crown-of-thorn starfish (Randall 1972).

Coral reefs have been known to recover relatively well if the stressing factors are removed soon enough before permanent damage is done (Dahl and Lamberts 1977). A strong and healthy barrier reef, in particular the *Porolithon* algal ridge of atolls, acts as a natural breakwater offering protection to coastal areas in the event of cyclones and such natural disasters, which are frequent in the region (Nunn 1993). However, the coral structure can be severely damaged and weakened as a result of siltation, eutrophication and the overgrowing of coral colonies by opportunistic filamentous algae (such as for instance happened in Kaneohe Bay, Hawaii; see Smith 1981), necessitating the construction of artificial barriers.

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Table II.C.4: Algal species occurrence in the AFPI.

AS: American Samoa; PA: Palmyra Atoll; JA: Johnston Atoll; MHI: Main Hawaiian Islands; NWHI: Northwestern Hawaiian Islands; WA: Wake Atoll; CNMI: Commonwealth of Northern Mariana Islands; GU: Guam

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Division Cyanophyta (Blue-green)												
Anacystis dimidiata							X					
Aphanocapsa grevillei	X											
Arthrospira brevis												X
Arthrospira laxissima	X											
Calothrix aeruginosa					X							
Calothrix confervicola												X
Calothrix crustacea							X				X	X
Calothrix pilosa												X
Calothrix scopulorum							X					
Chroococcus turgidus					X							
Entophysalis conferta					X							X
Entophysalis deusta							X					X
Hormothamnion enteromorphoides							X	X				X
Hormothamnion solutum					X							X
Hydrocoleum lyngbyaceum							X					
Hyella caespitosa	X											

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Isactis plana							X					
Lyngbya aestuarii					X		X					
Lyngbya confervoides					X		X					
Lyngbya gracilis					X							
Lyngbya infixa					X							
Lyngbya lutea							X					
Lyngbya majuscula	X				X		X	X		X	X	
Lyngbya pygmaea	X											
Lyngbya rivulariarum					X							
Lyngbya semiplana					X							
Lyngbya sordida					X							
Microchaete vitiensis	X											
Microcoleus chthonoplastes					X		X					
Microcoleus lyngbyaceus	X										X	X
Microcoleus tenerrimus							X					
Microcoleus vaginatus							X					
Oscillatoria bonnemaisonii					X							
Oscillatoria lutea												X
Oscillatoria nigro-viridis							X					
Oscillatoria submembranacea												X
Phormidium corium					X							

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Phormidium crosbyanum										X		
Phormidium penicillatum					X							
Phormidium submembranaceum					X		X					
Porphyrosiphon notarisii												X
Radaisea sp.	X											
Schizothrix calcicola	X	X					X				X	X
Schizothrix mexicana	X										X	X
Scytonema figuratum	X											
Scytonema hofmannii	X											X
Scytonema stuposum	X											
Spirulina major					X							
Spirulina subsalsa												X
Spirulina tenerrima							X					
Symploca atlantica							X					
Symploca hydnoides	X				X			X				
Symploca muscorum	X											
Division Chlorophyta (Green)												
Acetabularia clavata							X	X				
Acetabularia exigua											X	

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Acetabularia moebii							X	X	X		X	
Acetabularia tsengiana							X					
Acetabularia sp.							X					
Anadyomene wrightii					X						X	X
Avrainvillea erecta												X
Avrainvillea lacerata					X							
Avrainvillea obscura											X	X
Avrainvillea pacifica												X
Boergesenia forbesii											X	X
Boodlea coacta											X	X
Boodlea composita					X		X	X	X			X
Boodlea vanbosseae	X				X				X		X	X
Bornetella oligospora											X	
Bornetella sphaerica								X	X			
Bryopsis harveyana	X											
Bryopsis hypnoides									X			
Bryopsis pennata	X				X		X	X	X		X	X
Bryopsis plumosa											X	X
Bryopsis pottsii	X											
Bryopsis sp.								X				
Caulerpa ambigua					X		X	X	X		X	

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Caulerpa cupressoides										X	X	X
Caulerpa elongata											X	
Caulerpa fastigiata											X	
Caulerpa filicoides											X	X
Caulerpa lentillifera								X				X
Caulerpa lessonii												X
Caulerpa okamurai											X	X
Caulerpa peltata	X								X	X	X	X
Caulerpa plumaris												X
Caulerpa racemosa	X						X	X	X		X	X
Caulerpa serrulata			X		X			X	X	X	X	X
Caulerpa sertularioides								X			X	X
Caulerpa taxifolia								X	X		X	X
Caulerpa urvilliana					X		X				X	X
Caulerpa vickersiae					X						X	
Caulerpa verticillata								X				X
Caulerpa webbiana								X	X		X	X
Chaetomorpha antennina	X							X	X			
Chaetomorpha indica								X				X
Chaetomorpha restricta	X											
Chamaedoris orientalis												X

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Chlorodesmis fastigiata	X											X
Chlorodesmis hildebrandtii					X			X	X		X	X
Cladophora crystallina					X		X					
Cladophora fascicularis								X				
Cladophora glomerata	X											
Cladophora inserta					X							
Cladophora patentiramea					X							X
Cladophora patula								X				
Cladophora pinniger	X											
Cladophora socialis					X				X			
Cladophora vagabunda									X			
Cladophora sp.		X			X			X	X	X		
Cladophoropsis fascicularis											X	
Cladophoropsis gracillima		X	X		X							
Cladophoropsis infestans	X											
Cladophoropsis limicola	X											
Cladophoropsis luxurians								X				
Cladophoropsis membranacea								X			X	X
Cladophoropsis sundanensis					X			X				
Cladophoropsis sp.							X					
Codium arabicum							X	X	X			

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Codium dichotomum								X				
Codium edule								X	X		X	
Codium geppiorum	X				X							
Codium mamillosum								X	X			
Codium ovale												
Codium phasmaticum								X				
Codium reediae								X	X			
Codium spongiosum								X				
Codium tomentosa												X
Codium sp.							X		X			
Derbesia attenuata					X							
Derbesia marina					X		X					
Derbesia ryukiuensis					X							
Derbesia sp.							X					
Dictyosphaeria cavernosa		X	X		X			X	X	X	X	
Dictyosphaeria versluysii	X	X			X		X	X	X		X	X
Enteromorpha clathrata	X				X							X
Enteromorpha compressa												X
Enteromorpha flexuosa	X											
Enteromorpha intestinalis	X				X			X	X			
Enteromorpha kylinii		X			X		X					

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Enteromorpha prolifera	X											
Enteromorpha tubulosa					X				X			
Enteromorpha sp. 1									X			
Enteromorpha sp. 2									X			
Enteromorpha sp. 3									X			
Enteromorpha sp.								X				
Halimeda copiosa									X		X	
Halimeda cuneata											X	X
Halimeda cylindracea											X	
Halimeda discoidea	X				X		X	X	X		X	X
Halimeda fragilis					X							
Halimeda gigas												X
Halimeda gracilis					X						X	X
Halimeda incrassata	X										X	X
Halimeda lacunalis											X	
Halimeda macroloba	X										X	X
Halimeda macrophysa											X	
Halimeda opuntia	X				X				X	X	X	X
Halimeda tuna							X		X		X	X
Halimeda velasquezii									X			
Halimeda spp.			X									

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Microdictyon japonicum								X	X			
Microdictyon pseudohaptera					X						X	X
Microdictyon setchellianum							X	X	X			
Neomeris annulata	X							X	X	X	X	X
Neomeris bilimbata					X							
Neomeris dumetosa											X	X
Neomeris vanbosseae								X				
Ostreobium quekettii	X						X					X
Palmogloea protuberans							X					
Phaeophila dendroides					X							
Phaeophila engleri					X							
Phyllodictyon anastomosans								X	X			X
Pseudobryopsis oahuensis								X				
Pseudochlorodesmis furcellata											X	X
Pseudochlorodesmis parva							X					
Rhipidosiphon javensis								X	X		X	
Rhipilia geppii					X							
Rhipilia orientalis										X		
Rhipilia sinuosa												X
Rhizoclonium hieroglyphicum	X											
Rhizoclonium implexum	X				X							

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Rhizoclonium samoense	X											
Rhizoclonium tortuosum												X
Siphonocladus tropicus								X				
Spongocladia vaucheriaeformis											X	X
Struvea delicatula											X	
Struvea tenuis											X	X
Tydemannia expeditionis	X										X	X
Udotea argentea											X	X
Udotea indica											X	
Ulva fasciata		X	X					X	X			
Ulva reticulata								X				
Ulva rigida									X			
Ulva sp.									X			
Valonia aegagropila								X	X		X	X
Valonia fastigiata	X											X
Valonia trabeculata								X				
Valonia utricularis					X						X	X
Ventricaria ventricosa	X						X	X	X		X	X
Zygomitis sp.					X							
Division Phaeophyta (Brown)												

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Chnoospora implexa								X				X
Chnoospora minima	X							X	X			X
Colpomenia sinuosa								X	X			X
Dictyopteris australis								X	X			
Dictyopteris plagiogramma								X	X	X		
Dictyopteris repens	X								X	X	X	X
Dictyota acutiloba								X	X			
Dictyota bartayresiana								X			X	X
Dictyota cervicornis												X
Dictyota crenulata									X			
Dictyota divaricata					X			X	X	X	X	X
Dictyota friabilis	X		X		X			X	X			
Dictyota hamifera											X	
Dictyota lata	X											
Dictyota patens											X	X
Dictyota sandvicensis								X				
Dictyota sp.							X		X			
Dictyota sp. 1										X		
Dictyota sp. 2										X		
Dilophus radicans												X

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Ectocarpus vanbosseae	X											
Ectocarpus sp.					X		X					
Endarachne binghamiae								X				
Feldmannia indica	X	X			X		X		X		X	X
Feldmannia irregularis					X		X					
Hapalospongidion pangoense	X							X				X
Hincksia breviarticulata	X						X	X	X	X	X	
Hincksia conifera									X			
Hincksia mitchelliae									X			
Homoeostrichus flabellatus											X	
Hormophysa triquetra											X	
Hydroclathrus clathratus								X	X		X	X
Lobophora papenfussii					X							
Lobophora variegata					X		X	X	X	X	X	X
Nemacystus decipiens									X			
Padina australis								X				
Padina boergesenii									X			
Padina crassa									X			
Padina gymnospora												X
Padina japonica								X	X			
Padina jonesii											X	X

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Padina pavonia								X		X		X
Padina tenuis											X	X
Padina thivyi								X				
Padina sp.										X		
Ralfsia occidentalis								X				
Rosenvingea intricata								X			X	X
Sargassum anapense	X											
Sargassum crassifolium												X
Sargassum cristaefolium											X	X
Sargassum echinocarpum								X	X			
Sargassum fonanonense	X											
Sargassum hawaiiensis									X			
Sargassum microphyllum											X	
Sargassum obtusifolium								X	X			
Sargassum piluliferum									X			
Sargassum polycystum												X
Sargassum polyphyllum								X	X			
Sargassum tenerrimum												X
Sargassum sp.									X			
Spatoglossum solierii								X				
Sphacelaria ceylanica	X											

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Sphacelaria cornuta	X											
Sphacelaria furcigera	X				X		X	X				X
Sphacelaria novae-hollandiae					X		X	X	X			X
Sphacelaria rigidula									X			
Sphacelaria tribuloides							X		X			X
Sphacelaria sp.		X			X						X	
Sporochnus dotyi									X			
Stypopodium hawaiiensis								X	X		X	
Turbinaria condensata												X
Turbinaria ornata	X	X						X	X	X	X	X
Turbinaria trialata					X						X	X
Zonaria hawaiiensis												X
Division Rhodophyta (Red)												
Acanthophora pacifica								X				
Acanthophora spicifera								X			X	X
Acrochaetium actinocladium								X				
Acrochaetium barbadense								X				
Acrochaetium butleriae								X				
Acrochaetium corymbifera								X				

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Acrochaetium dotyi								X				
Acrochaetium gracile					X							
Acrochaetium imitator								X				
Acrochaetium liagorae								X				
Acrochaetium microscopicum								X				
Acrochaetium nemalionis								X				
Acrochaetium robustum					X			X				
Acrochaetium seriatum								X				
Acrochaetium trichogloeae								X				
Acrochaetium sp.									X			
Acrosymphyton taylorii								X				
Actinotrichia fragilis	X							X			X	X
Actinotrichia robusta											X	
Aglaothamnion boergesenii								X		X		
Aglaothamnion cordatum								X	X			
Ahnfeltiopsis concinna								X				
Ahnfeltiopsis divaricata												
Ahnfeltiopsis flabelliformis												
Ahnfeltiopsis pygmaea												
Alsidium cymatophilum								X				
Alsidium pacificum					X							

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Amansia glomerata									X			X
Amphiroa anceps	X											
Amphiroa beauvoisii								X	X			
Amphiroa crassa	X											
Amphiroa foliacea	X							X				X
Amphiroa fragilissima	X							X	X		X	X
Amphiroa rigida								X				
Amphiroa valonioides								X				
Amphiroa sp.							X					
Anotrichum secundum	X							X				
Anotrichum tenue								X				
Antithamnion antillanum					X		X	X				
Antithamnion decipiens								X	X			
Antithamnion erucacladellum								X				
Antithamnion nipponicum								X				
Antithamnion palmyrense					X							
Antithamnion percurrens								X				
Antithamnion sp.									X			
Antithamnionella breviramosa								X	X			
Antithamnionella graeffei								X				
Apoglossum gregarium								X				

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Ardreanema seriospora								X				
Arthrocardia sp.								X				
Asparagopsis taxiformis	X				X			X	X		X	X
Asterocystis ornata					X		X					
Balliella repens								X				
Bangia atropurpurea								X	X			
Bostrychia tenella	X											
Botryocladia skottsbergii								X			X	
Botryocladia tenuissima								X				
Branchioglossum prostratum								X				
Callidictyon abyssorum								X				
Callithamniella pacifica								X				
Callithamnion marshallensis							X					
Callithamnion sp.							X		X			
Calloglossa leprieurii					X		X					
Calloglossa viellardii	X											
Caulacanthus ustulatus								X				
Carpopeltis bushiae												
Centroceras clavulatum	X				X		X	X	X		X	X
Centroceras corallophilloides								X				
Centroceras minutum					X			X				X

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Ceramium aduncum								X				
Ceramium affine							X		X			
Ceramium borneense								X				
Ceramium byssoideum	X											
Ceramium cingulum								X				
Ceramium clarionense					X			X	X			
Ceramium codii					X			X				
Ceramium dumosertum								X				
Ceramium fimbriatum							X	X				
Ceramium flaccidum								X	X			
Ceramium gracillimum		X			X		X					
Ceramium hamatispinum								X	X			
Ceramium hanaense								X				
Ceramium jolyi								X				
Ceramium masonii					X							
Ceramium maryae							X					
Ceramium mazatlanense	X							X	X		X	
Ceramium paniculatum								X				
Ceramium punctiforme	X							X				
Ceramium serpens					X			X				
Ceramium taylori					X							

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Ceramium tenuissimum								X				
Ceramium tranquillum								X				
Ceramium vagans					X		X	X				X
Ceramium womersleyi								X				
Ceramium zacae							X					
Ceramium sp.		X			X		X		X			
Ceratodictyon spongiosum											X	
Chamaebotrys boergesenii								X				
Champia compressa	X											X
Champia parvula							X	X	X			X
Champia vieillardii								X				
Cheilosporum acutilobum	X											
Cheilosporum spectabile	X											
Chondracanthus acicularis								X				
Chondracanthus tenellus								X				
Chondria arcuata								X				
Chondria dangeardii								X				
Chondria minutula								X				
Chondria polyrhiza								X				
Chondria simpliciuscula								X				
Chondria repens					X		X		X			

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Chondria sp.									X			
Chondria sp. 1									X			
Chondria sp. 2									X			
Chondrus ocellatus								X				
Chroodactylon ornatum								X				
Chrysymenia kairnbachii								X				
Chrysymenia okamurae								X				
Chrysymenia procumbens								X				
Coelarthrum albertisii									X			
Coelarthrum boergesenii									X			
Coelothrix irregularis								X				
Corallina elongata								X				
Corallophila apiculata					X		X	X	X			
Corallophila huysmansii							X	X				X
Corallophila itonoi								X				
Corallophila ptilocladioides								X				
Crouania mageshimensis								X	X			
Crouania minutissima							X	X	X			
Crouania sp.								X				
Cruoriella dubyi					X							
Cruoriopsis mexicana					X							

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Cryptonemia decumbens	X											
Cryptonemia umbraticola					X			X				
Cryptonemia yendoi												
Cryptopleura corallinara								X				
Cubiculosporum koronicarpus								X				
Dasya adhaerens							X					
Dasya bailouvianna									X			
Dasya corymbifera									X			
Dasya kristeniae								X				
Dasya murrayana								X				
Dasya pilosa								X				
Dasya sinicola							X					
Dasya villosa									X			
Dasya sp.							X	X				
Dasyopsis sp.								X				
Dasyphila plumarioides												X
Delesseriopsis elegans								X				
Dermocorynus occidentalis								X				
Dermonema virens											X	
Dermonema pulvinatum								X				
Diplothamnion jolyi								X				

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Ditria reptans								X	X			
Dotyophycus pacificum								X				
Dotyophycus yamadae								X				
Dotyella hawaiiensis								X	X			
Dotyella irregularis								X				
Dudresnaya hawaiiensis								X				
Dudresnaya littleri								X				
Dudresnaya sp.									X			
Erythrocladia irregularis					X							
Erythrocolon podagricum								X				
Erythrotrichia carnea					X			X				
Erythrotrichia parietalis					X							
Erythrotrichia sp.							X					
Eucheuma denticulatum							X					
Eupogodon sp.									X			
Euptilocladia magruderi								X				
Exophyllum wentii								X				
Fernandosiphonia ecorticata								X				
Fernandosiphonia nana								X				
Fosliella farinosa												X
Galaxaura elongata											X	

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Galaxaura fasciculata								X				
Galaxaura fastigiata								X				
Galaxaura filamentosa	X							X			X	X
Galaxaura glabriuscula												X
Galaxaura marginata	X							X			X	X
Galaxaura obtusata								X			X	
Galaxaura pacifica									X		X	
Galaxaura rugosa	X							X	X		X	
Galaxaura subfructiculosa											X	
Galaxaura subverticillata								X				
Galaxaura sp.									X			
Ganonema farinosum								X				
Gelidiella acerosa								X				X
Gelidiella antipai								X				
Gelidiella bornetii					X							
Gelidiella machrisiana								X				
Gelidiella myrioclada								X				X
Gelidiella stichidiospora					X							
Gelidiella womersleyana												
Gelidiella sp.	X											
Gelidiocolax mammillata								X				

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Gelidiopsis acrocarpa												X
Gelidiopsis intricata	X				X			X	X		X	X
Gelidiopsis pannosa											X	X
Gelidiopsis repens	X											
Gelidiopsis rigida												X
Gelidiopsis scoparia								X				
Gelidiopsis variabilis								X				
Gelidiopsis sp.			X									
Gelidium abbotiorum	X											
Gelidium crinale					X		X	X				
Gelidium delicatulum	X											
Gelidium pluma								X				
Gelidium pusillum	X				X		X	X	X		X	X
Gelidium reediae								X				
Gelidium samoense	X											
Gibsmithia dotyi								X				
Gibsmithia hawaiiensis	X							X				
Gloiocladia iyoensis								X				
Goniolithon frutescens					X							
Goniotrichum alsidii							X					
Goniotrichum elegans					X							

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Gracilaria abbottiana								X				
Gracilaria arcuata												X
Gracilaria bursapastoris								X				
Gracilaria cacalia												X
Gracilaria coronopifolia								X	X			
Gracilaria dawsonii								X				
Gracilaria dotyi								X				
Gracilaria edulis											X	
Gracilaria epihippisora								X				
Gracilaria filiformis								X				
Gracilaria lemaneiformis								X				
Gracilaria lichenoides								X				X
Gracilaria minor											X	X
Gracilaria radicans												X
Gracilaria parvispora								X				
Gracilaria salicornia								X				X
Gracilaria tikvahiae								X				
Gracilaria verrucosa												X
Grateloupia filicina								X				
Grateloupia hawaiiana								X				
Grateloupia phuquocensis								X				

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Griffithsia heteromorpha								X				
Griffithsia metcalfii							X	X				
Griffithsia ovalis							X					
Griffithsia schousboei								X				
Griffithsia subcylindrica								X				
Griffithsia tenuis							X					X
Griffithsia sp.					X		X					
Gymnogongrus sp.								X				
Gymnothamnion elegans								X				
Halarachnion calcareum												X
Halichrysis coalescens								X				
Haliptilon subulatum								X	X			
Haloplegma duperreyi	X							X	X			
Halymenia actinophysa								X				
Halymenia chiangiana								X				
Halymenia cromwellii								X				
Halymenia durvillaei												X
Halymenia formosa								X				
Halymenia lacerata											X	X
Halymenia stipitata								X				
Hawaiia trichia								X				

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Helminthocladia rhizoidea								X				
Helminthocladia simplex								X				
Herposiphonia arcuata								X				X
Herposiphonia crassa								X				
Herposiphonia delicatula								X	X			
Herposiphonia dendroidea									X			X
Herposiphonia dubia								X	X			
Herposiphonia nuda								X	X			
Herposiphonia obscura								X				X
Herposiphonia pacifica								X	X			X
Herposiphonia parca								X	X			
Herposiphonia secunda	X				X			X	X			X
Herposiphonia variabilis								X				X
Herposiphonia sp.							X		X			
Heterosiphonia crispella					X		X	X	X			
Heteroderma subtilissima					X							
Heteroderma sp.					X							
Hydrolithon breviclavium								X				
Hydrolithon reinboldii	X							X	X			X
Hypnea cervicornis								X	X			
Hypnea chloroides								X				

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Hypnea chordacea								X				
Hypnea esperi					X		X		X		X	X
Hypnea musciformis								X				
Hypnea nidulans	X				X							
Hypnea pannosa	X							X	X			X
Hypnea rugulosa								X				
Hypnea spinella					X			X	X			
Hypnea valentiae								X				
Hypnea sp.		X										
Hypnea sp. 1									X			
Hypnea sp. 2									X			
Hypneocolax stellaris								X				
Hypoglossum attenuatum	X										X	
Hypoglossum barbatum								X				
Hypoglossum caloglossoides								X				
Hypoglossum minimum								X				
Hypoglossum rhizophorum								X				
Hypoglossum simulans								X				
Hypoglossum sp.									X			
Janczewskia hawaiiana								X				
Jania adhaerens	X							X				

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Jania capillacea	X	X			X		X		X		X	X
Jania decussato-dichotoma					X		X		X		X	
Jania mexicana									X			
Jania microarthrodia			X					X	X	X		
Jania natalensis									X			
Jania pumila								X				
Jania radiata												X
Jania tenella					X						X	X
Jania ungulata									X			
Jania verrucosa								X				
Jania sp.								X				
Kallymenia sessilis								X				
Kappaphycus alvarezii								X				
Kappaphycus striatum								X				
Laurencia brachyclados								X				
Laurencia cartilaginea								X				
Laurencia ceylanica	X										X	X
Laurencia corymbosa									X			
Laurencia crustiformans								X				
Laurencia decumbens								X				
Laurencia dotyi								X				

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Laurencia forsteri								X				
Laurencia galtsoffii								X	X			
Laurencia glandulifera								X				
Laurencia intricata											X	X
Laurencia majuscula								X	X			X
Laurencia mariannensis								X				
Laurencia mcdermidiae								X				
Laurencia nana		X	X									
Laurencia nidifica	X							X	X			
Laurencia obtusa								X	X		X	X
Laurencia papillosa	X											
Laurencia parvipapillata								X	X			
Laurencia perforata									X		X	
Laurencia pygmaea									X			
Laurencia rigida											X	X
Laurencia succisa								X			X	
Laurencia surculigera											X	
Laurencia tenera								X				
Laurencia tropica											X	
Laurencia undulata								X				
Laurencia yamadana								X				

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Laurencia sp.					X		X		X			X
Laurencia sp. 1									X			
Laurencia sp. 2									X			
Laurencia sp. 3									X			
Laurencia sp. 4									X			
Laurencia sp. 5									X			
Lejolisia colombiana					X							
Lejolisea pacifica								X				
Leveillea jungermannioides								X			X	X
Liagora albicans								X				
Liagora boergesenii								X				
Liagora ceranoides								X	X			
Liagora coarctata									X			
Liagora divaricata								X				
Liagora farinosa									X			
Liagora hawaiiana								X	X			
Liagora hirta	X											
Liagora kahukuana									X			
Liagora orientalis								X	X			
Liagora papenfussii								X	X			
Liagora perennis												

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Liagora pinnata								X				
Liagora samaensis								X				
Liagora robusta									X			
Liagora setchellii								X	X			
Liagora tetrasporifera								X				
Liagora valida								X	X			
Liagora sp.	X									X	X	
Liagorophyla endophytica								X				
Lithophyllum kaiserii	X											
Lithophyllum kotschyanum								X			X	X
Lithophyllum moluccense	X										X	X
Lithophyllum sp.								X				
Lithoporella melobesioides											X	X
Lithoporella pacifica												X
Lithoporella sp.	X											
Lithothamnion asperulum												X
Lithothamnion byssoides								X				
Lithothamnion funafutiense												X
Lithothamnion philippii												X
Lithothamnion spp.					X				X			
Lomentaria hakodatensis					X		X	X				

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Lomentaria sp.		X										
Lophocladia kipukaia								X				
Lophocladia trichoclados									X			
Lophosiphonia bermudensis					X							
Lophosiphonia cristata								X	X			
Lophosiphonia obscura	X											
Lophosiphonia prostrata								X				
Lophosiphonia scopulorum					X							
Lophosiphonia sp.					X							
Martensia fragilis	X							X	X		X	X
Mastophora lamourouxii												X
Mastophora macrocarpa												X
Mastophora melobesoides	X											
Mastophora plana												X
Mastophora rosea												X
Mazzaella volans								X				
Malaconema minimum								X				
Melanamansia daemelii								X				
Melanamansia fimbrifolia								X				
Melanamansia glomerata								X				
Mesophyllum erubescens	X											X

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Mesophyllum mesomorphum	X							X				X
Mesophyllum simulans	X											X
Micropeuce setosus								X				
Monosporus indicus								X				
Murrayella periclados												X
Myriogramme bombayensis								X				
Naccaria hawaiiana								X				
Neogoniolithon brasica-florida	X				X			X			X	X
Neogoniolithon fosliei												X
Neogoniolithon medioramus												
Neogoniolithon pacificum												X
Neogoniolithon reinboldii											X	
Neomartensia flabelliformis								X				
Nitophyllum adhaerens								X				
Osmundaria obtusiloba								X				
Ossiella pacifica								X				
Peleophycus multiprocarpium								X				
Peyssonelia conchicola								X				
Peyssonelia corallis											X	X
Peyssonelia delicata	X											
Peyssonelia foveolata	X											

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Peyssonelia inamoena								X				
Peyssonelia mariti	X											
Peyssonelia rubra	X				X			X				
Peyssonelia sp.									X			
Phaeocolax kajimurai								X				
Platoma ardreanum								X				
Pleonosporium caribaeum								X				
Peonosporium intricatum								X				
Plocamium sandwicense								X	X			
Polyopes hakalauensis								X				
Polysiphonia anomala								X				
Polysiphonia apiculata								X				X
Polysiphonia beaudettei								X				
Polysiphonia delicatula								X				X
Polysiphonia exilis								X	X			
Polysiphonia flaccidissima								X				X
Polysiphonia hancockii								X				
Polysiphonia hawaiiensis								X				
Polysiphonia herpa								X				X
Polysiphonia homoia								X				
Polysiphonia howei								X				

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Polysiphonia pentamera								X				
Polysiphonia poko								X				X
Polysiphonia polyphysa									X			
Polysiphonia poko								X				
Polysiphonia profunda								X				
Polysiphonia pseudovillum								X				
Polysiphonia rubrorhiza								X	X			
Polysiphonia saccorhiza								X	X		X	
Polysiphonia savatieri								X	X			X
Polysiphonia scopulorum	X				X			X	X			X
Polysiphonia setacea								X				X
Polysiphonia simplex								X	X			
Polysiphonia sparsa								X				X
Polysiphonia sphaerocarpa								X	X			X
Polysiphonia subtilissima								X				
Polysiphonia tepida								X				
Polysiphonia tongatensis	X							X				
Polysiphonia triton								X				
Polysiphonia tsudana								X				
Polysiphonia tuberosa												
Polysiphonia upolensis								X	X			X

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Polysiphonia sp.	X				X		X		X		X	X
Polystrata dura	X											
Porolithon craspedium					X						X	X
Porolithon gardineri					X			X				
Porolithon marshallense					X							
Porolithon onkodes	X				X			X			X	X
Porolithon sp.									X			
Porphyra vietnamensis								X				
Portieria hornemanni	X							X	X		X	X
Predaea laciniosa								X				
Predaea weldii								X				
Prionitis corymbifera								X				
Prionitis obtusa	X											
Pterocladia capillacea								X				
Pterocladia musiformis					X							
Pterocladia parva									X			X
Pterocladia tropica					X							
Pterocladia sp.					X							
Pterocladiella bulbosa								X				
Pterocladiella caerulescens								X				
Pterocladiella caloglossoides								X				

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Pterocladiella capillacea								X				
Pterosiphonia pennata								X				
Ptilocladia yuenii								X				
Ptilothamnion cladophorae								X				
Pugetia sp.									X			
Reticulocaulis mucosissimus								X				
Rhodolachne decussata								X				
Rhodymenia sp.	X											
Rhodymenia leptophylla								X				
Scinaia furcata								X				
Scinaia hormoides								X				
Spermothamnion sp.					X				X			
Spirocladia barodensis								X				
Spirocladia hodgsoniae								X				
Sporolithon erythraeum	X							X			X	
Sporolithon schmidtii												X
Sporolithon sibogae	X											
Spyridia filamentosa	X							X	X			X
Stenopeltis gracilis								X			X	
Stenopeltis liagoroides								X				
Stenopeltis setchelliae								X				

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Stictosiphonia kelanensis												X
Stylonema alsidii	X							X				
Stylonema cornu-cervi								X				
Symphyocladia marchantioides								X			X	
Taenioma macrourum							X					
Taenioma perpusillum								X	X			
Tayloriella dictyurus								X				
Tenarea tessellatum								X				
Tiffaniella codicola									X			
Tiffaniella saccorhiza								X	X			
Titanophora marianensis												X
Titanophora pikeana								X				
Tolypiocladia glomerulata	X							X			X	X
Trichogloea lubrica								X				
Trichogloea requienii								X	X			
Trichogloeopsis hawaiiana								X	X			
Irichogloeopsis mucosissima								X				
Tricleocarpa cylindrica								X	X			
Tricleocarpa fragilis								X	X		X	X
Ululania stellata								X				
Vanvoorstia coccinea								X				

Algae species	AS	BK	HL	JV	PY	KG	JS	HI	NWHI	WK	MR	GU
Vanvoorstia spectabilis								X				
Womersleyella pacifica								X				
Wrangelia anastomosans											X	
Wrangelia dumontii								X				
Wrangelia elegantissima								X				
Wrangelia penicillata								X				
Wrangelia tenuis									X			
Wurdemannia miniata					X			X			X	X
Wurdemannia sp.							X					
Yamadaella coenomyce								X				

***References Used:** Birkland *et al.* 1994; Setchell 1924; Tsuda and Trono 1968; Dawson 1959; Dawson *et al.* 1955; Hillis- Colinvaux 1959; Buggeln and Tsuda 1969; Vernon *et al.* 1966; Abbott 1988; 1999; Bailey and Harvey 1862; Egerod 1952; Eldredge and Paulay 1996; Magruder and Hunt 1979; Abbott 1989; Anon 1999; Bailey and Harvey 1862; Eldredge *et al.* 1977; Tsuda 1981; Tsuda and Wray 1977; Eldredge and Paulay 1996; Gilbert 1978; Gordon 1976; Itono and Tsuda 1980; King and Puttock 1989; Nam and Saito 1991; Tsuda 1981; Tsuda and Wray 1977

2. Porifera (sponges)

Important Summary Documents

Moore (1955) described the paleosponges and their dominance in ancient reefs.
Early records of Pacific sponges Bowerbank (1873) and Agassiz (1906). Bergquist (1965,1967, and 1977) catalogued sponges in Micronesia and Hawaii. Kelly-Borges and Valentine (1995) have reviewed the status of the sponges of Hawaii.

Taxonomic Issues

No overall classification of the *Porifera* exists. Calcarea: Burton (1963); Vacelet (1970). Demospongiae Levi (1973) and Bergquist (1978). Sclerospongiae: Hartman & Goreau (1970, 1975) Hexactinellida: Ijima (1927). De Laubenfels (1950a,b 1951, 1954; 1957) recorded the sponges from Hawaii. Species numbers: 84 species in Hawaii Berquist (1977); Chave and Jones (1991); 5000-9000 spp. (Colin and Arneson, 1991) and 10,000 spp. George and George (1979) world-wide.

Habitat Utilization

Use of chemical agents in competing for substrate. Often found at depth, in caves, and vertical areas where not colonized by hard coral. Rutzler and Rieger (1973) described the burrowing sponge *Cliona* into a calcareous substrate.

Life History

Adult: Appearance and Physical Characteristics

Vary greatly in size. The majority are irregular and exhibit massive, erect, encrusting, or branching growth pattern. Many are brightly colored. The body of the sponge is a system of water canals, where with incurrent pores allow water to flow into the atrium and out through the osculum (asconoid, syconoid, and leuconoid plans). The skeleton may be composed of calcareous and silaceous spicules, protein spongin fibers. The spicules exist in a variety of forms and are important in the identification and classification of species.

Of pharmaceutical interest due to the biologically active compounds, most probably used in defense. Some compounds affective against certain tumors and potential effective in treating other diseases.

Reproductive Strategies

Sexual (viviparous and oviparous), asexual and hermaphroditic. Synchronous release of gametes triggered by lunar or daily cycles. Eggs develop into larvae which swim or creep along the bottom. Asexual reproduction is through budding, fragmentation and gemmules (Barnes, 1987, Fromont, 1994). Recruitment may occur by fragmentation from predation (Kelly-Borges and Berguist, 1988).

Distribution

Table 5 shows the distribution of the sponges in some of the AFPI. In Guam and Mariana Islands Bryan(1973). Briggs (1974) provided information on broad distributions as did Hooper and Levi, 1994. In Hawaii, biological interactions affect the occurrence of the sponge *Damiriana hawaiiana* Casper (1981). Encrusting sponges may kill corals (Plucer-Rosario, 1987).

Feeding and Food

Particle feeding and ingestion of plankton and bacteria (Reiswig 1971,1975a)
Utilization of DOM, directly or indirectly, by symbiotic cyanobacteria (Barnes 1987; Wilkinson, 1979, 1983).

Behavior

Symbiosis common which includes shrimps, crabs, barnacles, worms, brittlestars, holothurians, and other sponges (Colin and Arneson, 1991). *Tethya sp.* produces filamentous extensions for mobility. *Placospongia* rapidly closes its plate-like surface when touched. *Tedania* (fire sponge) causes burning due to spicules and chemicals. *Hippospongia* and *Spongia* are used as bath sponges.

Diurnal rhythm in the active flow of water (Reiswig, 1971)

Spawning: Spatial and Temporal Distribution

Lunar and diurnal periodicity

Appearance and Physical Characteristics of Eggs (size, shape, color, etc) and Duration of Phase

During mass spawning events (Reiswig, 1971), sperm appears as clouds of smoke. In some cases, release of eggs causes appearance of opaque mucous covering sponge (Colin and Arneson, 1995).

Larvae: Appearance and Physical Characteristics of Larvae

The larval metamorphosis is described by Simpson (1986).

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Table II.C.5: Distribution of sponges within the American Affiliated Pacific Islands (AFPI) (after Kelly-Borges and Valentine, 1995)

AS: American Samoa; HI: Hawaiian Islands; NMI: Commonwealth of Northern Mariana Islands; GU: Guam

Taxonomy/occurrence	AS	HI	CNMI	GU
DEMOSPONGIAE				
Homosclerophorida				
Oscarella tenuis		X		
Plakina monolopha		X		
Plakortis simplex		X		
Astrophorida				
Ancorina acervus			X	
Asteropus kaena		X		
Dorypleres splendens			X	
Erylus caliculatus		X		
Erylus proximus		X		
Erylus rotundus		X		
Erylus sollasi		X		
Geodia gibberella		X		
Jaspis stellifera			X	
Melophlus sarasinorum				X
Rhabdastrella pleopora		X		
Stelletta debilis		X		
Zaplethes digonoxea		X		
Lithistida				
Aciculites papillata			X	
Leidermatium sp		X		
Spirophorida				
Cinachyra porosa			X	
Paratetilla bacca			X	
Hadromerida				
Anthosigmella valentis		X		

Taxonomy/occurrence	AS	HI	CNMI	GU
Chondrosia chucalla		X		
Chondrosia corticata			X	
Chondrosia sp		X		
Cliona vastifica		X		
Diplastrella spiniglobata		X		
Kotimea tethya		X		
Placospongia carinata			X	
Prosuberites oleteira		X		
Spheciospongia aurivilla			X	
Spheciospongia purpurea			X	
Spheciospongia vagabunda		X	X	
Spirastrella coccinea		X		
Spirastrella keaukaha		X		
Terpios aploos				X
Terpios granulosa		X		
Terpios hoshinoto				X
Terpios sp				X
Terpios zeteki		X		
Tethya coccinea			X	
Tethya diploderma		X		
Tethya robusta			X	
Timea xena		X		
Halichondrida				
Axechina lissa		X		
Axinella solenoides		X		
Axinyssa aplysinoides				X
Axinyssa pitys			X	
Axinyssa terpnis			X	
Axinyssa xutha			X	
Ciocalypta pencillus		X		

Taxonomy/occurrence	AS	HI	CNMI	GU
Cymbastella cantherella			X	
Densa mollis			X	
Eurypon distincta		X		
Eurypon nigra		X		
Halichondria coerulea		X		
Halichondria dura		X		
Halichondria melanadocia		X		
Higginsia anfractuosa			X	
Higginsia mixta			X	
Homaxinella anamesa		X		
Hymeniacidon chloris		X		
Myrmekioderma granulata			X	
Myrmekioderma sp.				X
Phycopsis aculeata		X		
Pseudaxinella australis			X	
Raphisia myxa		X		
Rhabderemia sorokinae			X	
Stylotella aldis			X	
Stylotella aurantium			X	X
Ulosa rhoda		X		
Haplosclerida				
Adocia gellindra		X		
Adocia turquosia			X	
Adocia viola				X
Aka mucosa			X	
Amphimedon sp				X
Callyspongia aerizusa			X	
Callyspongia diffusa		X		X
Callyspongia parva			X	
Gellius gracilis			X	

Taxonomy/occurrence	AS	HI	CNMI	GU
Haliclona acoroides			X	
Haliclona aquaeducta		X		
Haliclona flabellodigitata		X		
Haliclona koremella			X	
Haliclona lingulata				X
Haliclona pellasarca			X	
Haliclona permollis		X		
Haliclona streble			X	
Haliclona viridis			X	
Niphates cavernosa			X	
Niphates spinosella			X	
Sigmadocia amboinensis			X	
Sigmadocia symbiotica			X	
Toxadocia violacea		X		
Petrosida				
Pellina eusiphonia		X	X	
Pellina pulvilla				X
Pellina sitiens		X		
Petrosia puna		X		
Xestospongia sp				X
Poecilosclerida				
Acamas caledoniensis			X	
Amphinomia sulphurea			X	
Axociella kilauea		X		
Biemna fortis			X	
Clathria frondifera				X
Clathria procera		X		
Clathria vulpina			X	
Coelocartaria singaporense			X	
Crella spinulata			X	

Taxonomy/occurrence	AS	HI	CNMI	GU
Damiriana hawaiiana		X		
Desmacella lampra			X	
Echinodictyum antrodes				X
Esperiopsis anomala		X		
Iotrochota baculifera			X	
Iotrochota protea		X		
Kaneohea poni		X		
Lissodendoryx calypta		X		
Lissodendoryx oxytes			X	
Microciona eurypa			X	
Microciona cecile			X	
Microciona haematodes		X		
Microciona maunaloa		X		
Mycale cecilia		X		
Mycale contarenii		X		
Mycale maunakea		X		
Myxilla rosacea		X		
Naniupi ula		X		
Prianos phlox			X	
Strongylacidon sp.		X		
Tedania ignis		X		
Tedania macrodactyla		X		
Xytopsiphum kaneohe		X		
Xytopsiphum meganese		X	X	
Xytopsues zukerani		X		
Zygomycale parishii		X		
Dictyoceratida				
Coscinoderma denticulatum		X		
Fasciospongia chondrodes			X	
Hippospongia densa		X		

Taxonomy/occurrence	AS	HI	CNMI	GU
Hippospongia metachromia			X	
Hyrtios erecta				X
Lendenfeldia dendyi			X	
Lufferiella sp		X		
Lufferiella variabilis				X
Spongia irregularis dura		X		
Spongia irregularis lutea		X		
Spongia irregularis mollior		X		
Spongia irregularis tenuis		X		
Spongia denticulata		X		
Spongia oceania		X		
Stelospongia lordii		X		
Strepsichordaia lendenfeldi			X	
Verongida				
Aplysinella strongylata			X	
Aplysinella tyroeis			X	
Ianthella basta				X
Psammaplysilla purpurea		X		
Psammaplysilla verongiformis			X	
Dendroceratida				
Aplysilla rosea		X		X
Aplysilla sulphurea		X		
Aplysilla violacea		X		
Dendrilla cactus		X		
Dendrilla nigra			X	
Dysidea avara		X	X	X
Dysidea fragilis			X	
Dysidea herbacea		X		
Dysidea sp		X		X
Eurypongia lobata			X	

Taxonomy/occurrence	AS	HI	CNMI	GU
Pleraplysilla hyalina		X		
Slerosponges				
Acanthochaetetes wellsi			X	
Astrosclera willeyana			X	X
Stromatospongia micronesica			X	X
CALCAREA				
Clathrina sp		X		
Leucetta avacado				X
Leucetta solida		X		
Leuconia kaiana		X		
Leucosolenia eleanor		X		
Leucosolenia vesicula		X		
Murrayona phanolepis			X	
Sycandra coronata		X		
Sycandra parvula		X		
Sycandra staurifera		X		
HEXACTINELLIDA				
Euplectella sp		X		
Stylocalyx elegans		X		

3. *Millepora* sp. (Linnaeus, 1758) (stinging or fire coral)

Important Summary Documents

Lewis (1989) discussed the ecology of Millepora. Growth and age were investigated (Lewis, 1991).

Taxonomic Issues

Class Hydrozoa: Order Milleporina (Hydroidea): Family Milleporidae: 48 species
The history of *Millepora* taxonomy has been the opposite of scleractinian taxonomy where each minor growth form was often described as a new species (Veron, 1986).

Habitat Utilization

Found on projecting parts of the reef where tidal currents are strong. They are also abundant on upper reef slopes and in lagoons and may be a dominant component of some coral communities (Veron, 1986).

Life History

Adult: Appearance and Physical Characteristics

Colonial and hermatypic. Arborescent, plate-like, columnar or encrusting with a smooth surface perforated by near-microscopic pores. These are of two sizes: the larger are the gastropores, with each surrounded by five to seven smaller dactylopores. Fine straight hairs, visible under water, project from the colony surface. The growth variation is often based on environmental influences. Colors are green, cream or yellow. May be tan-coloured antler-like sheets with branch ends whitish.

Distribution

Globally, the genus is distributed from as far south as South Africa and southern Western Australia to the Kyushu Islands. From the African coast of western Indian Ocean and the Red Sea and the Marquesas in the east. The genus also occurs in the Central and Eastern Pacific and the Caribbean Sea.

Following is a summary of some Indo-Pacific species (adapted from Lewis 1989): their morphology, depth and reef zone and water circulation requirements.

Table II.C.6: Species summary of the genus *Millepora* (Lewis 1989).

Species	Form	Location on reef	Habitat type
Millepora dichotoma	Fan, branches, vertical sheets and walls	0-5m, reef edge	Turbulent, area of the surf
M. exaesa	Robust branches or solid and round	0-10m, reef edge, outer reef slope	Moderate to turbulent
M. platyphylla	Sheets, leaves fans branches	0-10m, reef edge, reef flat	Strong to powerful, turbulent
M. tenella	Fans, branches, sheets	0-10m, reef edge, outer reef slope	medium to strong

Feeding and Food

Gastrozoiids consume food and are the colony polyps have tentacles and a gastrovascular cavity. The dactylozoiids are used for prey capture and have numerous tentacles, which convey a fuzzy appearance. They have a potent sting. Autotrophic due to zooxanthellae but may rely on small plankton and dissolved nutrients.

Reproductive Strategies

Alternation of generations: a sessile, asexual polyp stage and a free-living, sexual medusa stage. Medusa are reproduced by asexual division or budding. The medusa has separate sexes and produce eggs or sperm, which unite and develop into free-swimming planula larvae. Planula larvae are able to swim freely, though largely planktonic.

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Veron J. E. N. 1986: *Coral of Australia and the Indo-Pacific.* Angus and Robertson. ISBN 0 207 15116 4.

4. Stylasteridae (Gray, 1847) (Stylasterines; lace corals)

Important Summary Documents

Veron (1986) Colin and Arneson (1995) and Fossa and Nilsen (1998) provide description of the family.

Taxonomic Issues

Class Hydrozoa; Class Stylasterina; Family Stylasteridae
Approximately 15 genera. Two are common reef genera: *Stylaster* Gray 1831 (48 species); *Distichopora* Lamarck 1816 (34 species) (Veron, 1986).
Taxonomy at the species level poorly known.

Habitat Utilization

With in the reef, sciaphilic or low light, often abundant under overhangs or on the roof of caves. Also found in deep reef conditions particularly if swept by tidal currents (Colin and Arneson, 1995)

Life History

Adult: Appearance and Physical Characteristics

Colonial, ahermatypic, usually arborescent, with tubular gastropores surrounded by smaller dactylopores and usually forming cyclosystems (Veron, 1986). Colour is bright and may be red, pink, orange, purple or white.

Stylaster spp.: Colonies are arborescent with fine branches, growing in one plane, which seldom anastomose. Cyclosystems alternate left and right side of branches.

Distichopora spp.: Colonies are arborescent with flattened, blunt-ended, non-anastomosing branches of uniform width, growing in one plane. There are no cyclosystems: gastropores are aligned along the lateral margins of branches with rows of dactylopores on either side (Veron, 1986; Sheer and Obrist, 1986).

Distribution

Stylaster spp.: Worldwide, extending to the Arctic and Antarctic.
Distichopora spp.: Circum-Australia, Central and the Indo-Pacific.

Feeding and Food

No zooxanthellae so heterotrophic, feeding presumably on small plankton. Dissolved nutrient absorption must be important.

Reproductive Strategies

Sexual individuals, the gonophores, develop in ampullae between the gastropores and release planula larvae.

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Veron J. E. N. 1986. *Coral of Australia and the Indo-Pacific.* Angus and Robertson. ISBN 0 207 15116 4.

5. Solanderidae (Gray) (hydroid fans)

Important Summary Documents

Cooke (1977) described Hawaiian fauna all, of which, have a wider distribution.

Taxonomic Issues

Class Hydrozoa; Order Hydroida; Suborder Athecata (=Anthomedusa; Gymnoblastea); Family Solanderiidae (George and George, 1977; Barnes, 1987).

Habitat Utilization

Shallow water to 100 metres (Colin and Arneson, 1995).
Often found in deeper water ore cave or overhang environment (Cooke, 1977).

Life History

Adult: Appearance and Physical Characteristics

Similar in appearance to gorgonians and other sea fans. May be branching, ramose or encrusting. Branching in one plane, perpendicular to the current or wave action. Commonly found in exposed areas on wave swept shallow outer reefs (Colin and Arneson, 1995). *Solanderia spp.* is branching and may be 30cm high. Family is characterized by the presence of a perisarc composed of anastomosing chitinous fibers with scattered capitate tentacles (Cooke, 1977).

Defense is accomplished by the specialized tentacle the dactylozooids.
Colour species dependent: dark brown to yellow brown, red with white tentacle.

Distribution

Occur from western Africa through the central Indo-Pacific. Northerly limit Japan and Hawaii.

From Cooke (1977):
Solanderia minima: Zanzibar, Africa; *Hawaii.*
S. secunda: Central Pacific
S. misakinensis: Japan; Hawaii
S. sp.: New Guinea (Colin and Arneson 1995)

Feeding and Food

Gastrozooids capture and ingest zooplankton that is small enough to be handled. Extra-cellular digestion takes place in the gastrozooid. The partially digested broth the passes into the common gastrovascular cavity where intracellular digestion occurs.

Reproductive Strategies

Reproduction is by means of fixed gonophores or gonozooids. Applying generalized hydroid reproduction, the gonophores bud off both male and female, mobile medusae, which develop

gonads and reproduce. The fertilized egg divides and develops into free-swimming larvae that attach to substrate to form a new hydroid.

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George, D. & J. George, 1979. An Illustrated Encyclopedia of Invertebrates in the Sea *Marine Life.*

6. Scleractinia (stony corals)

Important Summary Documents

Veron (1986) provides a popular taxonomic guide for stony corals and their biology. Birkeland (1997) is a modern synthesis of coral reef dynamics.
Fadlallah, (1983), Harrison and Wallace (1990) reviewed coral reproduction. Richmond and Hunter (1990) compared coral reproduction geographically.

Taxonomic Issues

Veron and Pichon (1976); Veron, Pichon and Wijsman-Best (1977); Veron and Pichon (1979); Veron and Pichon (1982); Veron and Wallace (1984) have revised the taxonomy of the order Scleractinia in the AIMS Monograph series. Many of the earlier checklists require revision for comparison. References for description and checklists of the AFPI are: Hawaii -Maragos (1977, 1992,1995); Guam - Jones and Randall (1973); CNMI - Randall (1995); American Samoa - Birkeland,, Randall and Amesbury (1994); Lamberts (1980); Wake I. - Anon. (1999); Midway Atoll, Northern Hawaiian Islands - DeFelice, Coles, Muir, Eldredge (1998); Johnston Atoll - Maragos and Jokiel (1986); Jokiel and Tyler (1992); Palmyra Atoll - Maragos (1979, 1988, in prep.)

Habitat Utilization

Stony coral attach to the reef substrate creating a variety of biological habitats on which many other groups rely for shelter and symbiosis. Coral skeletons with the aid of coralline algae create the reef structure.

The distribution of hard coral over the reef is the result of fortuitous settlement and environmental sorting. The history of disturbance in an area plays a large role in the nature of the coral assemblage. Generally, there is a near shore assemblage which is dominated by genera resistant to the influence of the terrestrial factors and tidal variation. (eg. siltation, flooding, and variation in temperature). The genus *Porites, Montipora* and *Pavona, in that order* to dominate the reef seleractinians in Hawaii. In Hawaii, the predominantly branching coral genus *Acropora* is rare and generally confined to several areas in the NWHI. Elsewhere in the region, *Acropora, faviids* and *Millepora* are dominant or very common along with the other genera mentioned above. In permanently sub-tidal areas and further offshore the *Acropora* dominate but often in association by substantial growths of a variety of other species. In Hawaii, this dominance is replaced by Montipora and Pocillopora. Stony coral are limited by light (depth), wave action and disturbance.

The AFPI span a broad biogeographic realm from Guam (144^0 45=E long.) to Hawaii (155^0 W. Long) and from American Samoa (15^0 S latitude) to the northern Hawaii Islands (28^0 40= N. Lat). In terms of coral development, the tropical/temperature gradient gives rise to a range of reef types and species assemblages. The luxuriance of the high island reefs of American Samoan, Guam are in contrast to the variety of reefs which occur in Hawaii. The Jarvis, Baker, Howland, Palmyra Johnston and Wake reefs are atolls as are some of the reefs northern Hawaiian Islands. For most of these areas, varying degrees of information is available, though being generally scant.

Life History

Adult: Appearance and Physical Characteristics

Corals are similar to anemones in having a polyp form which may be colonial or solitary. They are characterized by a hard skeleton of aragonite (calcium carbonate). The colonial form may manifest a variety of forms: branching, tabulate, massive or encrusting. Some forms are species specific while some species respond to environmental influences which condition the colonial morphology. Polyps have tentacle though these are absent in some genera. They are often a crown, in multiples of six, (Hexacorallia) encircling the mouth though these may be manifest in furrows or over the surface as in the solitary *Fungia*. They possess nematocysts. Internally, the mouth opens into a gastrovascular cavity with mensentaries and mesentarial filaments. The mesentaries extend from the scleroseptum. The skeleton has a thecal wall, sclosepta and a basal plate (Barnes, 1987).

The colony expands by budding of new polyps from the bases of old polyps or from the oràl discs of old polyps through intra-tentacular or extra-tentacular budding. Polyps of meandroid colonies share a common oral disc bearing many mouths (Barnes, 1987).

Age, Growth, Longevity

Corals can be very long lived for massive species. An estimated 1000 years has been estimated for some massive *Porites,* colonial sizes representing 300 is reasonably common. Growth rates have been recorded by Buddemeir and Kinzie (1976).
Corals as a group have a wide range of growth rates. The rate variable between 0.4 and 22.5 cm per year. The massive corals grow more slowly with a range of 0.4 to 1.8cm. (DeVantier, 1993).
Growth also includes fusion of colonies.

Table II.C.7: Growth rates among some scleractinian coral.

Species	Growth (cm/yr)
Faviidae *Favia, Favites* *Goniastrea,* *Montastrea* *Platygyra*	0-1.38 Mean range 0.07-1.25
Poritidae *Porites* *Goniopora*	0-1.88 Mean range 0.13-0.97
Mussidae *Lobophyllia* *Symphyllia* *Acanthastrea*	0-1.65 Mean range 0.38-0.94
Oculinidae *Galaxea*	0.67-1.18 Mean range 0.54-0.93
Merulinidae *Hydnophora*	.56-1.15 Mean 0.86
Caryophylliidae *Physogyra* *Euphyllia* *Plerogyra*	0.5-0.75 Mean range 0.5-0.75
Acroporiidae *Acropora*	10.17-22.58
Pocilloporiidae *Pocillopora*	0.4-3.59

Reproductive Strategies

Corals reproduce by both sexual (external fertilization and development and brooded planulae) and asexual development (brooded planulae, polyp-balls, polyp bail-out, fission, fragmentation and re-cementation). May be bisexual or hermaphroditic (protandric, protogynous or synchronous) (Chorneski and Peters, 1987). Self fertilisation occurs (Heyward and Babcock, 1986).

Asexual modes of reproduction:

brooded planulae
polyp-balls: *Goniopora spp.* (Sammarco 1986)
polyp bail-out: *Seriatopora spp.* (Sammarco 1981,1982)
reversible metamorphosis: *Pocillopora damicornis* (Richmond 1985)
fission: *Fungiidae*
fragmentation and re-cementation: *Acropora spp* and others (Tunnicliffe, 1981)

Corals may be free spawners or brooders depending on their geographic distribution. In Hawaii , *Tubastrea* is a brooder but in Australia is a brooder and free spawner.(Harrison and Wallace, 1990)

Sexual maturity depends, on growth as well as colony age (Kojis and Quinn, 1985)
Brooders reach maturity a few years earlier than free spawners. Ahermatypic corals reach sexual maturity earlier than hermatypic corals (Harriot, 1983). Fecundity increases with age. (Soong and Lang, 1992). Availability of light influences fecundity whether through depth or an increase in suspended particles in the water (Kojis and Quinn, 1984) or the reduction of UV light (Jokiel and York, 1982).

Distribution

Table 6 details the occurrence of Scleractinia in the AFPI. Veron (1993b) detailed the global distribution of coral genera and regionally with species. Regional variation in generic occurrence has been documented with latitudinal gradients (Wells 1956).

Zonation within reefs due to environmental influences is well known.(In American Samoa: Birkeland et al. 1994, 1996; In Hawaii: Palmyra Atoll: Maragos 1977, 1988, 1992; In Guam: Jones and Randall).

Discrete coral populations may result from asexual reproduction and possess the same genotype (Hunter, 1985; Willis and Ayre, 1985; Ayre and Resing, 1986) though many appear heterogenous.

Feeding and Food

Stony coral s feed on planktonic organisms or dissolved organic matter (DOM). Capture of prey is by tentacles, suspension feeding occurs and some use mesenterial filaments. Most prey capture at night though some feed during the day.

The presence of symbiotic zooxanthellae make some corals functional autotrophs (Muscatine et al. 1981) and contribute to all hermatypes nutrition. Muscatine and Porter (1977) determined plankton comprise approx. 20% of coral required nutrition. Franzisket (1970) showed coral could live without plankton, but additional nutrition was required from this source (Johannes et al. 1970). The relative dependance on heterotrophy varies with species and with environment. Sorokin (1973, 1995) described the relative dependence on predation, bacteria and DOM. The zooxanthellae receive elements from predation (i.e. nitrogen, iron, and vitamine B_{12}). Recycling of nutrients between corals and zooxanthellae is well known (Johannes 1974; Muscatine 1973; Porter, 1976).

Behavior

Competition for space is achieved by direct tentacular competition ; mesenterial filaments, sweeper tentacles, allopathy, over-growth, shading.

Spawning: Spatial and Temporal Distribution

Mass spawning has been described by Babcock et al. (1986) and follows a lunar periodicity (Richmond and Hunter , 1990). Geographic variation introduces the effects of temperature and

other climatic factors. In Australia, (GBR), *A .palifera* spawns only once per year at 23^{0}S latitude and through out the year at 14^{0}S lat.(Kojis and Quinn, 1984, 1986a).

Appearance and Physical Characteristics of Eggs (size, shape, color, etc) and Duration of Phase

Eggs are round and may pink, orange, blue, purple or white. Pigmentation may be UV protection. White eggs are non-fertile in *Galaxea fascicularis.* Maturation of eggs and ejection may be controlled by the hormone Estradiol-17*b* (Atkinson and Atkinson, 1992). Form into egg sperm bundles. Some eggs contain zooxanthellae. Eggs range in size from 1.5 x 1.00mm (*Flabellum rubrum)* to Acorporidae and Mussidae 0.4-0.8mm; Faviidae and Pectiniidae 0.3- 0.5mm, Portitidae, Agariciidae, Fungiidae and Pocilloporidae 0.05-0.25mm. The total length of sperm is <0.005mm. Eggs and sperm production is cyclic and maturity is reached at the same time for most corals. For *Stylophora pistillata* (Rinkevich and Loya, 1979), the time is different for different colonies. *Acropora palifera* spawning may take place in several stages in synchrony with moon phases with six reproductive cycles per year (Kojis, 1986a, b). Free spawners have a 12 month maturation cycle but brooders have several cycles per year.

Spawning is in synchrony with the lunar cycle begin on the 15th to the 24th night of the lunar cycle. Spawning starts at dusk and continues until midnight. It may vary geographically. A slick is often observed as the gammetes are brought together by currents. Likelihood of fertilization is increased and the abundance of material means predation is decreased through satiation.

Duration of gamete development after spawning is 30 minutes until the ability to fertilise, first cell division 1-2 hours, to planula stage 6-24 hours (Szmant-Froelich et al. 1980; Kojis and Quinn 1982, Bull 1986, Heyward 1986)

Larvae: Appearance and Physical Characteristics of Larvae

It is covered with cilia which provides locomotion. In *Porites porites,* 200 planula may be released from a section of colony (2cm^2) (Fadallah, 1983). They are ciliated, spherical initially and oval or pear-like when mobile.

Age, Growth and Duration of Larval Phase

Initially, they move to the surface of the water and drift as a ciliated ball. In 3-7 days they elongate into a conical shape. They have a cavity and mouth and are 1.5mm long with mesenteries developed. They then move to deeper water and seek substrate (Babcock and Heyward, 1986).

Coral with long lived larvae are: *Galaxea aspera* 49 days; Cyphastrea ocellina (Hawaii) 60 days; Acropora spp. 91 days; Pocillopora damicornis (Hawaii) 103 days (Gulko,1999).

Larval Feeding and Food

Nutrition in planulae is achieved as the result of energy reserves transferred from the embryonic cells. Zooxanthellae, most probably, provide nutrition through nutrient translocation. Some planula feed actively.

Habitat Utilization

Some planula have zooxanthallae and may exist for longer in the plankton and disperse further. Most settle with the proximity of the parent <1km. Discussion of factors in dispersal have been reviewed by Harrison and Wallace (1990). Currents must play a major role in the transport of the larvae. Longevity in the plankton will determine the potential distance of dispersal (Richmond, 1987).

Settlement sites are often cryptic. Clumping of planula may give rise to fusion into a single colony.

Habitat Features Affecting the Abundance and Density of Eggs and Larvae

Currents affect the abundance of eggs and larvae, often concentrating them into a dense mass and dispersing them with the flow. Rain storms may cause mass mortality at this stage as does grounding of the slick at low tide or along the shore. After settlement, the planulae develop primary polyps. The settlement site is important. If inshore, large amounts of organic particular matter and sediment will increase mortality. Wave action may destroy the primary polyps. Young polyps may abandon primary calyx, and relocate planktonically (Richmond, 1985) or through bailout responses.

There is the potential for rafting of coral polyps on driftwood or other current borne objects which would allow for the settlement by larvae and polyp growth (Jokiel, 1984).

Abundance and distribution of coral planulae was investigated in Kaneohe Bay, Oahu (Hodgson, 1985) and Bull (1986) for Australia.

Settlement occurs by finding a suitable location. The size of the new polyp is <2mm. Mortality at this stage is high. Both the environmental and biological environment affect the potential for coral development (Goreau, et al. 1981).

In Western Australia, large numbers of fish and coral died as the result of a coral spawn slick being embayed and using up the oxygen and then decaying (Simson 1993).

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7. Fungiidae (Dana, 1846) (mushroom corals)

Important Summary Documents

Veron (1986) provides a species summary of the systematics, anatomy and distribution in Australia and the Indo-Pacific. Veron (1993b) the family Fungiidae is discussed with respect to its global distribution.

Taxonomic Issues

Veron & Pichon (1979) revised the taxonomy of the family Fungiidae.

Has 11 extant genera: Cycloseris (7 spp.), *Diaseris* (4 nominal spp.), *Heliofungia, Fungia* (25 spp.), *Herpolitha* (2 spp.), *Polyphyllia* (3 spp.), *Halomitra* (1 spp.), *Sandalolitha* (2 spp.), *Lithophyllon (2 spp.), Podabacia (*1 spp.) and *Zoopilus* (1 spp.).

Habitat Utilization

Begin life as anthocauli attached to a hard substrate. Detach to continue life as a free-living colony inhabiting reef areas unsuitable for permanently attached corals such as sand or rubble.

Life History

Adult: Appearance and Physical Characteristics

All shallow water with the exception of the *Fungiacyathus (not occur AFPI).* The majority are hermatypic, solitary, and free living (not *Lithophyllum or Podabacia)* with attached juvenile stage. They may be individual with one mouth or colonial with many mouths and other anatomy characteristic of a colonial form.

From Veron (1986):
Cycloseris (Edwards & Haime, 1849): Solitary, free-living, flat or dome-shaped, circular or slightly oval in outline with a central mouth. Fine tentacles cover the upper surface of the disc. Pale brown to cream with a darker margin.
Diaseris (Edwards & Haime, 1849): Circular though with an irregular margin and segments. Colour is brown to green.

Heliofungia (Wells, 1966): Solitary, free-living, flat with central mouth. Septa have large lobed teeth. Polyps are extended day and night, and as a single polyp are the largest of all corals. Tentacles are longest of the stony corals and dark purple or green tentacle with pale tips. The oral disc is striped and the single mouth is 30mm wide.

Fungia (Lamarck, 1801): Free-living, circular or elongate

Herpolitha (Eschscholtz, 1825)**:** Free-living, elongate with and axial furrow that may extend to the corallum ends. Several centers or mouths occur in the furrow. Colonies may be heavily calcified and >1m in length. Tentacles are short and widely spaced.

Polyphyllia (Quoy and Gaimard, 1833): Free-living, elongate with many mouths and tentacles over the upper surface. Larger mouths are down the axial furrow. Long tentacles, which are always extended.

Halomitra (Dana, 1846): Colonies are large and free-living, circular and dome or bell shaped, thin and delicate and without an axial furrow. Corallites widely spaced. Tentacles are small and widely spaced and extended at night.

Sandalolitha (Quelch, 1884): Colonies are large, free-living, and circular to oval, dome-shaped, heavily constructed and without an axial furrow. Corallites are compacted.
Pale or darks brown, sometimes with purple margins and white centers.

Lithophyllon (Rehberg, 1892): Colonies are attached, encrusting or laminar, unifacial. Colonies may be large, up to several metres. Polyps extended at night. Dull green, grey or brown with white margins or white centers.

Podabacia (Edwards and Haime, 1849): Colonies are attached, encrusting or laminar, unifacial and up to 1.5m in diameter.

Their coloration may be frown, green, red or pink. They may have contrasting stripped design.

Distribution

Cycloseris: Extends from southern Africa to the Red Sea and Arabian Gulf through the Indo-Pacific ranging from south Western Australia, Lord Howe I. and Easter I. in the south to southern Japan in the north. It occurs in the Hawaiian Islands, though not in Midway. It is present in the eastern Pacific from Baja California, northern Mexico to Columbia. The recorded occurrence in the AFPI is Johnston Atoll, Hawaii and Guam

Diaseris: Similar to *Cycloseris* though narrower, extending from southern Madagascar and the Red Sea. Across the Pacific at varying latitude in the north to include Japan and in the south of New Caledonia and the Tuamotus Is. The recorded occurrence in the AFPI is Hawaii.

Heliofungia: Indonesia, Australia, Philippines, Ryukyu Is. east to the Caroline and Solomon Is and south to New Caledonia. The genus does not occur in the AFPI.

Fungia: South of Madagascar, to the Red Sea, Northern Australia, the Great Barrier Reef, south to Lord Howe I. and across to Pitcairn I. Its northerly extent is southern India, Southeast Asia, southern Japan, Midway I., Hawaiian Is. Its easterly extent is the Marquesas Is. The recorded occurrence by virtue of *Fungia scutaria* is present in all AFPI where checklists have been made. Considering the other species of the genus, occurrence is limited to American Samoa, Palmyra Atoll, and Guam.

Herpolitha: South of Madagascar to the Red Sea, Northern Australia, the Great Barrier Reef, south to New Caledonia and across to Pitcairn I. Its northerly extent is southern India, Philippines, and

Ryukyu Is., Japan. Its easterly extent is the Tuamotus Is. The AFPI that this species is found in is American Samoa, Palmyra Atoll and Guam.

Polyphyllia: Central Indo-Pacific: Northern Madagascar and the Seychelles Is in the west. Northern Australia, New Caledonia and Tonga in the south. American Samoa (only AFPI occurrence) in the east and Ryukyu Is, Japan in the north.

Halomitra: West Africa Madagascar in the west through Indonesia to the Line Is in the east. South to New Caledonia and Tonga and north to the Ryukyu I in the north. Present in the AFPI in American Samoa and Palmyra.

Sandalolitha: Occurs in Indonesia and Southeast Asia in the west to the Kyushu Is. in the north. Extends to Northern Australia and New Caledonia and Tubuai Is in the south. Also extends to the Tubuai Is and Line Is in the east. AFPI occurrence limited to American Samoa and Palmyra Atoll.

Lithophyllon: Similar to Sandalolitha, occurring to Indonesia in the west and the Malay Peninsula. Its southerly extent is northern Australia, New Caledonia, and Fiji to the east. It is confined to the western Pacific to include the Philippines and north to southern Japan. There are no occurrences in the AFPI.

Podobacia: Indo-Pacific: Occurs from west Africa and the Red Sea south to Madagascar, Northern Australia, New Caledonia to Tahiti. Range extends to the Fiji in the east. In the north, it extends along Southeast Asia to Japan. There are no occurrences in the AFPI.

Feeding and Food

Heterotrophic: prominent tentacles indicate prey capture. Autotrophic: abundant zooxanthellae.

Behavior

Are partially mobile. May free themselves if buried and some are capable of lateral movement, ability to right themselves, and able to climb over obstacles by using their tentacles and inflating their body cavities.

Mobility in *Cycloseris* by ciliary hairs, by inflation of the body cavity or use of tentacles. Tentacle extended at night.
Fungia and Herpolitha: Polyps are extended only at night.

Reproductive Strategies

Asexual: Fragmentation or natural regeneration through fracture. Many develop attached daughter polyps (acanthocauli) from the parent colony.

Sexual: Dioecious or hermaphroditic. Planula larvae settle to form the attached acanthocauli, which may grow to several centimeters before detaching due to degeneration of the stalk. *Heliofungia* has been reported as hermaphroditic while *Fungia* has separate sexes. It is likely the family has separate sexes, the females either brood planulae or release gametes (Veron, 1986).

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Table II.C.8: Distribution of Scleractinia (hard coral) in the American Flag Pacific Islands (AFPI).

AS: American Samoa; PA: Palmyra Atoll; JA: Johnston Atoll; MHI: Main Hawaiian Islands; NWHI: Northwestern Hawaiian Islands; WA: Wake Atoll; CNMI: Commonwealth of Northern Mariana Islands; GU: Guam

Coral Order, Family and Species	AS	PA	JA	MHI	NWHI	WA	NMI	GU	Site Record
Order SCLERACTINIA									
Family ASTROCOENIIDAE									
Stylocoeniella armata (Ehrenberg, 1834)	X						X	X	3
Stylocoeniella guentheri (Bassett-Smith, 1890)							X	X	2
Family THAMNASTERIIDAE									
Psammocora contigua (Esper, 1797)	X							X	2
Psammocora digitata Edward & Haime, 1851							X	X	2
Psammocora explanulata van der Horst, 1922				X					1
Psammocora folium (Syn)	X								1
Psammocora (P.) haimeana Edwards and Haime, 1851	X	X						X	3
Psammocora nierstraszi van der Horst,1921	X		X	X			X	X	5
Psammocora profundacella Gardiner,1898		X						X	2
Psammocora stellata (Verril,1866)		X	X	X	X			X	5
Psammocora superficiales Gardiner,1898	X								1
Psammocora (V.) tutuilensis (Syn)	X								1
Psammocora verrilli Vaughan				X				X	2
Family POCILLOPORIDAE									
Pocillopora ankeli Sheer & Pillai, 1974	X								1

Coral Order, Family and Species	AS	PA	JA	MHI	NWHI	WA	NMI	GU	Site Record
Pocillopora damicornis (Linnaeus,1758)	X	X	X	X	X			X	6
Pocillopora eydouxi *Edwards & Haime,1860*	X	X	X	X		X		X	6
Pocillopora ligulata Dana, 1846	X			X				X	3
Pocillopora molokensis Vaughan, 1907				X					1
Pocillopora setchelli Hoffmeister,1929	X						X	X	3
Pocillopora verrucosa (Ellis & Solander, 1786)	X	X	X	X	X	X	X	X	8
Pocillopora woodjonesi Vaughan,1918	X							X	2
Seriatopora crassa Quelch, 1886	X								1
Seriatopora hystrix Dana, 1846	X							X	2
Stylophora pistillata Esper, 1797	X	X					X	X	4
Family ACROPORIDAE									
Acropora (A.) aculeus (Dana, 1846)	X					X			2
Acropora (A.) acuminata (Verrill, 1864)	X	X						X	3
Acropora (A.) aspera (Dana, 1846)	X	X						X	3
Acropora (A.) azurea Veron & Wallace, 1984	X								1
Acropora (A.) bushyensis Veron & Wallace, 1984								X	1
Acropora (A.) carduus (Dana, 1846)		X						X	2
Acropora (A.) cerealis (Dana, 1846)	X	X	X				X	X	5
Acropora (A.) clathrata (Brook, 1891)	X								1
Acropora (A.) cuspidata Dana	X								1
Acropora (A.) cytherea (Dana,1846)	X	X	X	X				X	5

Coral Order, Family and Species	AS	PA	JA	MHI	NWHI	WA	NMI	GU	Site Record
Acropora (A.) danai (Milne-Edwards & Haime, 1860)	X	X					X	X	4
Acropora (A.) digitifera (Dana, 1846)	X	X					X	X	4
Acropora (A.) divaricata (Dana, 1846)	X								1
Acropora (A.) echinata (Dana, 1846)								X	1
Acropora (A.) elseyi (Brook, 1892)		X	X						2
Acropora (A.) florida (Dana, 1846)		X							1
Acropora (A.) formosa (Dana, 1846)	X	X						X	3
Acropora (A.) gemmifera *(Brook, 1892)*	X	X							2
Acropora (A.) granulosa (Edwards & Haime, 1860)	X						X	X	3
Acropora (A.) horrida *(Dana, 1846)*	X								1
Acropora (A.) humilis (Dana, 1846)	X	X	X	X			X	X	6
Acropora (A.) hyacinthus (Dana, 1846)	X	X					X	X	4
Acropora (A.) latistella (Brook, 1892)	X								1
Acropora (A.) listeri (Brook, 1893)	X								1
Acropora (A.) longicyathus (Edwards & Haime, 1860)	X								1
Acropora (A.) millepora (Ehrenberg, 1834)	X							X	2
Acropora (A.) monticulosa (Bruggemanni, 1879)	X	X						X	3
Acropora (A.) multiacuta Nemenzo,1967		X							1
Acropora (A.) loripes (Brook, 1892)	X	X					X	X	4

Coral Order, Family and Species	AS	PA	JA	MHI	NWHI	WA	NMI	GU	Site Record
Acropora (A.) nana (Studer, 1878)	X	X						X	3
Acropora (A.) nasuta (Dana, 1846)	X	X				X	X	X	5
Acropora (A.) nobilis (Dana, 1846)	X	X						X	3
Acropora (A.) ocellata (Klunzinger, 1897)	X							X	2
Acropora (A.) pagoensis Hoffmeister	X								1
Acropora (A.) palmerae Wells, 1954	X							X	2
Acropora (A.) paniculata Verrill,1902	X		X	X					3
Acropora (A.) paxilligera *(Dana, 1846)*	X								1
Acropora (A.) polystoma ***(Brook, 1891)***	X	X							2
Acropora (A.) pulchra (Brook, 1891)	X								1
Acropora (A.) rambleri (Bassett-Smith, 1890)	X							X	2
Acropora (A.) robusta (Dana, 1846)	X							X	2
Acropora (A.) samoensis (Brook, 1891)	X	X							2
Acropora (A.) schmitti	X								1
Acropora (A.) secale (Studer, 1878)	X								1
Acropora (A.) selago (Studer, 1878)	X	X	X					X	4
Acropora (A.) studeri (Brook, 1893)								X	1
Acropora (A.) tenuis (Dana, 1846)	X						X	X	3
Acropora (A.) teres (Verrill, 1866)	X							X	2

Coral Order, Family and Species	AS	PA	JA	MHI	NWHI	WA	NMI	GU	Site Record
Acropora (A.) valenciennesi (Edwards & Haime, 1860)	X								1
Acropora (A.) valida (Dana, 1846)	X	X	X	X		X		X	6
Acropora (A.) vaughani Wells, 1954		X							1
Acropora (A.) yongei Veron & Wallace, 1984	X		X						2
Acropora (A.) sp.1	X				X			X	3
Acropora (A.) sp.2	X								1
Acropora (A.) sp.3	X								1
Acropora (I.) brueggemanni ***(Brook, 1893)***	X	X						X	3
Acropora (I.) cuneata (Dana, 1846)	X	X							2
Acropora (I.) palifera (Lamarck, 1816)	X	X					X	X	4
Astreopora cucullata Lamberts, 1980	X								1
Astreopora explanata		X							1
Astreopora gracilis Bernard, 1896		X						X	2
Astreopora listeri ***Bernard, 1896***	X							X	2
Astreopora myriophthalma (Lamarck, 1816)	X	X				X	X	X	5
Astreopora randalli Lamberts,1890	X								1
Astreopora sp. 1	X						X		2
Montipora aequituberculata Bernard, 1897	X			X				X	3
Montipora berryi Hoffmeister, 1925	X								1

Coral Order, Family and Species	AS	PA	JA	MHI	NWHI	WA	NMI	GU	Site Record
Montipora bilaminata	X								1
Montipora caliculata (Dana, 1846)	X								1
Montipora conicula Wells								X	1
Montipora danae Edwards & Haime, 1851						X		X	2
Montipora dilatata Struder, 1901				X					1
Montipora efflorescens Bernard, 1897	X								1
Montipora ehrenbergii Verrill, 1875	X							X	2
Montipora elschneri Vaughan, 1918	X							X	2
Montipora eydouxi	X								1
Montipora flabellata Struder, 1901				X					1
Montipora floweri Wells, 1954								X	1
Montipora foliosa (Pallas, 1766)	X	X						X	3
Montipora foveolata (Dana, 1846)	X	X				X		X	4
Montipora granulosa Bernard, 1897	X							X	2
Montipora hispida ***(Dana, 1846)***	X	X	X						3
Montipora hoffmeisteri Wells, 1954	X	X				X		X	4
Montipora incrassata Dana, 1846			X	X					2
Montipora informis *Bernard, 1897*	X					X			2
Montipora lobulata *Bernard, 1897*	X							X	2

Coral Order, Family and Species	AS	PA	JA	MHI	NWHI	WA	NMI	GU	Site Record
Montipora marshallensis	X								1
Montipora millepora Crossland, 1952								X	1
Montipora monasteriata (Forskal, 1775)		X	X	X	X	X		X	6
Montipora peltiformis Bernard, 1897				X				X	2
Montipora spumosa (Lamarck, 1816)	X								1
Montipora tuberculosa (Lamarck, 1816)	X	X	X	X				X	5
Montipora turgescens Bernard, 1897					X				1
Montipora undata Bernard, 1897	X								1
Montipora venosa (Ehrenberg, 1834)	X								1
Montipora verrucosa (Lamarck, 1816)				X		X		X	3
Montipora sp.1 (green spine)	X				X		X	X	4
Montipora sp.2 (ramose tuber.)	X						X	X	3
Montipora sp.3 (Pago)	X						X	X	3
Montipora sp.4 (Ramose pap.)							X	X	2
Montipora sp.5 (thick branch)							X	X	2
Family AGARICIIDAE									
Gardineroseris planulata (Dana, 1846)	X			X				X	3
Leptoseris hawaiiensis Vaughan, 1907			X	X				X	3
Leptoseris incrustans (Quelch, 1886)	X		X	X				X	4
Leptoseris mycetoseroides Wells, 1954	X	X		X		X		X	5
Leptoseris papyracea ***(Dana, 1846)***				X					1

Coral Order, Family and Species	AS	PA	JA	MHI	NWHI	WA	NMI	GU	Site Record
Leptoseris scabra Vaughan, 1907			X	X					2
Pachyseris levicollis	X								1
Pachyseris speciosa (Dana, 1846)	X							X	2
Pachyseris rugosa (Lamarck, 1801)	X								1
Pavona clavus (Dana, 1846)	X	X	X	X	X		X	X	7
Pavona decussata (Dana, 1846)	X							X	2
Pavona diffluens (Lamarck, 1816)	X								1
Pavona divaricata (Lamarck, 1816)	X							X	2
Pavona explanulata (Lamarck, 1816)	X	X							2
Pavona frondifera (Lamarck, 1816)	X							X	2
Pavona gigantea	X								1
Pavona maldivensis (Gardiner, 1905)	X	X	X	X			X	X	6
Pavona minuta Wells, 1954	X							X	2
Pavona qardineri van der Horst								X	1
Pavona varians Verrill, 1864	X	X	X	X		X	X	X	7
Pavona (P.) venosa (Ehrenberg, 1834)	X							X	2
Family BALANOPHYLLIDAE									
Balanophyllia sp.cf. *affinis* (Semper, 1872)				X					1

Coral Order, Family and Species	AS	PA	JA	MHI	NWHI	WA	NMI	GU	Site Record
Balanophyllia hawaiiensis Vaughan, 1907				X					1
Family SIDERASTREIDAE									
Coscinaraea columna (Dana, 1846)	X							X	2
Coscinaraea wellsi Veron & Pichon, 1879				X					1
Family FUNGIIDAE									
Cycloseris hexagonalis ***Edwards & Haime, 1848***				X					1
Cycloseris patelliformis Boschma, 1923	X								1
Cycloseris tenuis Dana, 1846				X					1
Cycloseris vaughani (Boschma, 1923)			X	X					2
Diaseris distorta Michelin, 1842				X					1
Fungia (D.) danai Edwards & Haime, 1851	X	X							2
Fungia (D.) valida Verrill, 1864		X							1
Fungia (C.) echinata (Pallas,1766)	X								1
Fungia (F.) fungites (Linnaeus, 1758)	X	X						X	3
Fungia (P.) paumotensis Stutchbury, 1833	X	X						X	3
Fungia (P.) scutaria Lamarck, 1801	X	X	X	X	X	X	X	X	8
Fungia (V.) concinna Verrill, 1864	X	X						X	3
Fungia (V.) granulosa Klunzinger, 1879	X			X					1
Fungia (V.) repanda Dana, 1846	X	X							2
Fungia (C.) simplex ***(Gardiner, 1905)***	X								1

Coral Order, Family and Species	AS	PA	JA	MHI	NWHI	WA	NMI	GU	Site Record
Halomitra pileus (Linnaeus, 1758)	X	X							2
Herpolitha limax ***(Houttuyn, 1772)***	X	X						X	2
Polyphyllia talpina (Lamarck, 1801)	X								1
Sandalolitha robusta (Quelch,1886)	X	X							2
Family PORITIDAE									
Alveopora allingi ***Hoffmeister, 1925***	X								1
Alveopora japonica								X	1
Alveopora superficialis Sheer & Pillai, 1976	X								1
Alveopora verrilliana Dana, 1846	X	X						X	3
Alveopora viridis Quoy & Gaimard, 1833	X								1
Goniopora arbuscula Umbgrove								X	1
Goniopora columna Dana, 1846	X							X	2
Goniopora parvistella Ortmann, 1888	X								1
Goniopora somaliensis Vaughan, 1907	X								1
Goniopora sp.1	X						X	X	3
Goniopora sp.2							X	X	2
Porites (P.) annae ***Crossland, 1952***	X							X	2
Porites (P.) australiensis Vaughan, 1918		X						X	2
Porites (P.) cocosensis Wells								X	1

Coral Order, Family and Species	AS	PA	JA	MHI	NWHI	WA	NMI	GU	Site Record
Porites (P.) compressa Vaughan				X				X	2
Porites (P.) cylindrica Dana, 1846	X							X	2
Porites (P.) duerdeni Vaughan				X				X	2
Porites (P.) cf. *Evermanni* Vaughan, 1907				X					1
Porites (P.) latistella	X								1
Porites (P.) lichen ***Dana, 1846***	X			X				X	3
Porites (P.) lobata Dana, 1846	X	X	X	X	X		X	X	7
Porites (P.) lutea Edwards & Haime, 1860	X	X	X			X	X	X	6
Porites (P.) matthaii Wells	X							X	2
Porites (P.) murrayensis Vaughan, 1918	X			X				X	3
Porites (P.) pukoensis Vaughan, 1907	X			X					2
Porites (P.) queenslandi septima	X								1
Porites (P.) solida (Forskal, 1775)						X			1
Porites (P.) stephensoni Crossland, 1952	X								1
Porites (P.) studeri Vaughan, 1907				X					1
Porites (P.) sp.1(nodular)	X				X			X	3
Porites (S.) horizontalata Hoffmeister, 1925	X							X	2
Porites (S.) rus (Forskal, 1775)	X			X				X	3

Coral Order, Family and Species	AS	PA	JA	MHI	NWHI	WA	NMI	GU	Site Record
Porites (N.) vaughani ***Crossland, 1952***		X							1
Stylaraea punctata ***(Linnaeus, 1758)***								X	1
Synaraea horizontalata	X								1
Family FAVIIDAE									
Caulastrea furcata Dana, 1846	X								1
Cyphastrea chalcidicum (Forskal, 1775)			X	X	X			X	4
Cyphastrea microphthalma (Lamarck, 1816)	X					X			2
Cyphastrea serailia (Forskal, 1775)	*X*					*X*		*X*	3
Diploastrea heliopora ***(Lamarck, 1816)***	X						X	X	3
Echinopora hirsuitissima ***(Edwards & Haime, 1849)***	X								1
Echinopora lamellosa (Esper, 1795)	X					X	X	X	4
Favia favus (Forskal, 1775)	X					X		X	3
Favia helianthoides Wells, 1954	X								1
Favia laxa (Klunzinger, 1879)	X								1
Favia matthaii Vaughan, 1918	X							X	2
Favia pallida (Dana, 1846)	X	X				X	X	X	5
Favia rotumana (Gardiner, 1899)	X							X	2
Favia russelli (Wells)								X	1

Coral Order, Family and Species	AS	PA	JA	MHI	NWHI	WA	NMI	GU	Site Record
Favia speciosa (Dana)	X	X					X	X	4
Favia stelligera (Dana, 1846)	X	X				X		X	4
Favia sp.1 (small calice)	X	X					X		3
Favia sp.2							X		1
Favites abdita (Ellis & Solander, 1786)	X	X				X		X	4
Favites chinensis (Verrill, 1866)	X								1
Favites complanata (Ehrenberg, 1834)	X							X	2
Favites favosa (Ellis & Solander)								X	1
Favites flexuosa (Dana, 1846)	X	X				X		X	4
Favites halicora (Ehrenberg, 1834)	X	X				X			3
Favites pentagona (Esper, 1794)		X							1
Favites russelli (Wells, 1954)	X								1
Goniastrea australensis (Edwards & Haime, 1857)	X								1
Goniastrea edwardsi Chevalier, 1971	X							X	2
Goniastrea favulus (Dana, 1846)	X					X			2
Goniastrea palauensis (Yabe,Sugiyama & Eguchi, 1936)	X								1
Goniastrea pectinata (Ehrenberg, 1834)	X	X				X		X	4
Goniastrea retiformis (Lamarck, 1816)	X					X	X	X	4
Hydnophora exesa (Pallas, 1766)	X	X						X	3

Coral Order, Family and Species	AS	PA	JA	MHI	NWHI	WA	NMI	GU	Site Record
Hydnophora microconos ***(Lamarck, 1816)***	X	X						X	3
Hydnophora rigida ***(Dana, 1846)***	X								1
Leptastrea bottae ***(Edwards & Haime, 1849)***				X				X	2
Leptastrea cf. I*mmersa* Klunzinger, 1879	X								1
Leptastrea purpurea (Dana, 1846)	X	X	X	X	X	X	X	X	8
Leptastrea transversa Klunzinger, 1979	X	X						X	2
Leptoria phrygia (Ellis & Solander, 1786)	X					X	X	X	4
Montastrea annuligera ***(Edwards & Haime, 1849)***	X								1
Montastrea curta (Dana, 1846)	X	X				X	X		4
Montastrea valenciennesi (Edwards & Haime, 1848)						X			1
Oulangia bradleyi (Verrill, 1866)			X						1
Oulophyllia crispa (Lamarck, 1816)	X							X	2
Platygyra daedalea (Ellis & Solander, 1786)	X	X				X		X	4
Platygyra lamellina (Ehrenberg, 1834)	X	X					X	X	4
Platygyra pini Chevalier, 1975	X						X	X	3
Platygyra sinensis (Edwards & Haime, 1849)						X		X	2
Plesiastrea versipora ***(Lamarck, 1816)***	X	X						X	3
Family RHIZANGIIDAE									

Coral Order, Family and Species	AS	PA	JA	MHI	NWHI	WA	NMI	GU	Site Record
Culicia rubeola (Quoy & Gaimard)							X		1
Culicia sp.cf. *tenella* Dana, 1846				X					1
Family OCULINIDAE									
Acrhelia horrescens ***(Dana, 1846)***	X							X	2
Galaxea cf. astreata ***(Lamarck, 1816)***	X							X	2
Galaxea fascicularis ***(Linnaeus, 1767)***	X						X	X	3
Family MERULINIDAE									
Clavarina triangularis Veron & Pichon, 1979	X								1
Merulina ampliata (Ellis & Solander, 1786)	X	X				X		X	4
Family MUSSIDAE									
Acanthastrea echinata (Dana, 1846)	X					X	X	X	4
Acanthastrea sp.1								X	1
Lobophyllia corymbosa (Forskal, 1775)	X	X						X	3
Lobophyllia hemprichii (Ehrenberg, 1834)	X							X	2
Symphyllia radians ***(Edwards & Haime, 1849)***						X			1
Symphyllia recta ***(Dana, 1846)***	X					X			2
Symphyllia valenciennesii ***Edwards & Haime, 1849***	X								1
Family PECTINIIDAE									

Coral Order, Family and Species	AS	PA	JA	MHI	NWHI	WA	NMI	GU	Site Record
Echinophyllia aspera *(Ellis & Solander, 1786)*	X							X	2
Mycedium elephantotos (Pallas, 1766)	X								1
Oxypora lacera (Verrill, 1864)	X								1
Family CARYOPHYLLIIDAE									
Euphyllia (E.) glabrescens (Chamisso & Eysenhardt, 1821)	X						X	X	3
Plerogyra simplex ***Rehberg, 1892***	X								1
Plerogyra sinuosa ***(Dana, 1846)***							X	X	2
Polycyathus verrilli ***Duncan***								X	1
Family DENDROPHYLLIIDAE									
Tubastrea aurea ***(Quoy & Gaimard)***	X						X		2
Tubastraea coccinea Lesson, 1831	X	X		X	X				4
Turbinaria frondens ***(Dana, 1846)***	X								1
Turbinaria peltata (Esper, 1794)	X								1
Turbinaria reniformis Bernard, 1896	X								1
Order COENOTHECALIA									1
Family HELIOPORIDAE									
Heliopora coerulea (Pallas, 1766)	X						X	X	3
Order STOLONIFERA									

Coral Order, Family and Species	AS	PA	JA	MHI	NWHI	WA	NMI	GU	Site Record
Family TUBIPORIDAE									
Tubipora musica ***Linnaeus, 1758***								X	1
Order MILLEPORINA									
Family MILLEPORIDAE									
Millepora dichotoma Forskal, 1775	X						X	X	3
Millepora exaesa Forskal, 1775						X	X	X	3
Millepora platyphyllia Hemprich & Ehrenberg, 1834	X						X	X	3
Millepora tenera Boschma, 1949	X		X						2
Millepora tuberosa Boschma, 1966	X								1
Millepora sp.1	X								1
Family STYLASTERIDAE									
Distochopora gracilis Dana, 1846	X								1
Distochopora violacea (Pallas, 1776)			X					X	2
Distochopora sp.1								X	1
Stylaster gracilis Dana, 1846	X								1
Stylaster sp.			X						1
Order ALCYONACEA									
Family ALCYONIIDAE									
Lobophytum sp.1		X							1

Coral Order, Family and Species	AS	PA	JA	MHI	NWHI	WA	NMI	GU	Site Record
Sinularia abrupta Tixier-Durivault, 1970				X					1
Sinularia sp.1		X							1
Corallimorpharia spp.	X								1
Palythoa sp.	X	X	X	X					4
Tethya sp.	X								1
Zoanthus sp.	X			X					2
Number of: Scleractinians	222	82	29	51	13	39	53	159	
Acyonarians	4	1		1					
Hydrozoans	7	1	3			1	3	5	
Coelothecalia	1							1	

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Comment: *Oulangia bradleyi (Verrill, 1866): Johnston Atoll.* This record does not conform to the current taxonomy though is included subject to further clarification.

Table II.C.9: Zooxanthellate corals likely to be found in the American Flag Pacific Islands. (Adapted from Veron 1995.)

Family and genus	Extant species {no.}	Present distribution	General abundance
Astrocoeniidae Stylocoeniella	At least 3	Red Sea to central Pacific	Uncommon, cryptic
Pocilloporidae Pocillopora	Approx. 10	Red Sea and western Indian Ocean to far eastern Pacific	Very common, very conspicuous
Stylophora	Approx. 5	Red Sea and western Indian Ocean to southern Pacific	Very common, very conspicuous
Seriatopora	Approx. 5	Red Sea and western Indian Ocean to southern Pacific	Very common, conspicuous
Acroporidae	At least 80	Red Sea and western Indian	Extremely common
Acropora	At least 150	Cosmopolitan in Indo-Pacific reefs	Extremely common, very conspicuous, usually dominant
Astreopora	Approx. 15	Red Sea and western Indian Ocean to southern Pacific	Generally common, conspicuous
Poritidae Porites	Approx. 80	Cosmopolitan	Extremely common, conspicuous at generic level
Stylaraea	1	Red Sea and western Indian Ocean to westernPacific	Rare, occurs only in shallow,wave-washed biotopes
Goniopora	Approx. 30	Red Sea and western Indian Ocean to southern Pacific	Generally common, very conspicuous
Alveopora	Approx. 15	Red Sea and western Indian Ocean to southern Pacific	Sometimes common, very conspicuous
Siderastreidae Psammocora	Approx. 15	Red Sea and western Indian Ocean to far eastern Pacific	Generally common, sometimes cryptic
Coscinaraea	Approx. 12	Red Sea and western Indian Ocean to southern Pacific	Generally common, conspicuous
Agariciidae Pavona	Approx. 22	Red Sea and western Indian Ocean to far eastern Pacific	Very common, conspicuous
Leptoseris	Approx. 14	Red Sea and western Indian Ocean to far eastern Pacific and Caribbean and Gulf of Mexico	Sometimes common, mostly conspicuous
Gardineroseris	At least 2	Red Sea and western Indian	Generally

Family and genus	Extant species {no.}	Present distribution	General abundance
Pachyseris	Approx. 4	Red Sea and western Indian	Very common, very
Fungiidae Cycloseris	Approx. 16	Red Sea and western Indian Ocean to far eastern Pacific	Generally uncommon, non-reefal
Diaseris	At least 3	Red Sea and western Indian Ocean to far eastern Pacific	Generally uncommon, non-reefal
Fungia	Approx. 33	Red Sea and western Indian Ocean to southern Pacific	Very common, very conspicuous
Herpolitha	2	Red Sea and western Indian Ocean to western Pacific	Generally common, very conspicuous
Sandalolitha	2	Central Indian Ocean to southern Pacific	Sometimes common, very conspicuous
Halomitra	2	Western Indian Ocean to southern Pacific	Generally uncommon, very conspicuous
Oculinldae Galaxea	Approx. 5	Red Sea and western Indian Ocean to southern Pacific	Very common, very conspicuous
Acrhelia	1	Eastern Indian Ocean to southern Pacific	Generally uncommon, conspicuous
Pectiniidae Echinophyllia	Approx. 8	Red Sea and western Indian Ocean to southern Pacific	Very common, conspicuous
Oxypora	At least 3	Western Indian Ocean to southern Pacific	Generally common, conspicuous
Mycediurn	At least 2	Red Sea and western Indian Ocean to southern Pacific	Generally common, conspicuous
Mussidae Acanthastrea	Approx. 6	Red Sea and western Indian Ocean to southern Pacific	Generally uncommon, Favites-like
Lobophyllia	Approx. 9	Red Sea and western Indian Ocean to southern Pacific	Very common, very conspicuous
Symphyllia	Approx. 6	Red Sea and western Indian Ocean to southern Pacific	Generally common, very conspicuous
Merulinidae Hydnophora	Approx. 7	Red Sea and western Indian Ocean to southern Pacific	Generally common, very conspicuous
Merulina	3	Red Sea and western Indian Ocean to southern Pacific	Sometimes common, conspicuous

Family and genus	Extant species {no.}	Present distribution	General abundance
Scapophyllia	1	Eastern Indian Ocean to	Generally
Faviidae	Approx. 4	Red Sea and western Indian	Generally common,
Favia	At least thirty	Cosmopolitan	Extremely common, conspicuous
Favites	Approx. 15	Red Sea and western Indian	Very common,
Goniastrea	Approx. 12	Red Sea and western Indian Ocean to southern Pacific	Very common, generally conspicuous
Platygyra	Approx. 12	Red Sea and western Indian Ocean to southern Pacific	Extremely common, conspicuous but may be confused with Goniastrea
Leptoria	2	Red Sea and western Indian	Sometimes common,
Oulophyllia	Approx. 3	Red Sea and western Indian Ocean to western Pacific	Sometimes common, conspicuous
Montastrea	Approx. 13	Cosmopolitan	Generally common, conspicuous
Plesiastrea	At least 2	Red Sea and western Indian Ocean to far eastern Pacific	Sometimes common
Diploastrea	1	Red Sea and western Indian Ocean to southern Pacific	Generally common, very conspicuous
Leptastrea	Approx. 8	Red Sea and western Indian Ocean to southern Pacific	Generally common, conspicuous
Cyphastrea	Approx. 9	Red Sea and western Indian Ocean to southern Pacific	Very common, conspicuous
Echinopora	Approx. 7	Red Sea and western Indian Ocean to southern Pacific	Very common, conspicuous
Caryophylliidae Euphyllia	9	Red Sea and western Indian Ocean to southern Pacific	Generally common, very conspicuous
Plerogyra	3	Red Sea and western Indian Ocean to southern Pacific	Generally uncommon, very conspicuous
Dendrophylliidae Turbinaria	Approx. 15	Red Sea and western Indian Ocean to southern Pacific	Very common, very conspicuous

Family and genus	Extant species {no.}	Present distribution	General abundance
Duncanopsammia	1	Central Indo-Pacific	Uncommon, very conspicuous

8. Ahermatypic Corals (Azooxanthellate)

Important Summary Documents

Veron (1986) describes the three genera with photos of living and skeletal examples.

Taxonomic Issues

Order Scleractinia; Family Dendrophylliidae; Genera *Dendrophyllia* (de Blainville, 1830), *Tubastraea* (Lesson. 1829), *Balanophyllia spp.* (Wood, 1844). *Duncanopsammia axifuga* is of the same family and has a skeletal structure and growth form intermediate between hermatypic and ahermatypic forms. As it is zooxanthellate, it is not described here. Other zooxanthellate corals such as *Heteropsammia* and *Psammoseris* (both Dendrophyllidae), *and Heterocyathus* (Caryophylliidae) are they small, single polyp forms and appear as partial ahermatypes (Veron, 1986). Their contribution to reef growth is minor and they occur on sand and rubble substrates. Heteropsammia spp. doesn't occur in the AFPI.

Other genera occur in deep water or deep inter-reef areas and are listed with their recorded depth range (after Veron, 1986): Letepsammia (165-457m); Fungiacyathus (190-600m); Madrepora (55-450m); Cyathelia (40m); Culicia and Astrangia (inter-tidal to 128m, largely temperate); Flabellum (10-824m); Placotrochus (to 188m); Monomyces (3-40m); Gardineria (55m); Anthemiphyllia (to 210m); Caryophyllia (119-1006m); Tethocyathus; Premocyathus (20-230m); Cythoceras (86-766m); Trochocyathus (86-531m); Deltocyathus (16-531m); Boureotrochus (210-531m); Sphenotrochus; Polycyathus (>40m); Aulocyathus (163-190m); Conotrochus (210-365); Stephanocyathus (366-1006m); Oryzotrochus (9-15m); Conocyathus (8-22m); Trematrochus (>27m); Dunocyathus (100-531m); Paracyathus(>20m); Patytrochus (28-183m); Cylindrophyllia; Peponocyathus (339-365); Holcotrochus (11-183m); Desmophyllum; Solenosmilia (860m); Stenocyathus (455-531m); Septosammia (8-86m); Endopachys; Notophyllia (36-457m); Thecopsammia (270m).

Habitat Utilization

Not dependent on light so able to colonizes overhangs and caves. Competes best in areas of low scleractinian coral or algal occurrence. *T. micrantha* competes best due to its erect arborescent nature and may be dominant below 15m in areas of exposed currents.

Life History

Adult: Appearance and Physical Characteristics

Dendrophyllidae :
Solitary and colonial corals with more than two rings of tentacles on the polyps. Numerous skeletal element of the ridges form an almost continuous sheet and rods connect adjacent ridges. *Dendrophyllia* and *Tubastrea spp.* may appear similar superficially but are separated by differences in septal plans.

Dendrophyllia spp.: Often brightly colored (yellow or orange) resulting from the corals own pigment, as no zooxanthellae are present. Colonies are dendroid and proliferate through extra-tentacular budding. Generally nocturnal but also diurnal extension.

Tubastraea spp.: Tubular corallites forming hemispherical colonies. *Tubastrea aurea* forms domed clumps up to 10cm dia. Polyps protrude for a common encrusting base. Usually found in low-light conditions in caves and beneath rocky overhangs. Common species *T. faulkneri, T. coccinea, T. diphana and T. micrantha.*

Tubastrea micrantha forms tree-like branching colonies to 1m in height. Colour dark brown and green. Occurs in deeper reef environments.

Balanophyllia spp.: Solitary corals which bud to form closely packed clumps. Clumps may be 50cm diam. Thick walls. Polyps are oval and tapering towards the base, and the septa are fuse. Color black, bright-orange or yellow polyps.

Feeding and Food

Heterotrophic with dependence on the capture of zooplankton. Nocturnal and diurnal feeding.

Reproductive Strategies

Dioecious. Fertilization is internal and larvae are brooded. Asexual larval reported (Richmond and Hunter, 1990). The larvae are 1mm long and crawl or swim after release before settling. They may also be free-spawners (Harrison and Wallace, 1990). Planula takes four to seven days before they settle and form a primary polyp.

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Table II.C.10: Deep-water Ahermatypes from Hawaii. (From Maragos 1977; data Vaughan (1907)).

Species	Shallowest Collection Record
Anisopsammia amphelioides (Alcock)	40 fm
Anthemiphyllia pacifica Vaughan	92 fm
Balanophyllia desmophyllioides Vaughan	78 fm
Balanophyllia diomeseae Vaughan	148 fm
Balanophyllia hawaiiensis Vaughan	190 fm
Balanophyllia laysanensis Vaughan	130 fm
Bathyactis hawaiiensis Vaughan	963 fm
Caryophyllia alcocki Vaughan	876 fm
Caryophyllia hawaiiensis Vaughan	92 fm
Caryophyllia octopali Vaughan	28 fm
Ceratotrochus laxus Vaughan	319 fm
Cyathoceras diomedeae Vaughan	169 fm
Deltosyathus andamanicus Alcock	147 fm
Dendrophyllia oahensis Vaughan	154 fm
Dendrophyllia serpentina Vaughan	147 fm
Desmophyllum cristagalli Milne- Edwards & Haine	
Endopachys oahense Vaughan	53 fm
Flabellum deludens v. Marenzeller	670 fm
Flabellum parvoninum Lesson	127 fm
Gardineria hawaiiensis Vaughan	272 fm
Madracis kauaiensis Vaughan	24 fm
Madrepora kauaiensis Vaughan	294 fm
Paracyathus gardineri Vaughan	
Paracyathus mauiensis Vaughan	95 fm
Paracyathus molokensisx Vaughan	88 fm
Paracyathus tenuicalyx Vaughan	252 fm
Placotrochus fuscus Vaughan	148 fm
Stephanophyllia formosissima Moseley	66 fm
Trochocyathus oahensis Vaughan	252 fm

9. Actiniaria (anemones)

Important Summary Documents

Symbiosis between anemones and fish was first noted by Collingwood (1868). Fishelson (1970, 1971) speculated on the ecological role of this association. The taxonomy of symbiotic anemones was revised by Dunn (1981). The taxonomy of the Hawaiian anemones were described in Eldredge and Devaney (1977). Chia (1976) has described reproduction in terms of patterns and adaptive radiation. Fautin and Allen (1992) describe the biology of anemonefish and their host anemones.

Taxonomic Issues

Ecotypes are common (e.g. *Entacmaea quadricolor)* which has given rise to taxonomic confusion Allen (1975) described the deeper water as *Radianthus gelam* and the smaller individuals a *Physobranchia douglasi.* Their ability to adopt a varied coloration both in terms of background color and geographic variation has made taxonomy difficult.

Habitat Utilization

Anemones attach to hard substrate by their basal disc, burrow into soft substrate or attach as symbionts to sessile and mobile reef creatures.

Life History

Adult: Appearance and Physical Characteristic

Anemones have a body column and oral disc with tentacles with nematocysts and a central mouth. They are attached by a basal or pedal disc to the substrate (Barnes, 1980). They are often associated with symbiotic relationships such as with fish or shrimps (Fautin and Allen, 1992). *Heteractis magnifica* reaches a diameter of 30-50cm though may reach 1m.

Ten species are recognized as symbiotic anemones (Actiiidae; Thalassianthidae; Stichodactylidae).

Both *Actinodendron plumosum* and *Phyllodiscus semoni* have severe stings if touched.

Some species of anemones can exhibit mimicry appearing like their background or other reef entities like hard coral or algae.

Age, Growth, Longevity

The growth of tropical anemones is variable being largely dependent on nutrition. Longevity among tropical anemones is poorly known. Anemones approaching a meter in diameter may exceed 100 years old (Fautin and Allen, 1992). *Actinia tenebrosa* requires 8 to 66 years to reach a column diameter of 40mm and has an average longevity of 50 years (Ottaway, 1980).

Reproductive Strategies

Asexual: Common: Pedal laceration and longitudinal or transverse fission

Asexual reproduction has been observed as budding (Vine, 1986). Devaney & Eldredge (1977) describe *Boloceroides mcmurrichi* as reproducing sexually in spring and asexually in fall when the asexually young arise as buds on the outer tentacles and are shed when they have developed 10 to 30 tentacles.

Eggs and sperm are produced and host anemones appear to be characterised by separate sexes.

Absence of small individuals is indicative of low fertilization, larval survival or larval settlement or young have high mortality (Fautin and Allen, 1992).

Most are hermaphroditic but reproduce only one type of gamete per reproductive period. Groups of clones evident.

Distribution

Anemones are often widely distributed. The common anemone *Entacmaea quadricolor* is found from Samoa to East Africa and the Red Sea and from the surface down to 40 metres. Of nearly 1000 species, only 10 species are host to anemone fishes. In Hawaii, There is only one host species recorded from Hawaii though without commensal fish (Fautin and Allen, 1992).

Feeding and Food

Anemones are polyphagous opportunists (Ayre 1984). Prey is caught by the tentacles, paralyzed by nematocysts and carried to the mouth. The food consists of plankton borne crustacea but fish worms, and algal fragments are includes Sand dwelling anemones such as *Heteractis malu* ingest gastropods (Shick, 1990) as does *Catalophyllia sp.* Some anemones are suspension feeders (Barnes , 1980).

Specialized corallimorpharians such as *Rhodactis, Actinodiscus, Discosoma, Amplexidiscus* can capture large prey by enveloping them with the entire disk (Hamna and Dunn, 1980; Elliott and Cook, 1989).

Anemones which contain symbiotic zooxanthelle but also capture plankton and other detrital or water borne food. Those without zooxanthella are dependent on plankton and may capture pother food such as crustaceans or smaller fish.

Absorption of dissolved organic material (DOM) by anemones occurs Schlichter (1980) and Schlichter et al. (1987). DOM is important in times of no solid food. (Shick, 1975)

Extracellular digestion is achieved by mesenterial filaments (Nicol, 1959)

Some species of anemones extend their tentacles at night and diminutive during the day (*Alicia sp).* Others feed during daylight hours.

Behavior

The family Boloceriodidae contains anemones capable of swimming by beating their tentacles. The Hawaiian species *Boloceroides mcmurrichi* has a large crown of tentacles compared to a relatively

small body. They become capable of swimming at the 10 to 30 tentacle stage (Devaney and Eldredge, 1977).

Edwardsia spp. are found on sandy bottoms and dig themselves into the substrate.

Anemones are basically sedentary but are able to move over the substrate slowly, some can swim for short distances.

There commensal behavior with fish where it gains protection and food and in turn protects the anemone from some predators and removes sediment and other material by its swimming motion (Barnes, 1987).

Spawning: Spatial and Temporal Distribution

Spawning is synchronised with the full moon or low tide (Fautin and Allen, 1992).

Eggs are fertilized in the gastrovascular cavity or occurs outside in the seawater (Fautin and Allen, 1992).

Free swimming planula

Larval Feeding and Food

Ingest copepods, chaetognaths, or larvae of other cnidarians. Unicellullar algae and dinoflagellates has been observed Widersten, 1968; Siebert, 1974)

The planula may be planktotrophic or lecithotrophic and has a variable larval life span. The young sea anemone lives as a ciliate ball, unattached and free swimming. The larvae settles, attaches and forms tentacles.

Habitat Utilization

Asexual of reproduction give rise to many individuals in close proximity, often forming a continuous surface by adjacent oral discs. Like other sessile benthos, settlement of larval stages colonizes available substrate.

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Table II.C.11: Actinaria from Hawaii (Cutress, 1977).

Order ACTINIARIA

Family BOLOCEROIDIDAE
Boloceroides memurrichi (Kwietniewski 1898)
Bunodeopsis medusoides (Fowler 1888)

Family ALICIIDAE
Triactis producta Klunzinger 1877

Family ACTINIIDAE
Anemonia mutabilis Verrill 1928
Anthopleura nidrescens (Verrill 1928)
Anthopleura sp. *a*
Anthopleura sp. *b*
Actiniogeton sesere (Haddon & Shackleton 1893)
Cladactella manni (Verrill 1899)

Family STOICHACTINIDAE
Antheopsis papillosa (Kwietniewski 1898)
Stoichactis sp.

Family PHYMANTHIDAE
Heteranthus verruculatus Klunzinger 1877

Family ISOPHELLIDAE
Telmatactis decora (Hemprich and Ehrenberg 1834)
Epiphellia pusilla (Verrill 1928)
Epiphellia humilis (Verrill 1928)

Family HORMATHIIDAE
Calliactis polypus (Forskal 1775)

Family SAGARTIIDAE
Anthothoe sp.

Family AIPTASIIDAE
Aiptasia pulchella Carlgren 1943

Family DIADUMENIDAE
Diadumene leucolena (Verrill 1866)

Family EDWARDSIDAE
Edwardsia sp. *a;*. *Edwardsia* sp. *b.*

10. Zoanthidae (colonial anemones)

Important Summary Documents

Hyman (1940) details systematics and anatomy. Mather and Bennett (1993) discuss the order Zoanthidae. Burnett et al. (1997) a good summary of systematics for some central Indo-Pacific species. Walsh (1967) produced an annotated bibliography for the family.

Taxonomic Issues

Class Anthozoa; subclass Zoantharia (=Hexacorallia); order Zoanthiniaria (=Zoanthidea); suborder Brachcnemina; family Zoanthidae; genera Acrozoanthus; *Zoanthus; Isaurus; Protopalythoa; Palythoa; Sphenopus. s*uborder Macrocnemina; family Epizoanthidae; genera *Epizoanthus; family* Epizoanthidae, *Thoracactis*; genus *Parazoanthus, Gerardia, Isozoanthus* (Barnes, 1987; Muirhead and Ryland, 1985).

Poorly known due to reliance on preserved specimens and a high degree of inter-population variability. Nominal species 300.

Differentiated from the Actinaria by the presence of a fifth cycle of mesenteries.

Zoanthiniarian systematics is discussed by Herberts (1972a; 1987) and Mather and Bennett (1993).

Habitat Utilization

Often distinct zonation: back reef flats, lagoon floors, reef crests and shallow sublitoral zone. Palythoa spp.: Growth in large numbers on reef flats immediately behind the reef crest, also found on lagoon floors and the spur and groove channels of reef slopes. Tide pools in Hawaii.

Parazoanthus ssp., Epizoanthus ssp., Acrozoanthus spp.: May colonize worm tubes, hydroids, sponges and gorgonian skeletons. May be epizootic on sponges, or ascideans as ATuff Balls or providing as protection (Colin and Arneson, 1995).

Protopalythoa spp.: Shallow fore reefs, reef crests or outer reef flat areas. Shallow reef zones may be dominated by this genus and cover may be >90%. May occur as small assemblages of polyps or separate individuals.

Zoanthus spp.: They are found in back reef areas and the shallow sub-littoral zone.

Life History

Adult: Appearance and Physical Characteristics

Zoanthid anemones are solitary or colonial, zooxanthellate (except *Sphenopus*). Principal tropical genera are *Palythoa, Protopalythoa* and *Zoanthus.* Generally, discs are 1-2cm in diameter with tentacles 3-5mm long but may extend to 2-3cm. Coloration varies from red, orange, yellow, turquoise,

green or brown. The stem (scapus), disc (capitulum), tentacles or coenenchyma vary in coloration. Zooanthids differ from other Zoantharia in that they don't produce skeleton but incorporate sediment into the body wall. As well, they don't have a pedal disc and a differing septal arrangement (this forms the basis for the two suborders).

Isaurus spp.: Loosely connected colonies without connecting stolons. Height varies 15- 160cm. Colonies with < 50 individuals. Taxonomically best known (Muirhead and Ryland, 1985). Often inconspicuous. Nocturnal tentacular extension.

Palythoa spp.: Growth in massive colonies. Sand particles are encrusted into the coenenchyme. Colonies are convex and 30cm. Coenenchyme is light brown to yellow.
Often buried in the sand to the level of the disc.

Protopalythoa spp.: Generally in loosely connected colonies. Often the polyps lack contact or have contact at the base through a stolon. Polyp height is 15-25 mm high and 7-11mm in diameter. Expanded discs may attain a diameter of 2-3cm. May occur as large areas of colonization, small assemblages or individual polyps. Polyps are encrusted with sand particles. For some, full retraction is not possible due to the size of the disc. Colour is uniform on the stem and disc; brown or green. It may be variable due to the intensity of light.

Zoanthus spp.: Sediments are not incorporated in their tissues but are tolerant of sediment environments. Most species are brightly coloured, often contrasting disc, tentacles and stem.

Growth

Growth morphology may depend on the environment. *Z. pacificus* has a lamellar coenenchyme with crowded polyps and separate bases. In surge pools, the bases are joined and crowding less. In wave washed area the coenenchyme can be lamellar or stoloniforous with single polyps or groups of two or three (Walsh and Bowers, 1971).

In *Palythoa,* growth is by the spreading of the thickened coenenchyme. Yamazato et al. (1973), found 0.18 new polyps per day increase in *Palythoa tubercles.* Density of colonies may be 671 polyps/0.1m^2 (*Zoanthus sociatus*) and 302 polyps/ 0.1m^2 for *Z. solanderi.* (Karlson, 1981). 12,000/m^2 of *Palythoa vestitus* where found in Kaneohe Bay.

Distribution

Isaurus spp: Widespread in all tropical seas; present in Hawaii.

Palythoa spp.: Pan-tropical; present in Hawaii.

Protopalythoa spp.: Pan tropical; occurs in Hawaii, American Samoa and Tahiti.

Zoanthus spp.: Pan-tropical; occurs in Hawaii, American Samoa and Tahiti.

Feeding and Food

Heterotrophic (zooplankton); autotrophic (zooxanthellae) (Reimer 1971b).

Muscatine et al. (1983) determined zooxanthellae could provide 48% of the carbon requirement for *Zoanthus sociatus.*

Palythoa, Protopalythoa and Zoanthus are diurnal in expansion. Others are nocturnal Isaurus and Sphenopus. Able to ingest a variety of live and dead crustacea and fish portions (Reimer, 1971a). Crustacean and detrital fragments were found in *Zoanthus Sociatus*, though few contained food items with only a greater frequency at night (Sebens, 1977). Azooxanthellate genera (*Epizoanthus and Parazoanthus)* rely greatly on feeding to obtain sufficient nutrition.

The uptake of dissolved organic matter may contribute to nutrition (Reimer, 1971; Trench, 1974). The common presence of *Zoanthus* spp and *Protopalythoa* in shore may be due to the higher organic levels. With the reduction in sewage contamination in Kaneohe Bay, zoanthid population declined.

Isaurus spp: Autotrophic nutrition from the zooxanthellae but also feeds on plankton nocturnally. Polyps never open in the day.

Palythoa spp.: Generally autotrophic but tentacles and diurnal expansion indicate reliance on zooplankton.

Protopalythoa spp.: Heterotrophic; autotrophic

Zoanthus spp.: Heterotrophic; autotrophic

Reproductive Strategies

Asexual by the arising of new polyps from a spreading sheet of coenenchyma or stolons or budding from the parent polyp. Extensive monoclonal colonies occur.
Fragmentation is common.

Sexual reproduction: Both dioecious (gonochoristic) and sequential and simultaneous hermaphrodites.

Isaurus spp: Unknown.
Palythoa spp.: Readily reproduces asexually. Yamazoto et al. (1973) studied the reproductive cycle of *Palythoa tuberculosa* in Okinawa. The oocytes grow from March/April, to a peak in the middle of the year, which followed by a second peak in October indicative of two spawnings per year. Mature eggs are rather large with a length of 300-500um.

Protopalythoa spp.: Asexual and sexual. Babcock and Ryland (1990) and Ryland and Babcock (1991) describe reproduction and larval development.

Zoanthus spp.: Asexual and sexual. Cooke (1976) describes reproduction for *Zoanthus pacificus* and for *Z. solanderi and Z. sociatus* by Fadlallah et al. (1989).

Spawning: Spatial and Temporal Distribution

Ovaries develop initially in the cycle along the margin of the mesenteries with the testis later in the cycle. Seasonal free spawning. Report of spawning synchronous with the mass spawning of the stony coral, on the 4th to 6th nights after full moon in November (Ryland and Babcock, 1991). In Hawaii, *P. versitis* was only active May to September while *Z. pacificus* was bound to be sexually active all year but greatest during the summer (Cooke, 1976).

Eggs and Larvae

Egg diameter range from 75um to 280 um. Sperm are bell shaped and 50 um long. Egg counts range from 800 to 2400 (Ryland and Babcock, 1991). Larvae settle in areas of coralline algae and crawl to find a site. Suitable sites are often shaded. Fecundity is high and settlement rates are low. Sexual reproduction is therefore thought to allow for dispersal and colonization over large distances (Karlson, 1981).

The larvae are oval in shape and have a girdle of cilia near the oral end. The Larvae of *Protopalythoa spp.* are referred to as zoanthella and are elongate with a ventral band of long cilia (Hyman, 1940).

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Table II.C.12. Zoanthiniaria from Hawaii: (Walsh and Bowers 1971).

Order ZOANTHINIARIA

Family ZOANTHIDAE
Isaurus elongatus Verrill 1928
Palythoa vestitus (Verrill 1928)
Palythoa tuberculosa (Esper 1791)
Palythoa psammophilia Walsh and Bowers 1971
Palythoa toxica Walsh and Bowers 1971
Zoanthus pacificus Walsh and Bowers 1971
Zoanthus kealakekuaensis Walsh and Bowers 1971

11. Subclass Alcyonaria (=Octocorallia); Order Alcyonacea; Suborder Alcyoniina (soft corals)

Important Summary Documents

Bayer et al. (1983) and Bayer (1981) details anatomical terminology and taxonomy.
Hyman, (1940) describes the anatomy.

Taxonomic Issues

Subclass Alcyonaria (=Octocorallia); order Alcyonacea; suborder Alcyoniina: families: Paralcyoniidae; Alcyoniidae; Asterospiculariidae; Nephtheidae; Nidaliidae; Xeniidae

The taxonomy of common intertidal and lagoon genera *Sarcophyton* and *Sinularia* are revised in Verseveldt (1980, 1982).

Habitat Utilization

Colonies characteristic of large size grow in shallow water areas in high light intensity and intertidally. Generally colonies are smaller on roofs of caves.

Life History

Adult: Appearance and Physical Characteristics

Alcyonaria: Colonial, tentacles and mesenteries 8 with tentacles pinnate attached.
Alcyonacea: Alcyoniina (Soft corals): Fleshy, stolon, membranous, encrusting or erect with tree-like branching. Monomorphic polyps (autozooids: function in food intake, water movement and bear the gonads). Some genera have dimorphic polyps (autozooids and tentacle-less siphonozooids) e.g. *Lobophytum spp.* and *Sarcophyton spp.* Dimorphism attributed to need for transport of water (Bayer, 1973). Skeleton has calcite spicules (sclerites). Coenechyme is the general colonial mass filled with solenia that connect with the polyps and their anthocodium. Tentacular contraction possible in some and only partial in others.

Zooxanthellate with resulting colour of greens to brown or bright coloration in the sclerites.

Paralcyoniidae: Lobed to arborescent upper portions and are able to retract this region into the lower stalk. Rigidly reinforced with large sclerites.

Alcyoniidae: Large, lobed colonial forms with considerable amounts of scleritic coenenchyme.

Nephtheridae: The coenenchyme between polyps is thin, arboresent with polyps grouped at the ends of branches. Hydrostatic pressure important to provide support.

Nidalidae: Rigid, brittle, arborescent colonies with narrow stems and branches. Densely covered with spindle shaped sclerites. Similar in appearance to gorgonians Xeniidae: Fleshy with sclerite mass reduced. Characterized by tentacular oscillation.

Age, Growth, Longevity

Two main growth forms massive and arborescent.

Growth by vegetative budding from the system of solenial canals between confluent coenenchyme. Mucus production high in some and effective in cleaning of the surface of the colony. Colonies are often prolific with numerous colonies covering large areas. In Guam population density of up to 24 colonies per square meter of *Asterspicularia randalli* (Gawel, 1976).

Distribution

Occurring in all oceans at all latitudes, they are most abundant in the tropics.

Paralcyoniidae: *Studeiroides spp.: Indo-Pacific*

Alcyoniidae: *Sarcophyton spp./ Lobophytum spp.: Cladiella spp.:* Very common in the Indo-Pacific. *Sinularia spp.:* Indo-Pacific Philippines, Malayan Archipelago Great barrier Reef- Australia, Vietnam, Palau, New Caledonia and the Ryukyu Island, Japan.

Asterospiculariidae: *Asterospicularia sp.:* Guam

Nephtheidae: *Capnella spp. / Nepthea spp. / Dendroneptha spp.:* Very common in the Indo-Pacific.

Nidaliidae: *Chironephthya spp./ Nephthyigorgia spp/ Siphonogorgia spp.*: Very common in the Indo-Pacific.

Xeniidae: *Xenia spp./ Cespitularia spp.:* Indo-Pacific

Feeding and Food

Heterotrophic through zooplankton capture. Autotrophic through nutrient exchange with zooxanthellae, digestion of zooxanthellae and absorption of dissolved organic matter in the seawater (Fabricius, et al. 1995a,b).

Food is taken in through the mouth. Prey are immobilized by nematocysts and conveyed to the mouth by tentacles.

Behavior

Defensive

Chemical substances provide advantage over other organisms for protection by preventing feeding or securing space on the reef. Majority of species of soft corals contain toxic terpene compounds which they release in to their surroundings (Coll et al. 1982; and Coll and Sammarco 1983; 1986; Sammarco et al. 1983; Webb and Coll 1983). These may influence the reproductive capability or survivorship of scleractinian corals (Aceret et al. 1995a,b).

Physical defenses involve the use of sweeper tentacles, sclerites, overtopping,

Reproductive Strategies

Asexual: Almost all increase colonial numbers through mechanisms such as fragmentation, budding, transverse fission and pedal laceration.

Fragmentation: Takes place in *Dendronephthya* in 5-10 days (Fabricius, 1995). Fragmentation can occur through constriction or though parting of the stolons.

Sexual: Dioecious and hermaphroditic. Gonads occur on the mesenteries and reproduction involves the release of gametes into the surrounding water. Fertilization may occur externally through broadcast spawning or within the polyp cavity. Internal fertilization gives rise to an internal brooded planula. Also internal fertilization may give rise to an externally brooded planulae. (Benayahu, and Loya 1983, 1984a, 1984b; Yamazato et al. 1981).

Alcyonium, Heteroxenia, Lobophytum, Parerythropodium, Sarcophyton and Xenia planulae were released between 11 and 13 days after the full moon in November. Egg size range from 625um (*Lobophytum*) to 810um (*Sarcophytum)* (Alino and Coll, 1989). Some are may be dioecious, external surface planula brooders (Benayahu, and Loya, 1983; 1984b; 1986). Presence of zooxanthellae is likely in planulae.

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12. Subclass Alcyonaria (=Octocorallia); Order Alcyonacea; Suborder Scleraxonia; Holoaxonia (gorgonian corals, sea fans and sea whips)

Important Summary Documents

Bayer (1956, 1973, and 1981) summarizes taxonomy and anatomy.

Taxonomic Issues

Subclass Alcyonaria (=Octocorallia); Order Alcyonacea; Suborder Scleraxonia; Families: Briareidae; Anthothelidae; Subergorgiidae; Coralliidae; Melithaeidae; Parisididae; Holoaxonia; Families: Acanthogorgidae; Plexuridae; Gorgoniidae; Ellisellidae; Ifalukellidae: Chrysogorgiidae; Primnidae; Isididae.

Habitat Utilization

Strong current location; low light conditions such as depths and overhangs.

Life History

Adult: Appearance and Physical Characteristic

Generally arborescent in nature, some unbranched. Skeletal support by stiff axis utilizing the flexible gorgonin. Divided taxonomically on basis of a central supporting axis (gorgonin and fused sclerites) or core (cortex around chambered gorgonin). Polyps have pinnate tentacles, anthocodia sit in coenenchymal calyx and sheath is formed around the central axis.

The main stem is attached by to a plate or branchlets to the surface. Stem contains a central strengthening rod. The rod may be calcareous but is commonly of horny gorgonin. Short polyps occur all over the branches of the colony but not on the main stem. Colonies are often brightly colored and may reach 3m in height. Epizoic life common (George and George, 1979).

From (George and George, 1979):

Suborder Scleraxonia

Briareidae: Erect, finger-like processes of spongy texture (20cm height) or massive and encrusting. Zooxanthellate. Polyps monomorphic

Anthothelidae: Thinly branched sea-fan. Fragments easily. Polyps monomorphic.

Subergorgiidae: Sea-fan with anastomosing branches (1m height), strong and flexible, polyps monomorphic.

Coralliidae: Calcareous skeleton with color from pink to red. Retractile white feathery polyps and branch in any plane. Polyps dimorphic.

Melithaeidae: Sea-fan with jointed axis and brittle (50cm height).

Suborder Holoaxonia

Plexuridae: Dichotomously branched species.

Gorgoniidae: Sea-fan with anastomosing box-section branches, flattened, bushy or feathery branches (1m height).

Ellisellidae: Whip-like (1m long).

Primnidae: Stems stiff and heavily calcified. Polyp bases composed of spicules are arranged in whorls around the stem.

Isididae: Parallel with upright branches

Age, Growth, Longevity

Photosynthetic gorgonians grow rapidly 15 cm (*Gorgonia ventalin*); 2.5 cm/mon./branch *Pseudoplexaura spp and Pseudopterogorgia acerosa* (Sprung and Delbeek 1997)

0.8-4.5cm/yr. found in Puerto Rico. (Yoshioka and Buchanan-Yoshioka 1991)
Small colonies grow vertically faster but not necessarily in area.

Distribution

Cosmopolitan though most abundant in warmer waters.

Indo-Pacific occurrence:
Suborder Scleraxonia
Briareidae: *Solenopodium spp.; Briareum spp.*
Anthothelidae: *Erythropodium spp*
Subergorgiidae: *Subergorgia spp*
Melithaeidae: *Melithaea spp.; Mopsella spp.*
Ellisellidae: *Ellisella spp. / Junceella spp.*

Suborder: Holoaxonia
Acanthogorgidae: *Acanthogorgia spp.; Muricella spp.*
Plexuridae: *Bebryce spp.*
Gorgoniidae: *Lophogorgia spp.*
Chrysogorgiidae: *Stephanogorgia sp.*
Isididae: *Isis spp.*

Feeding and Food

Heterotrophic by the capture of zooplankton. Autotrophic through nutrient translocation from zooxanthellae. Relative few holoaxonic zooxanthellate genera in the Indo-Pacific. Particulate feeding described (Lasker, 1981)

Require strong current situations for effective feeding by fan-like colonies.

Behavior

Periodic shedding of the waxy cuticle as a means of surface cleaning.

Reproductive Strategies

Parthenogenetic planulae production possible with planulae internal brooders (Brazeau and Lasker, 1989) though most where produced through broadcast spawning (Lasker and Kim, 1996).

Clonal propagation occurs (Lasker 1990).

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13. *Heliopora coerulea* (DeBlainville, 1830) (Alcyonaria, Coenothecalia) (blue coral)

Important Summary Documents

Zann and Boulton (1985) detail the distribution, abundance and ecology in the Pacific. Hyman (1940) and Bayer (1973, 1981) describe the anatomy and taxonomy.

Taxonomic Issues

Subclass Alcyonaria (=Octocorallia): Order Coenothecalia (=Helioporacea); monotypic, family Helioporidae with a single species. It is a soft coral with a hard, >stony coral-like= skeleton.

Habitat Utilization

High abundance of *Heliopora* is attributed to a reduction in competition from *Acropora, Pocillopora* and faviids in areas where theses are mutually exclusive. *Heliopora* frequently co-existed with *Porites* and *Montipora.* In terms of interspecific aggression, Heliopora is a good competitor as both *Acropora* and *Pocillopora* are considered aggressive (Lang, 1973).

It is a warm-water generalist with a wide habitat range.

Life History

Adult: Appearance and Physical Characteristics

Zooxanthellate and colonial with a blue calcium carbonate skeleton which is the result of iron salts (Hill, 1960). Bouillon and Houvenaghel-Crevecoeur (1970) conclude the blue pigmentation is composed primarily of biliverdin IX and secondary oxidation products. (Hyman, 1940) describes the skeleton as composed of crystalline slivers of aragonite fused into a layer. There are no sclero-proteinaceous structures as in the rest of the Octocorallia. The skeleton contains strontium but in smaller amounts in comparison to hermatypic scleractinia.

Colour and growth form is highly variable: corallum pale to deep blue; living coral is light brown-grey with extended polyps grey-white. Growth forms: encrusting, columnar and branching (coalescent compressed, flabellate fronds, fine branching). May form massive micro-atolls (Zann and Boulton, 1985). Appears like a species of *Millepora.* There is a clear correlation between colony shape and environmental conditions (Veron 1986).

Skeleton with blind tubes internally one for the polyps and one for the solenia (Hyman, 1940).

Reproductive Strategies

Dioecious with fertilization taking place internally and the eggs are brooded externally (Babcock, 1990). External brooding is where they fertilized eggs are shed from the polyp and adhere to the side in mucus pouches were they the developed until they are released. Weingarten (1992) describes a synchronous annual of oocytic development following the general octocorallian reproductive strategy. The gametes are typically released in January, after the full moon, at the summer thermal maximum. Where its distribution is geographically marginal, it takes more than one year for the gametes to mature. It broods its larvae, which settle immediately after release.

Zann and Boulton (1985) suggest the limitation to its distribution to more isolated areas due to a relatively short larval life span. The short larval stage may be nutrient limited as the planula is azooxanthellate.

Distribution

Duration of larval life span, prevailing currents, and the geological and climatic history of isolated archipelagoes determine its distribution. Though widely distributed since the Cretaceous, now more abundant in the equatorial Central Pacific than in the Western Pacific. Comprises 16% of beach sediment in Tuvalu and 40% of substrate between 6m and 10m on Tarawa Atoll, Kirribati. Competition with Acroporidae and Faviidae influence its occurrence (Zann and Boulton, 1985). Globally, it occurs along West Africa, Red Sea, Indonesia and the Maldives, where it may be the dominant coral fauna. It occurs as far south as Madagascar and north to the Ryukyu Islands in Japan (Veron, 1986).

With regard to the AFPI, it is only present in Guam (Randall, 1977), Commonwealth of the Northern Marianas and American Samoa (rare) (U.S. Army Corps Engineers 1980).

Its habitat distribution is inter-tidal reef flats, reef front reef slope in Guam from < 1m to >30m. It is uncommon or rare (e.g. GBR; American Samoa) while it is abundant elsewhere. Heliopora zones have been described in the Marshall Islands and where it is considered as the most common coral (Emory et al. 1954; Wells, 1954a).

Feeding and Food

Heterotrophic and autotrophic by virtue of its zooxanthellae symbiosis. Prey capture is tentacular using nematocysts. Other sources of nutrition may be dissolved organic material and suspension feeding.

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14. *Tubipora Musica* (Linnaeus, 1758) (organ-pipe coral or star polyps)

Important Summary Documents

Veron (1986) describe the species.

Taxonomic Issues

Subclass Alcyonaria (=Octocorallia); Order Stolonifera; Family Tubiporidae; Genus Tubipora with one species *Tubipora musica*

Four nominal species, probably one true species (Veron, 1986).

Order Stolonifera may be considered a sub-order, with the Order Alcyonacea. Two genera present, *Tubipora* and *Pachyclavularia,* often confused with *Clavularia spp.* One form has tentacles which look like *Alveopora* though eight tentacles.

Habitat Utilization

Requires high illumination and strong circulation through wave action or currents. Abundant in shallow lagoons in turbid water. Also found on reef slopes and in deep water with clear or turbid water. In back reef locations, large heads form in sand or coral rubble. On the reef flat the colonies are smaller and encrusting (Sprung and Delbeek, 1997).

Life History

Adult: Appearance and Physical Characteristic

Colonies are massive, formed by long, parallel, calcareous tubes (stolons) of fused spicules connected by horizontal platforms. The tubes contain the polyps (zooids), each of which has eight pinnate or feather-like tentacles. The skeleton is a permanent dark-red colour. Polyp colour greenish-brown or grey polyps (Veron, 1986; Barnes 1987).

Age, Growth, Longevity

Asexual growth by budding from the solenial canals. Linking of polyps by outward growth from the body wall. The secondary stolon are platform-like and the scerites fuse producing hard massive colonies.

Distribution

Extends from the Red Sea and west Africa, east to Fiji and the Marshall Is. Southerly distribution from south of Madagascar and south Western Australia, north to the Kyushu Is., Japan. Not present in Hawaii, though in Guam and the CNMI.

Feeding and Food

Heterotrophic, autotroph with zooxanthellae

Reproductive Strategies

Sexual and asexual. Sexual reproduction is unknown in *Tubipora musica.* An example of other genera within the family may provide an analogous understanding. Morphologically similar, *Briareum stechei, Pachyclavularia violacea* was found to be dioecious external brooder with the developing planulae residing just beside the mouth. The reddish-brown planulae were released between 11 and 13 days after the full moon in November (Alino and Coll, 1989). The colour of the planulae suggests the presence of zooxanthellae.

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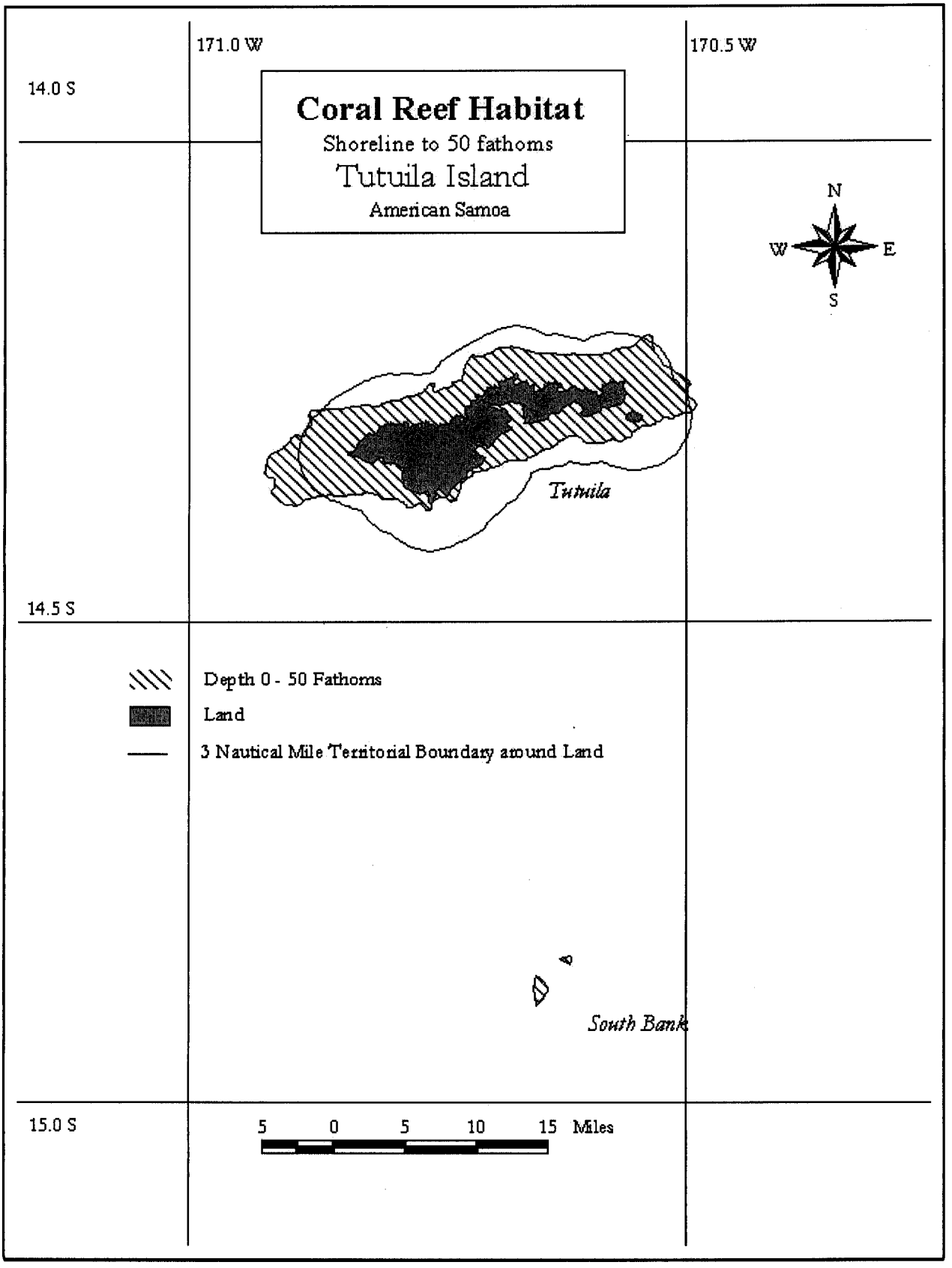
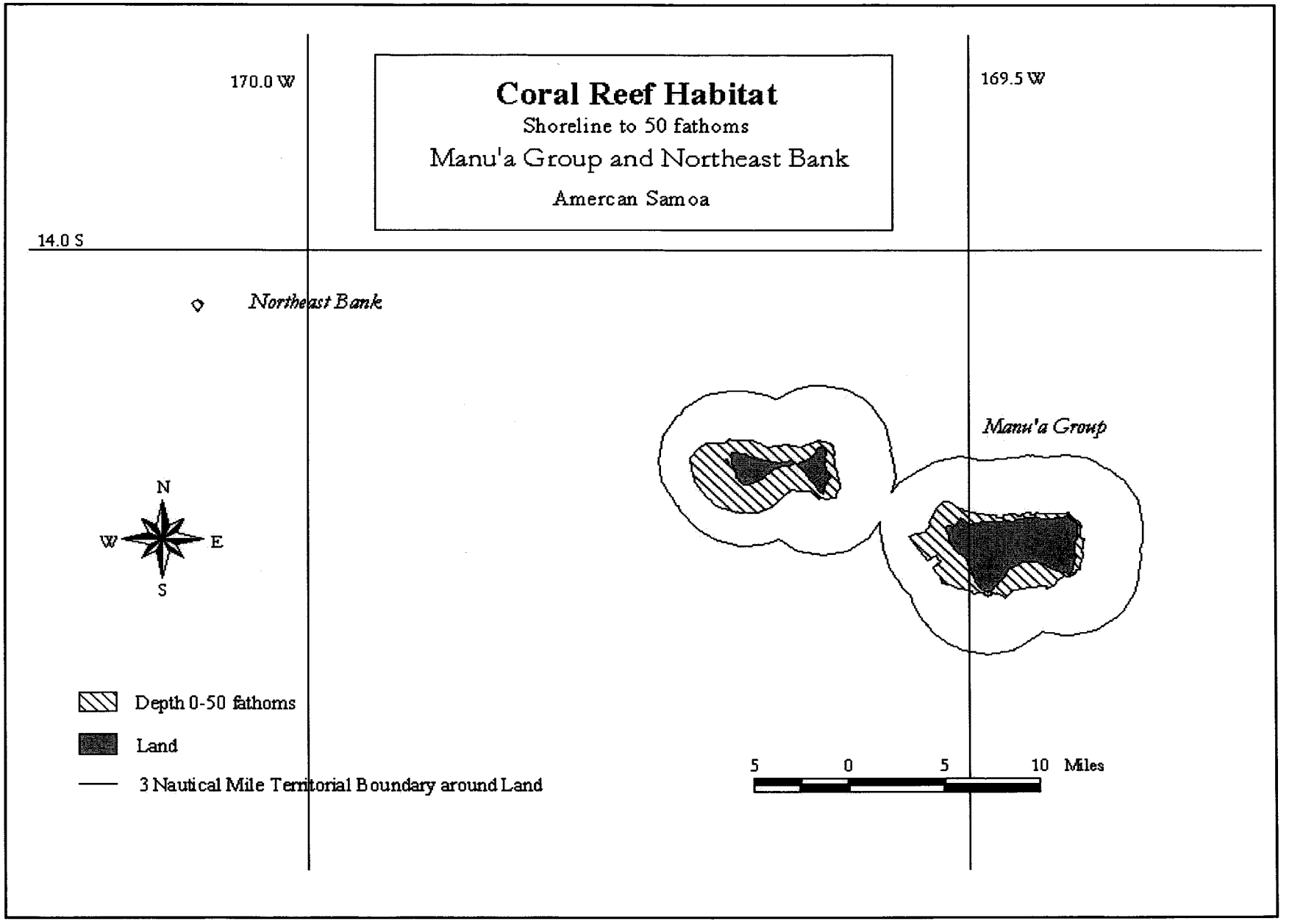
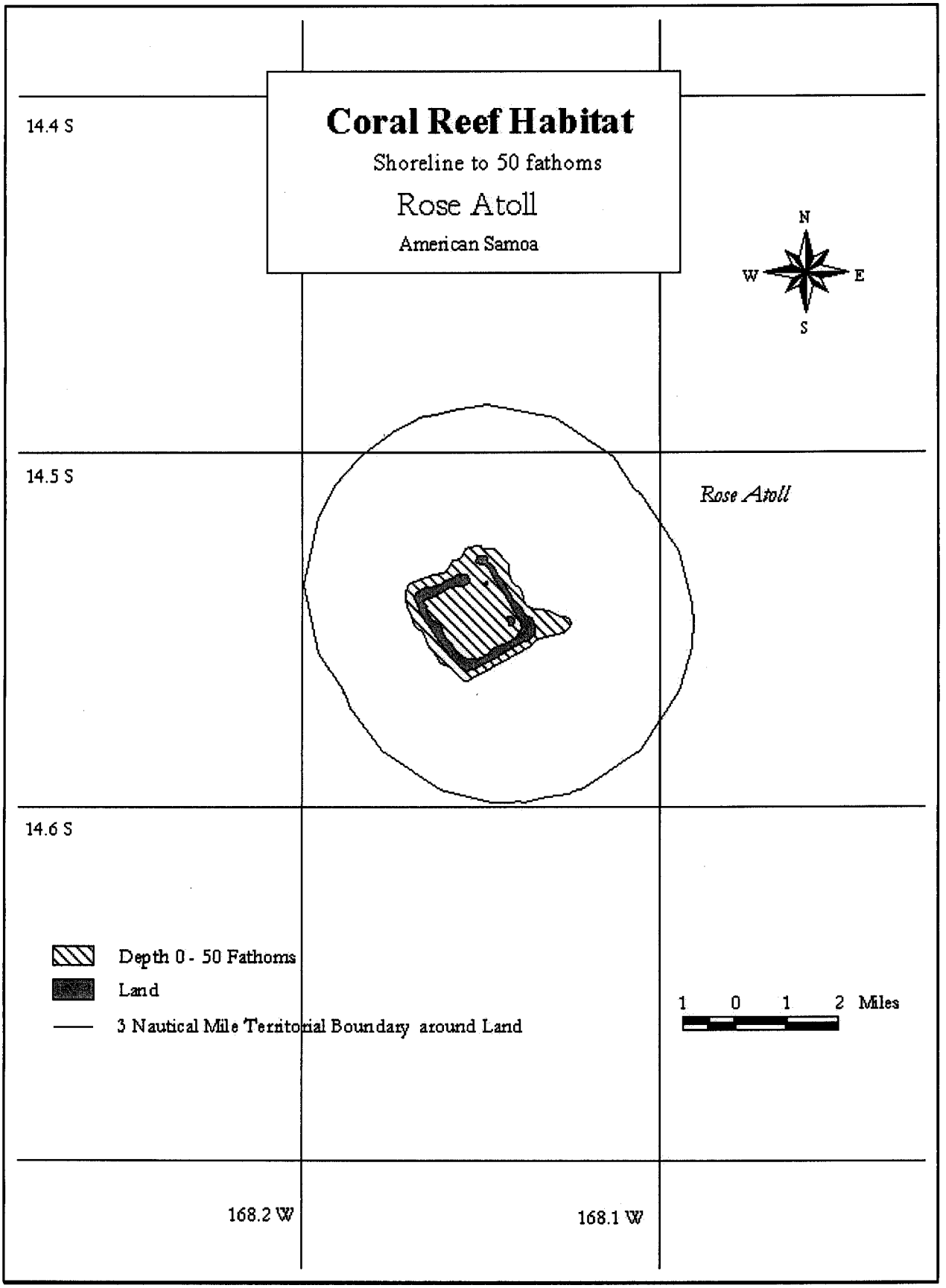
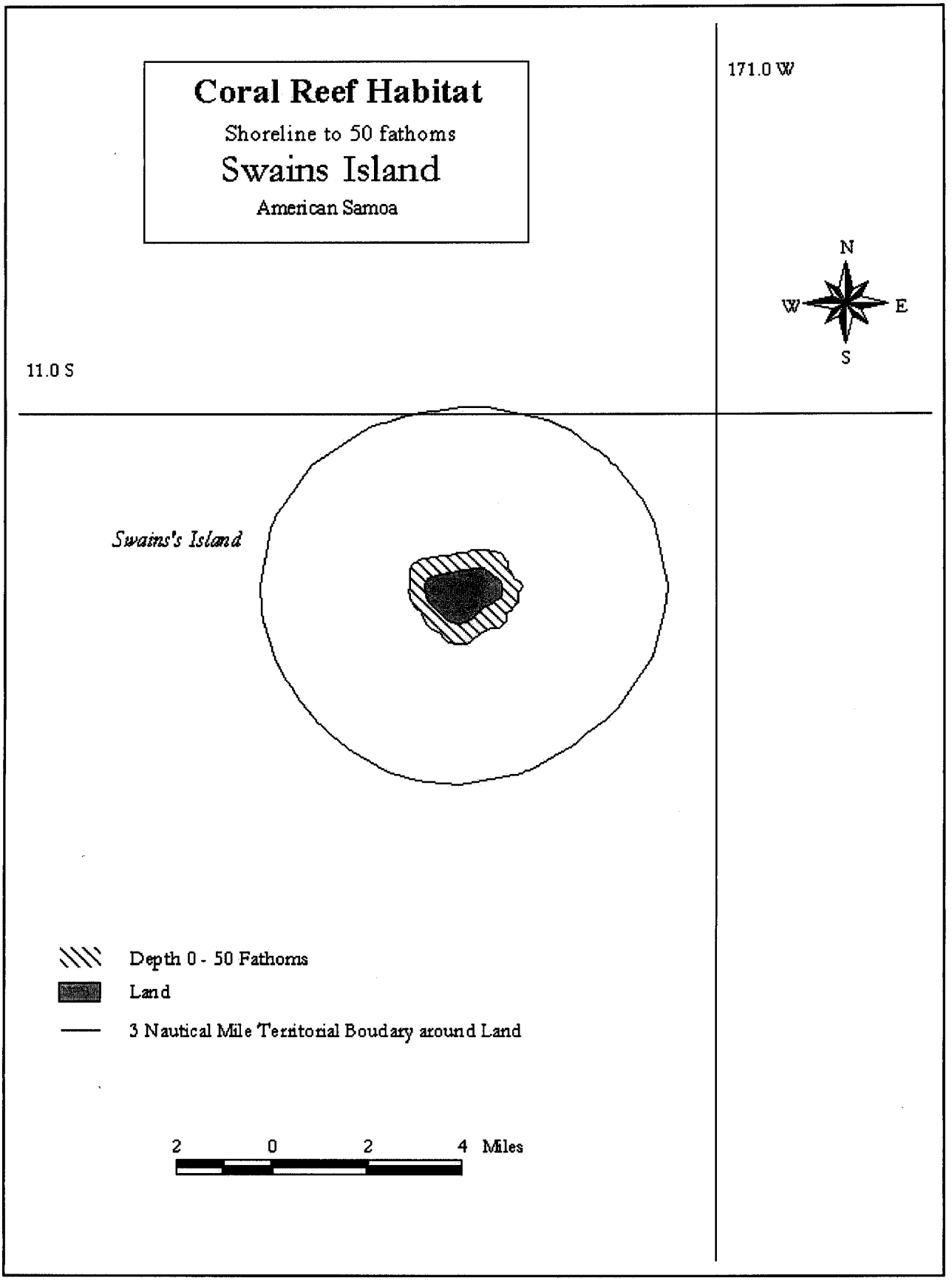
III. MAPS OF CORAL REEF HABITAT IN THE WESTERN PACIFIC REGION


171.0 W
170.5 W
14.0 S
Coral Reef Habitat
Shoreline to 50 fathoms
Tutuila Island
American Samoa
N
W
E
S
Tutuila
14.5 S
Depth 0 - 50 Fathoms
Land
3 Nautical Mile Territorial Boundary around Land
South Bank
15.0 S
5 0 5 10 15 Miles


Coral Reef Habitat
Shoreline to 50 fathoms
Manu'a Group and Northeast Bank
American Samoa
170.0 W
169.5 W
14.0 S
Northeast Bank
Manu'a Group
N
W
E
S
Depth 0-50 fathoms
Land
3 Nautical Mile Territorial Boundary around Land
5 0 5 10 Miles


Coral Reef Habitat
Shoreline to 50 fathoms
Rose Atoll
American Samoa
N
W
E
S
14.4 S
14.5 S
14.6 S
Rose Atoll
Depth 0 - 50 Fathoms
Land
3 Nautical Mile Territorial Boundary around Land
1 0 1 2 Miles
168.2 W
168.1 W


Coral Reef Habitat
Shoreline to 50 fathoms
Swains Island
American Samoa
171.0 W
N
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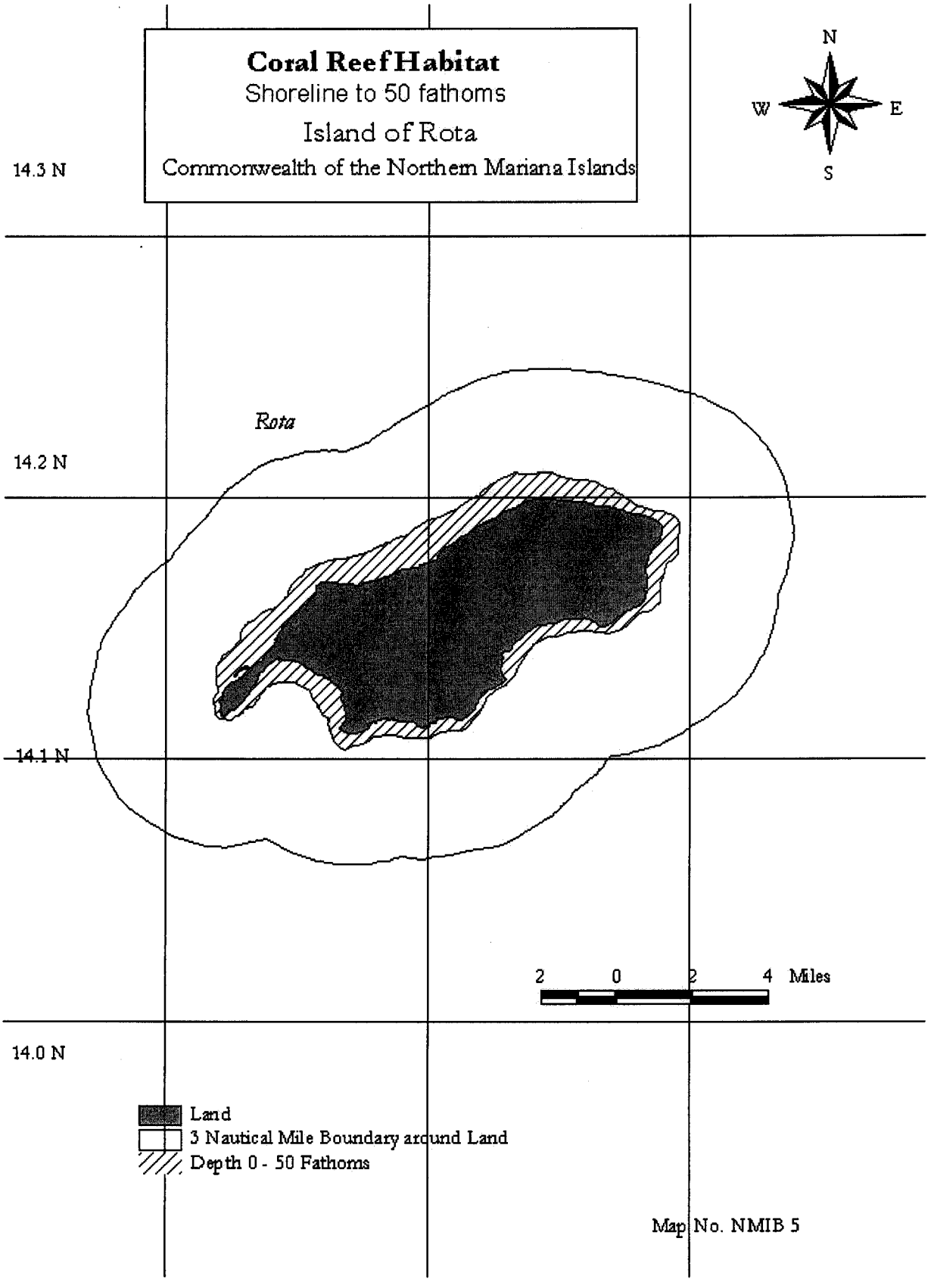
11.0 S
Swains's Island
Depth 0 - 50 Fathoms
Land
3 Nautical Mile Territorial Boudary around Land
2 0 2 4 Miles


Coral Reef Habitat
Shoreline to 50 fathoms
Island of Rota
Commonwealth of the Northern Mariana Islands
N
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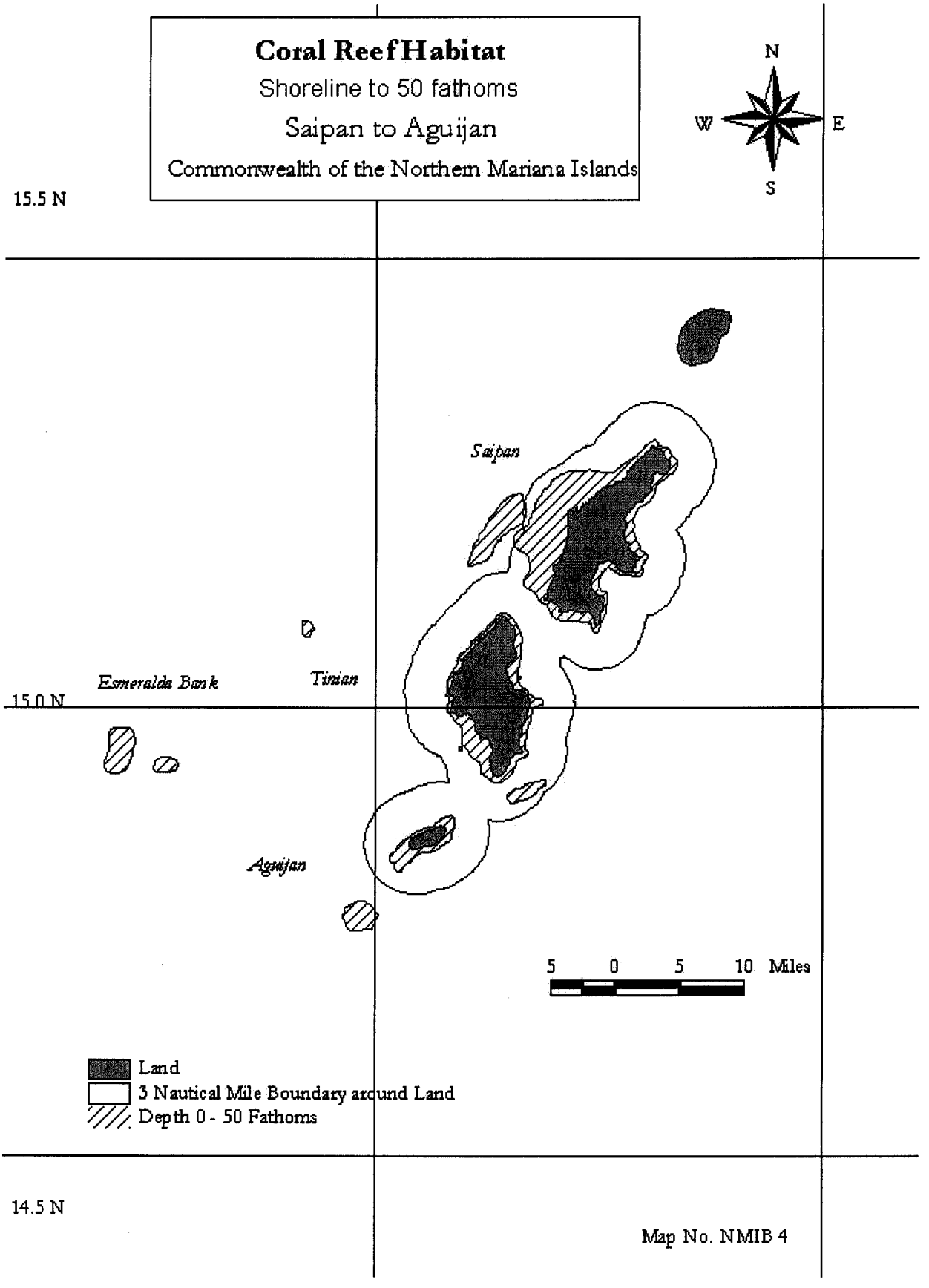
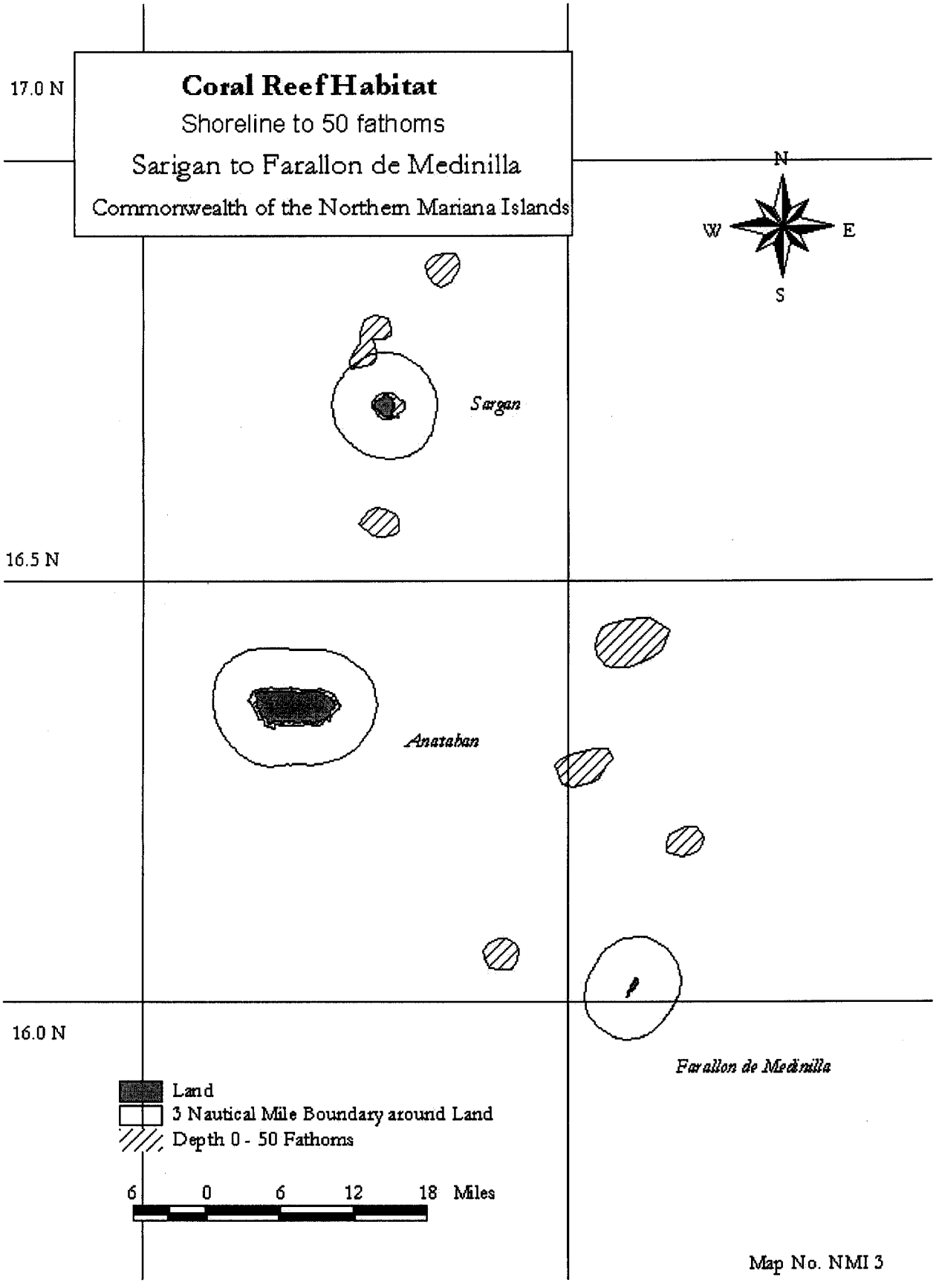
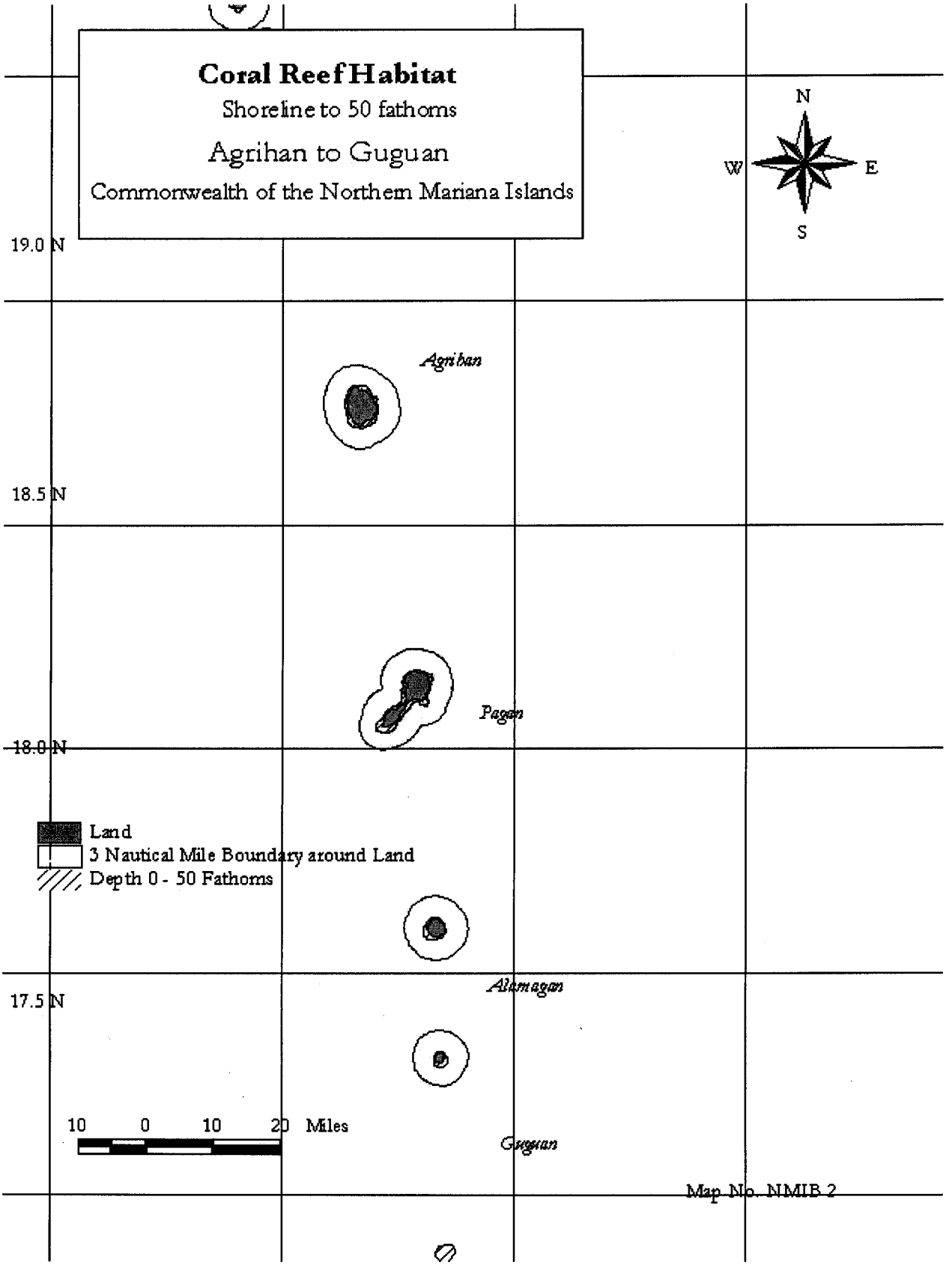
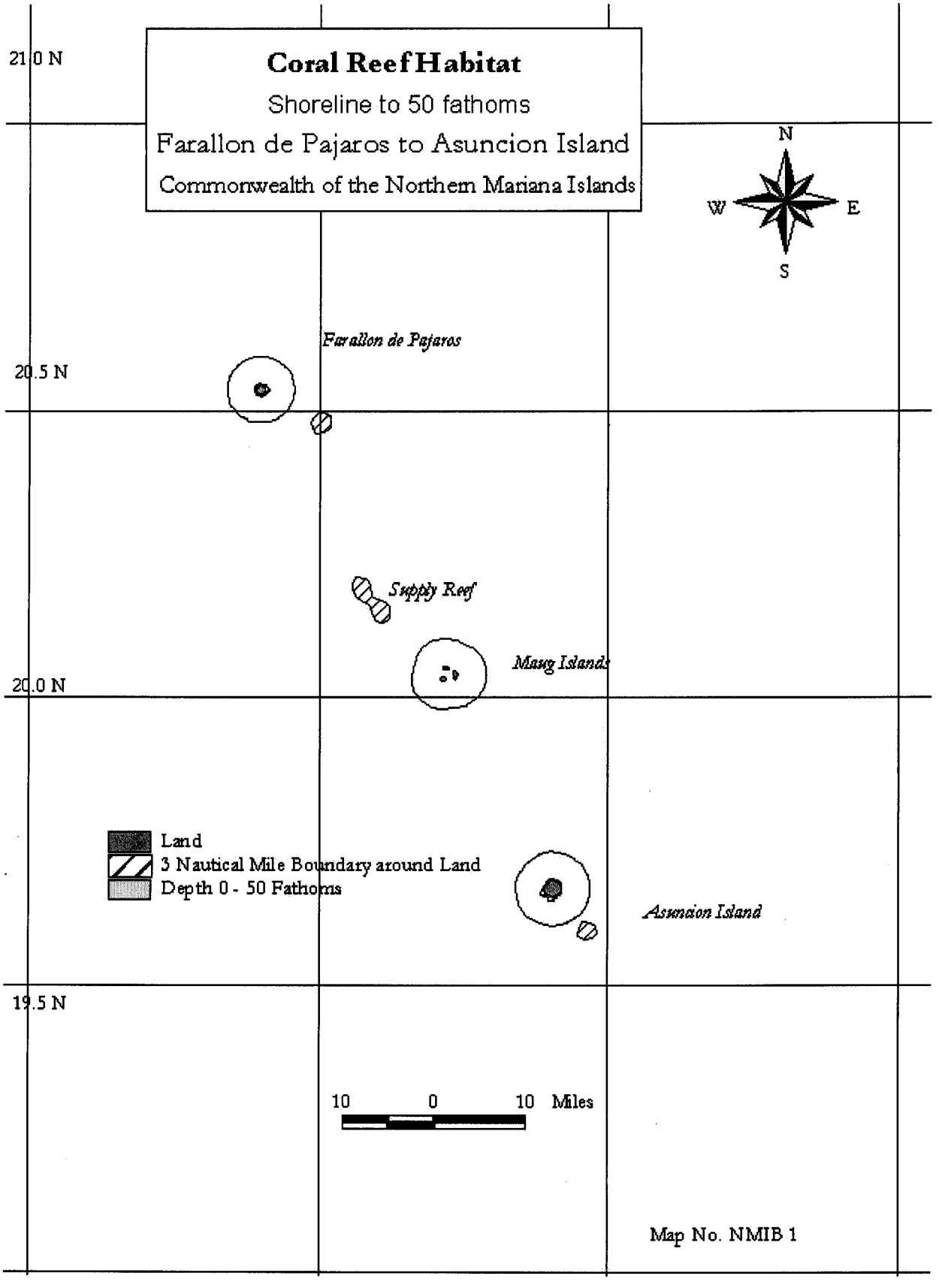
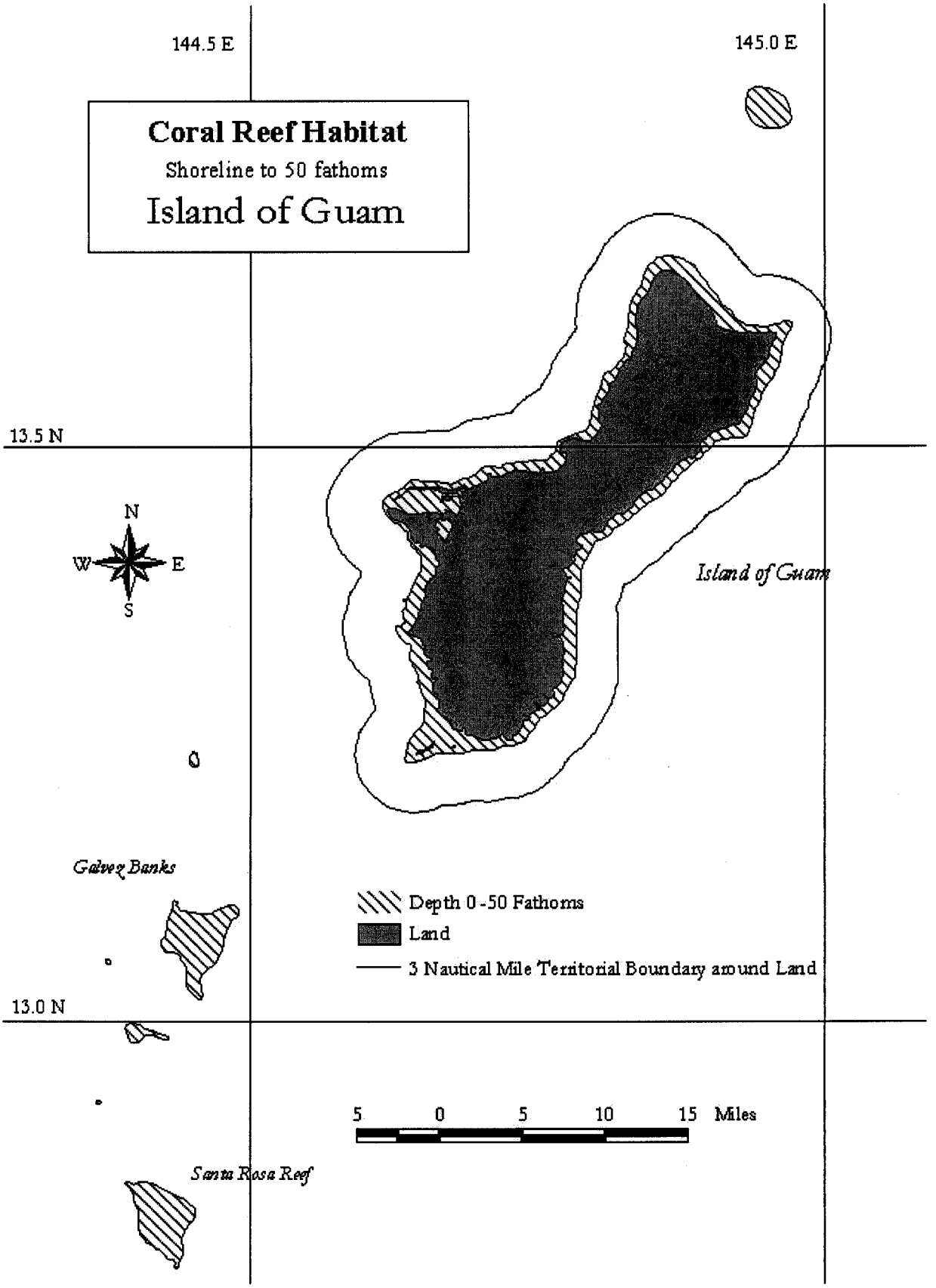
S
14.3 N
Rota
14.2 N
14.1 N
2 0 2 4 Miles
14.0 N
Land
3 Nautical Mile Boundary around Land
Depth 0 - 50 Fathoms
Map No. NMIB 5

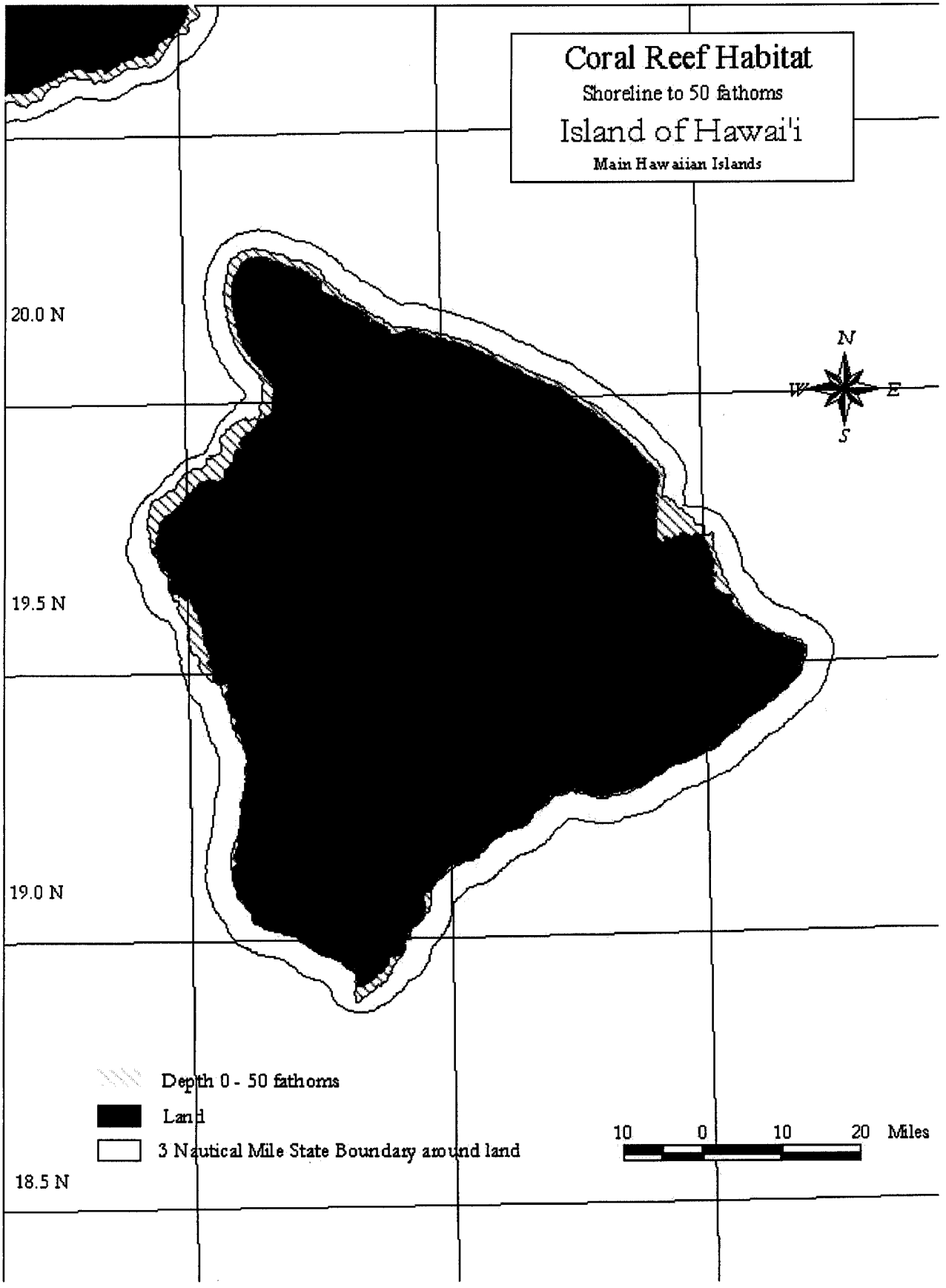

Coral Reef Habitat
Shoreline to 50 fathoms
Saipan to Aguijan
Commonwealth of the Northern Mariana Islands
N
W
E
S
15.5 N
Saipan
Esmeralda Bank
Tinian
15.0 N
Aguijan
5 0 5 10 Miles
Land
3 Nautical Mile Boundary around Land
Depth 0 - 50 Fathoms
14.5 N
Map No. NMIB 4

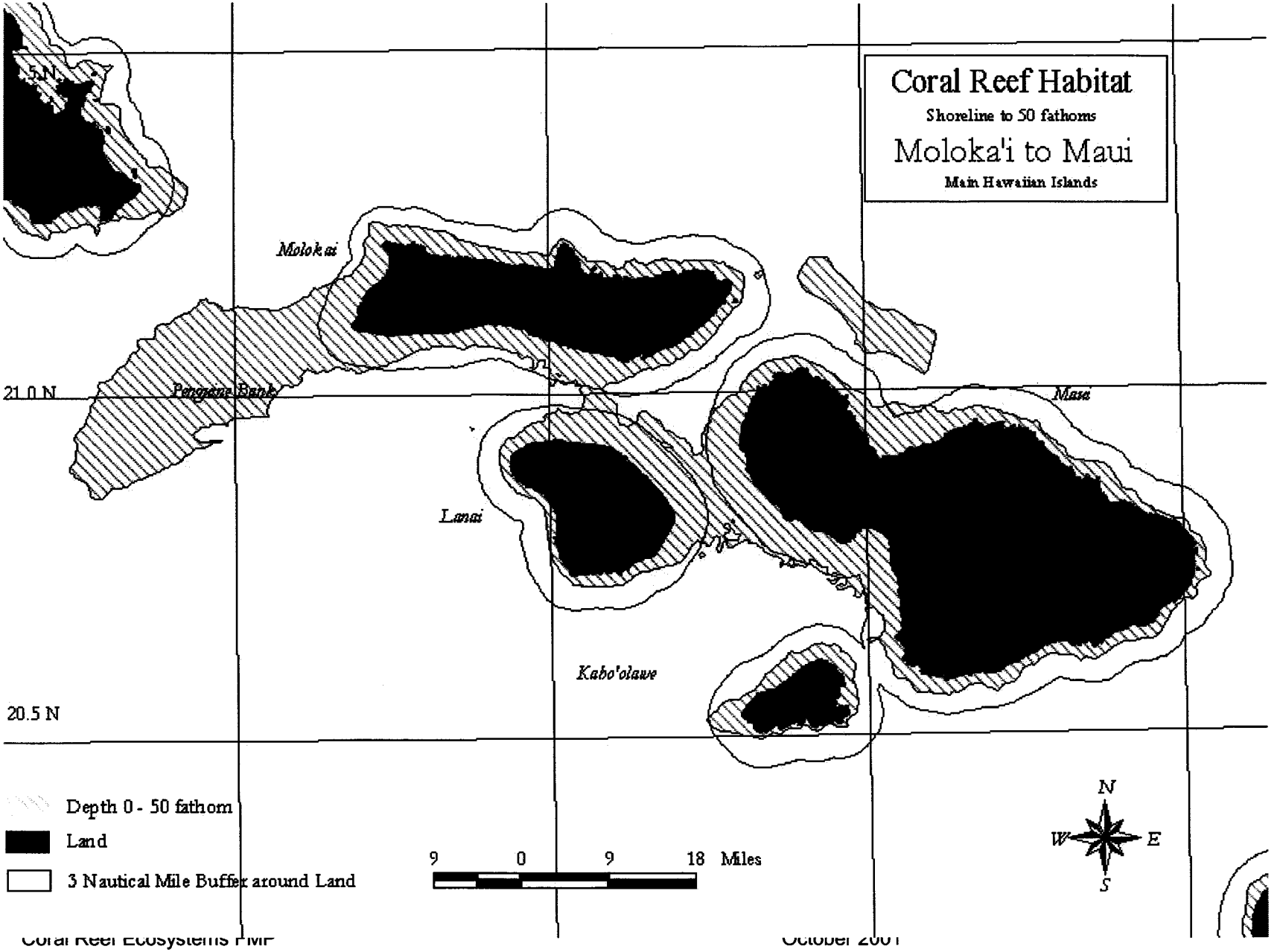

Coral Reef Habitat
Shoreline to 50 fathoms
Sarigan to Farallon de Medinilla
Commonwealth of the Northern Mariana Islands
17.0 N
16.5 N
16.0 N
N
W
E
S
Sarigan
Anatahan
Farallon de Medinilla
Land
3 Nautical Mile Boundary around Land
Depth 0 - 50 Fathoms
6 0 6 12 18 Miles
Map No. NMI 3

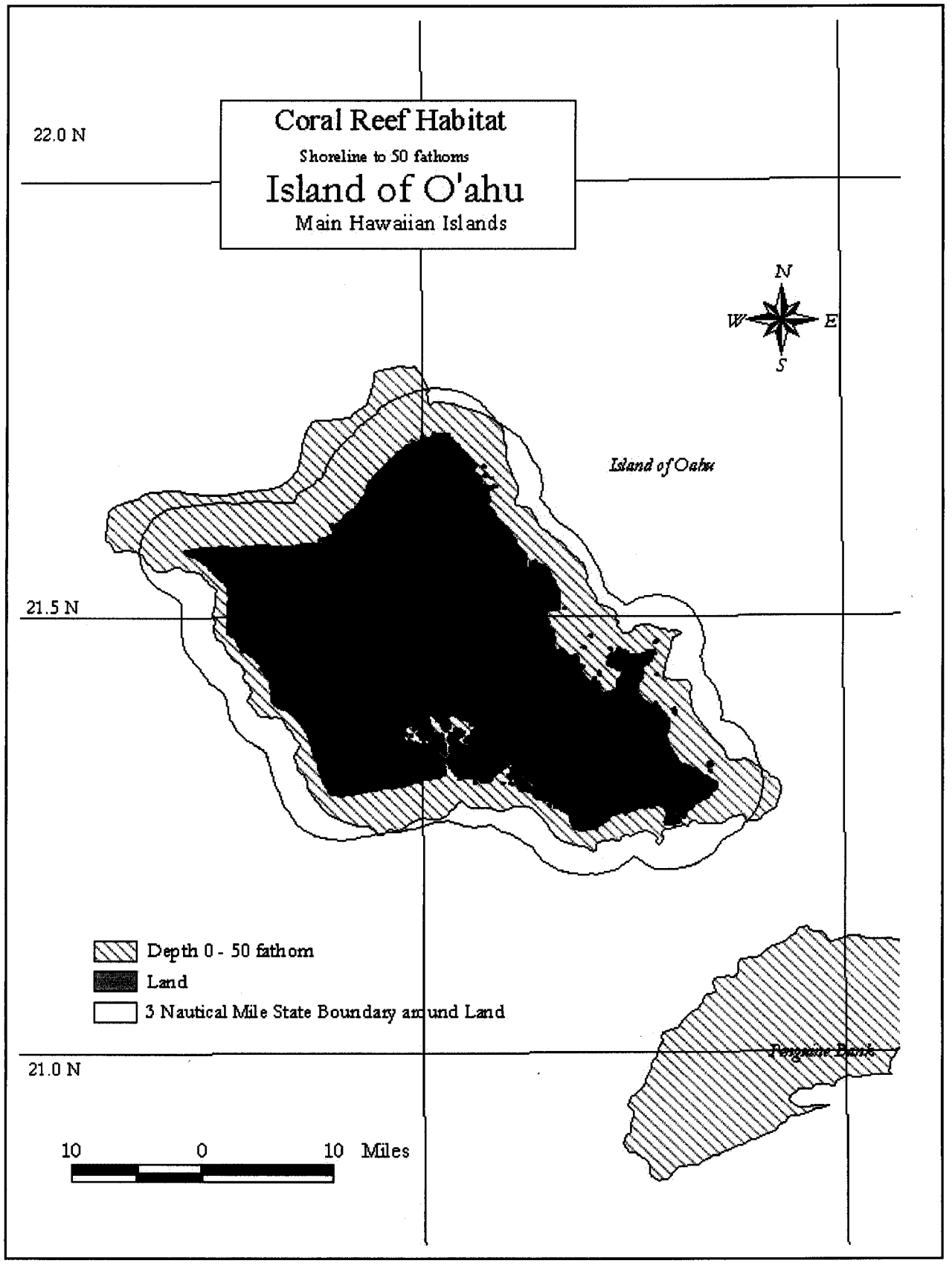

Coral Reef Habitat
Shoreline to 50 fathoms
Agrihan to Guguan
Commonwealth of the Northern Mariana Islands
N
W
E
S
19.0 N
18.5 N
18.0 N
17.5 N
Agrihan
Pagan
Alamagan
Guguan
Land
3 Nautical Mile Boundary around Land
Depth 0 - 50 Fathoms
10 0 10 20 Miles
Map No. NMIB 2

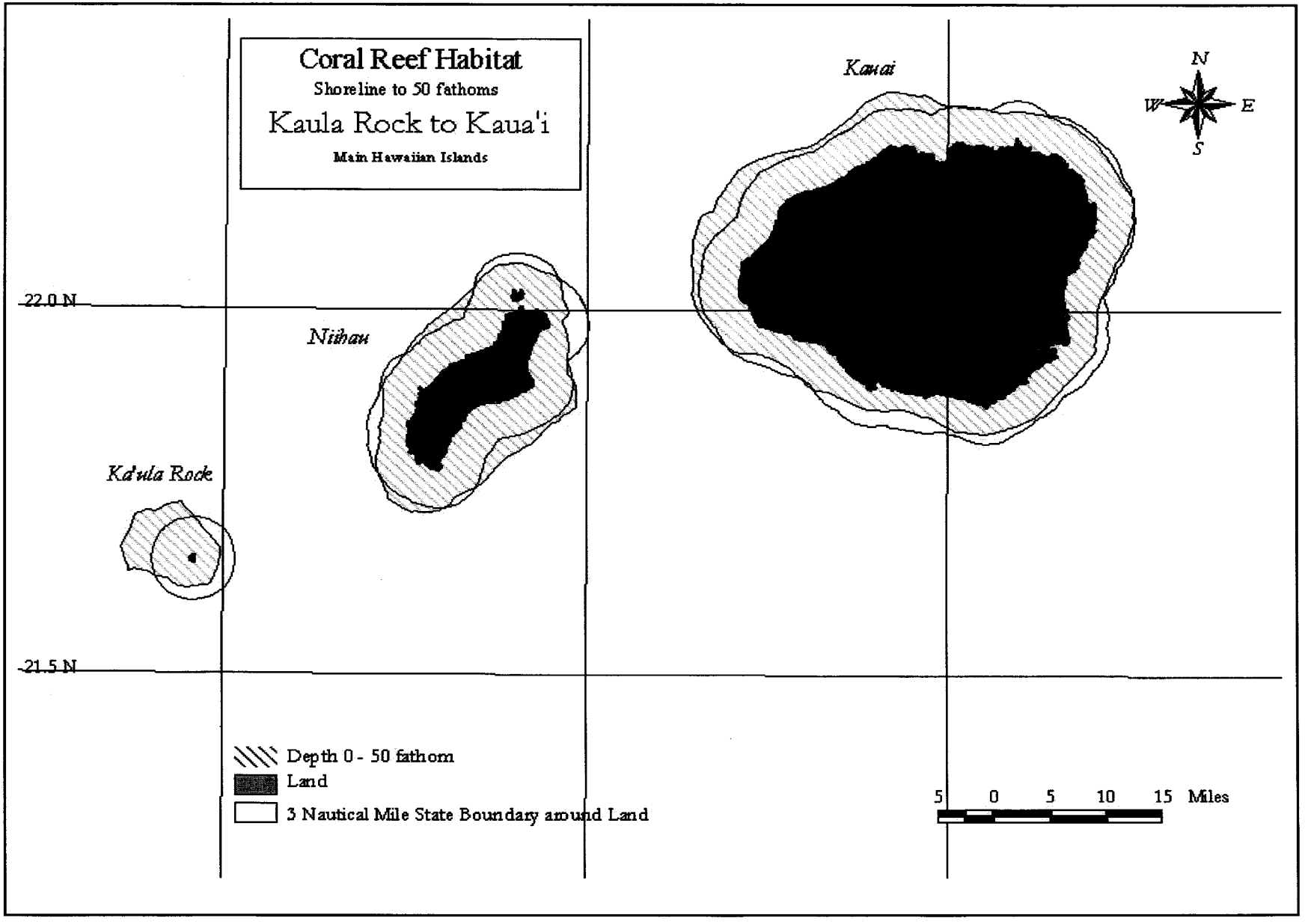

Coral Reef Habitat
Shoreline to 50 fathoms
Farallon de Pajaros to Asuncion Island
Commonwealth of the Northern Mariana Islands
21.0 N
20.5 N
20.0 N
19.5 N
N
W
E
S
Farallon de Pajaros
Supply Reef
Maug Islands
Asuncion Island
Land
3 Nautical Mile Boundary around Land
Depth 0 - 50 Fathoms
10 0 10 Miles
Map No. NMIB 1

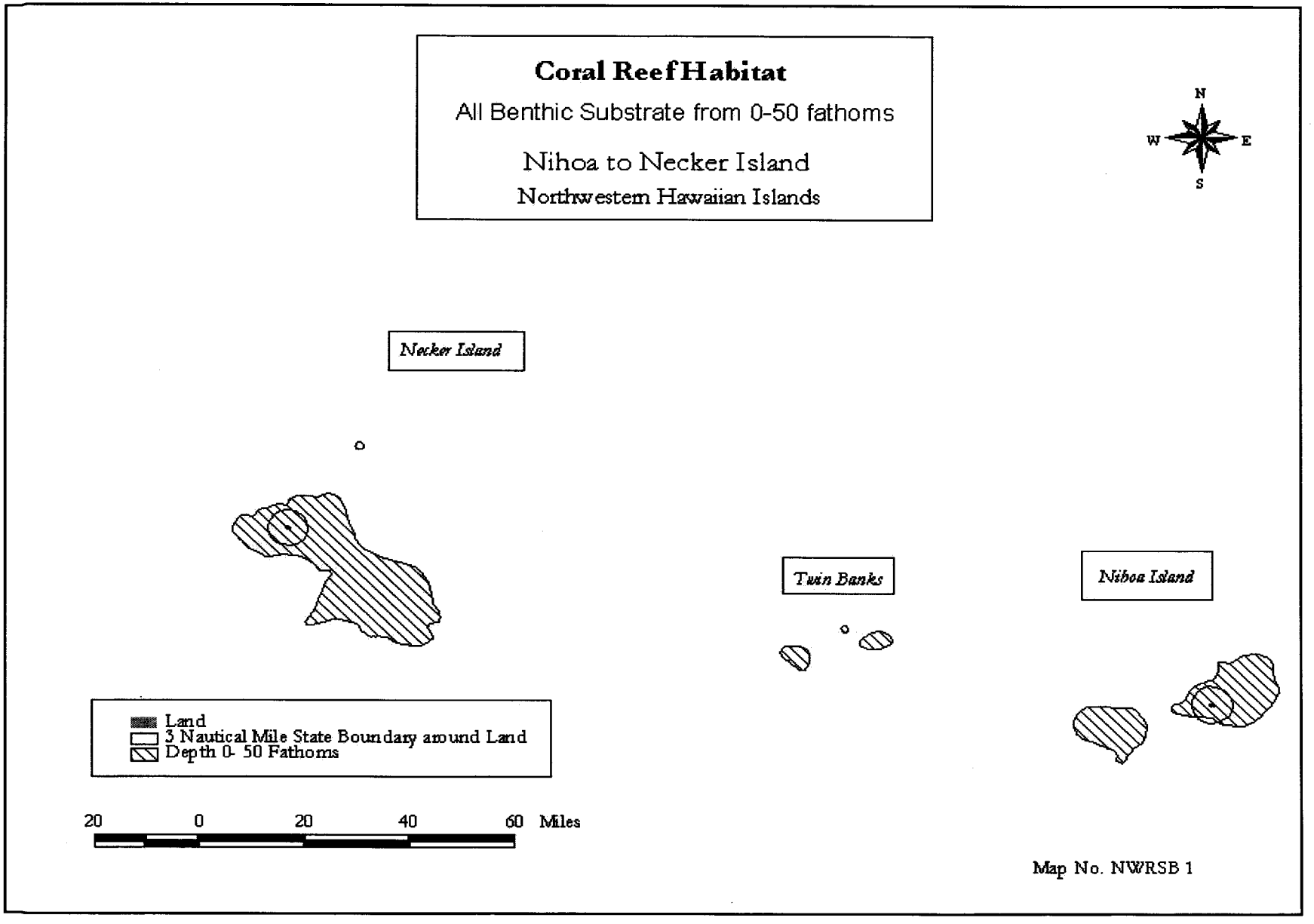

144.5 E
145.0 E
Coral Reef Habitat
Shoreline to 50 fathoms
Island of Guam
13.5 N
N
W
E
S
Island of Guam
Galvez Banks
Depth 0-50 Fathoms
Land
3 Nautical Mile Territorial Boundary around Land
13.0 N
5 0 5 10 15 Miles
Santa Rosa Reef

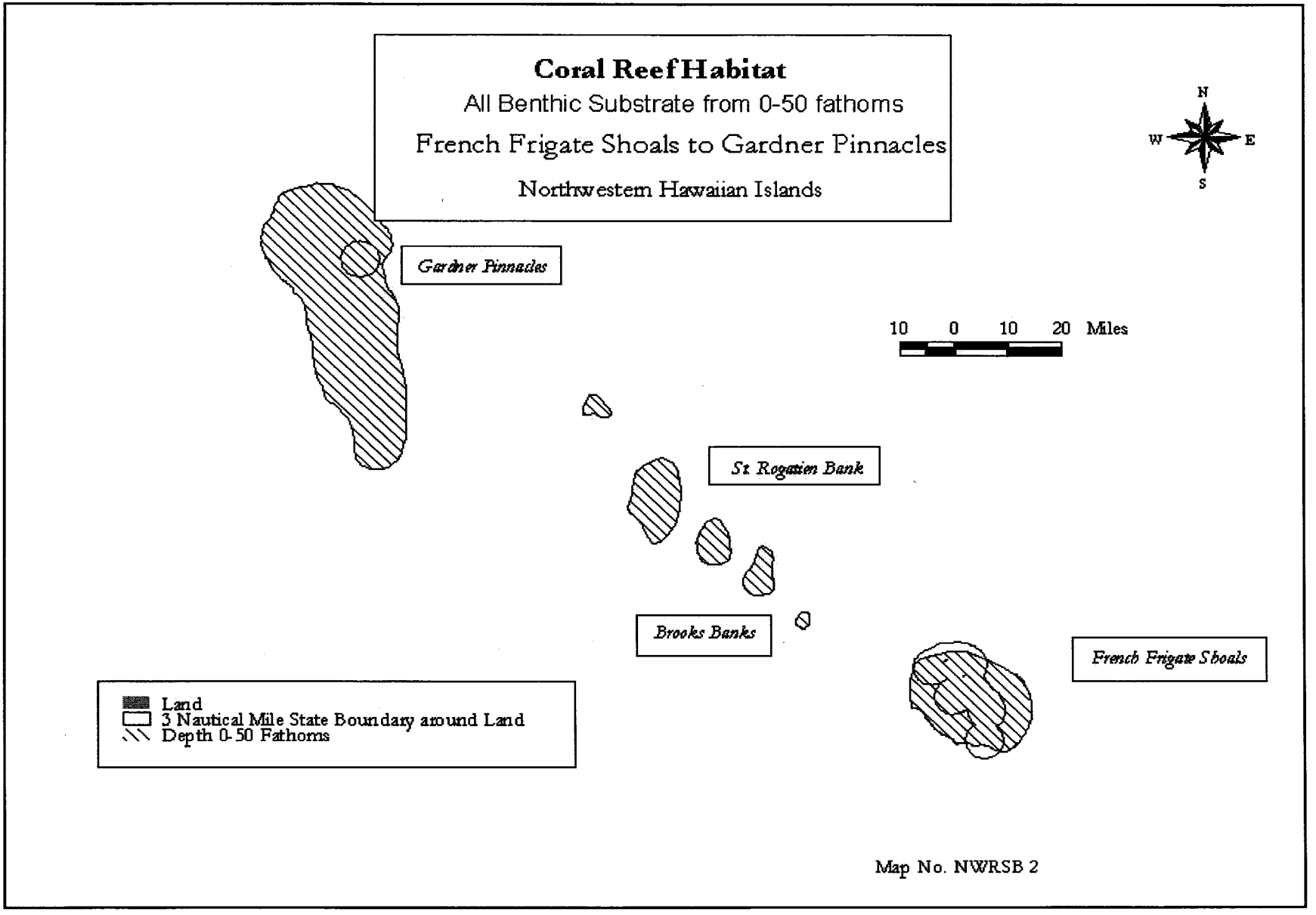

Coral Reef Habitat
Shoreline to 50 fathoms
Island of Hawai'i
Main Hawaiian Islands
20.0 N
19.5 N
19.0 N
18.5 N
N
W
E
S
Depth 0 - 50 fathoms
Land
3 Nautical Mile State Boundary around land
10 0 10 20 Miles

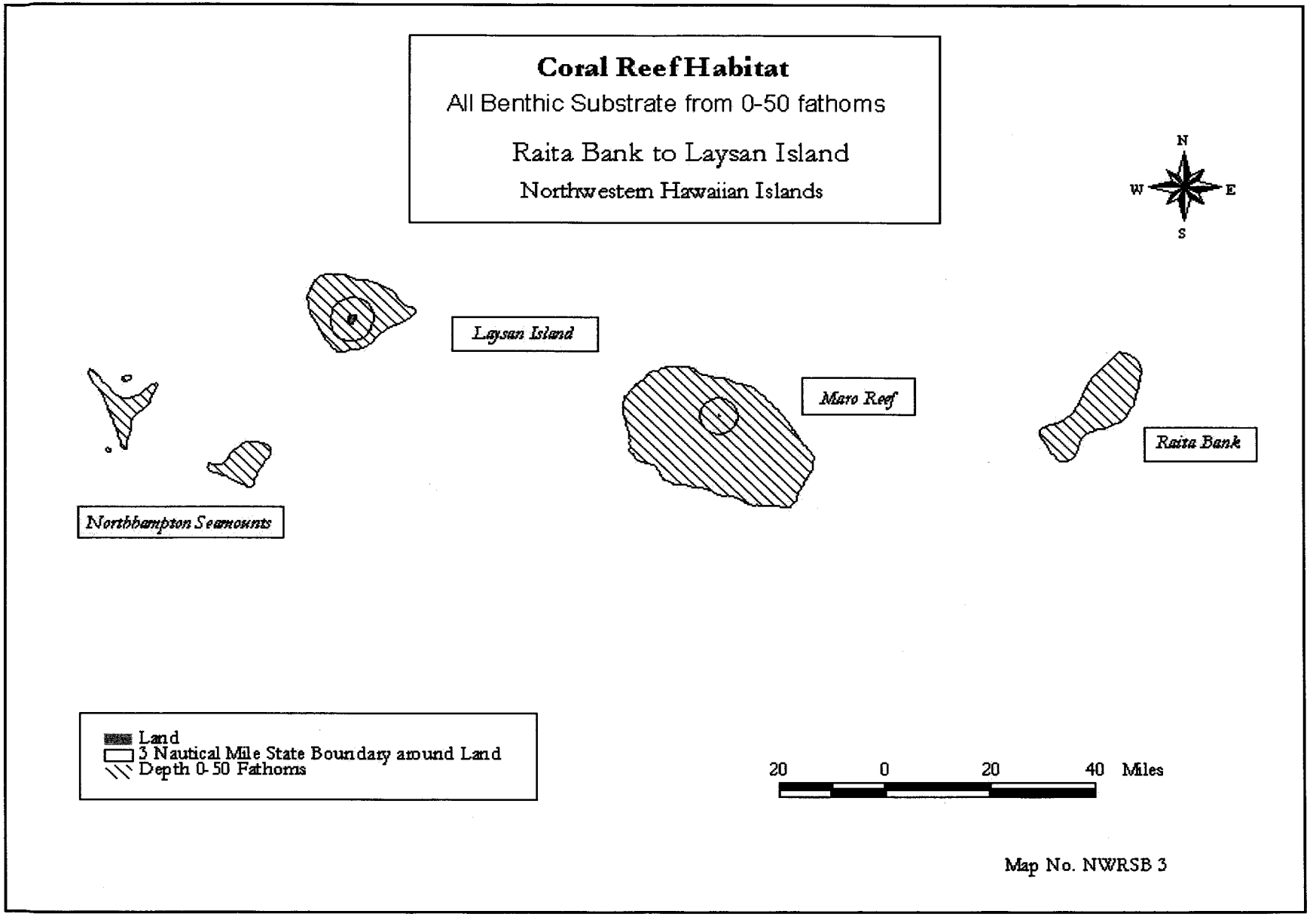

Coral Reef Habitat
Shoreline to 50 fathoms
Moloka'i to Maui
Main Hawaiian Islands
Molokai
Penguine Bank
Maui
Lanai
Kaho'olawe
21.0 N
20.5 N
Depth 0 - 50 fathom
Land
3 Nautical Mile Buffer around Land
9 0 9 18 Miles
N
W
E
S

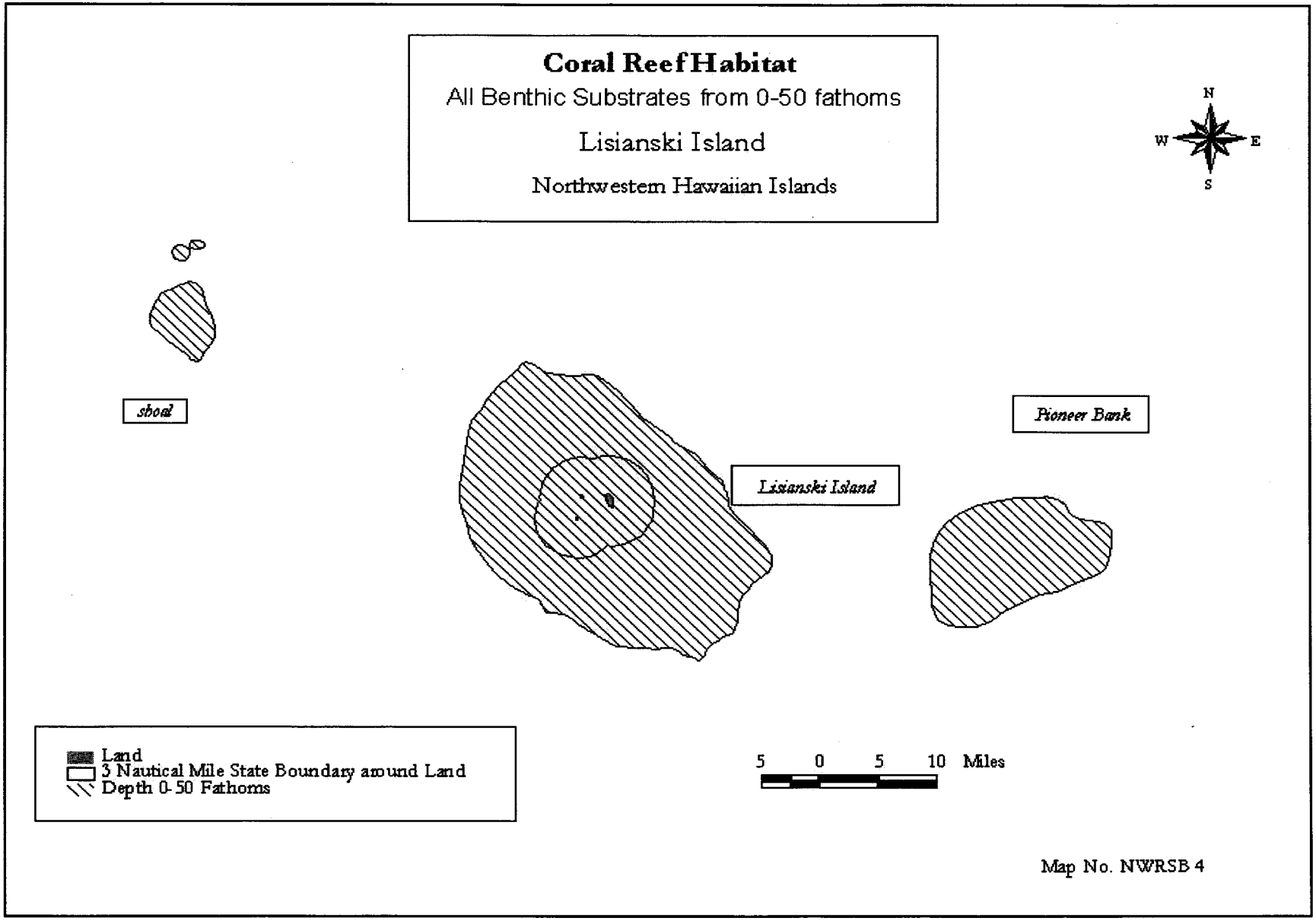

Coral Reef Habitat
Shoreline to 50 fathoms
Island of O'ahu
Main Hawaiian Islands
22.0 N
21.5 N
21.0 N
N
W
E
S
Island of Oahu
Penguine Bank
Depth 0 - 50 fathom
Land
3 Nautical Mile State Boundary around Land
10 0 10 Miles

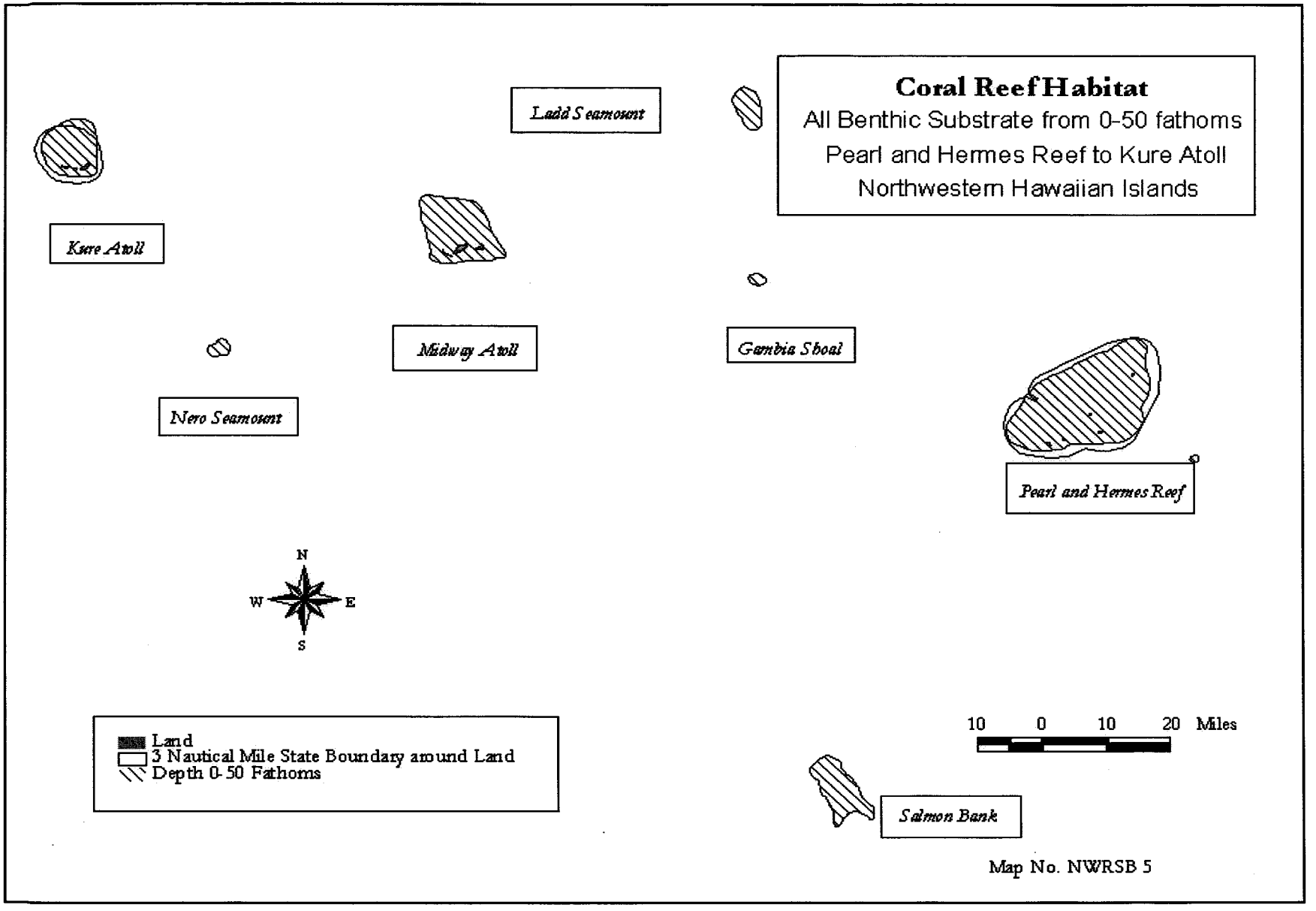

Coral Reef Habitat
Shoreline to 50 fathoms
Kaula Rock to Kaua'i
Main Hawaiian Islands
Kauai
Niihau
Ka'ula Rock
N
W
E
S
22.0 N
21.5 N
Depth 0 - 50 fathom
Land
3 Nautical Mile State Boundary around Land
5 0 5 10 15 Miles

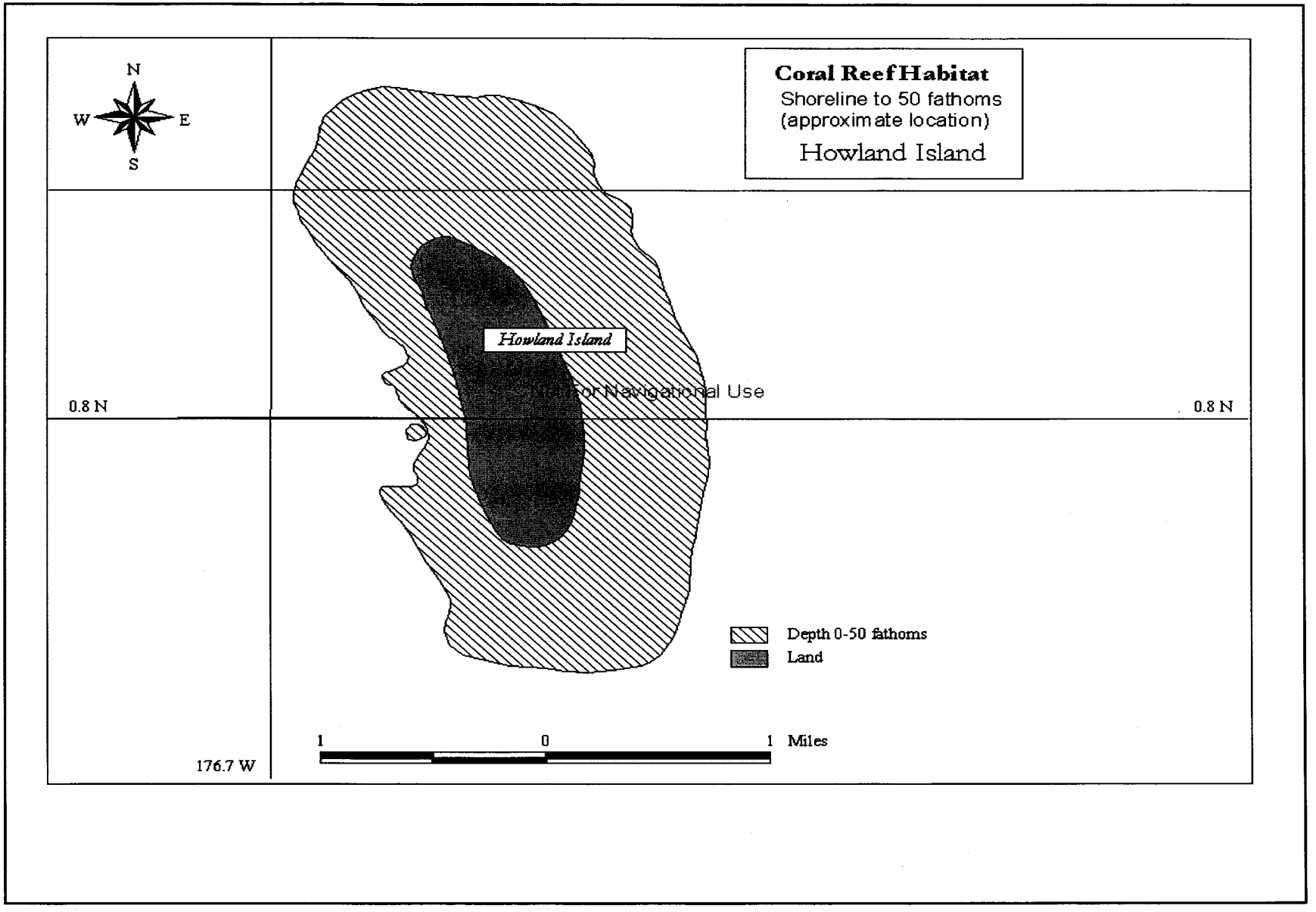

Coral Reef Habitat
All Benthic Substrate from 0-50 fathoms
Nihoa to Necker Island
Northwestern Hawaiian Islands
N
W
E
S
Necker Island
Twin Banks
Nihoa Island
Land
3 Nautical Mile State Boundary around Land
Depth 0- 50 Fathoms
20 0 20 40 60 Miles
Map No. NWRSB 1

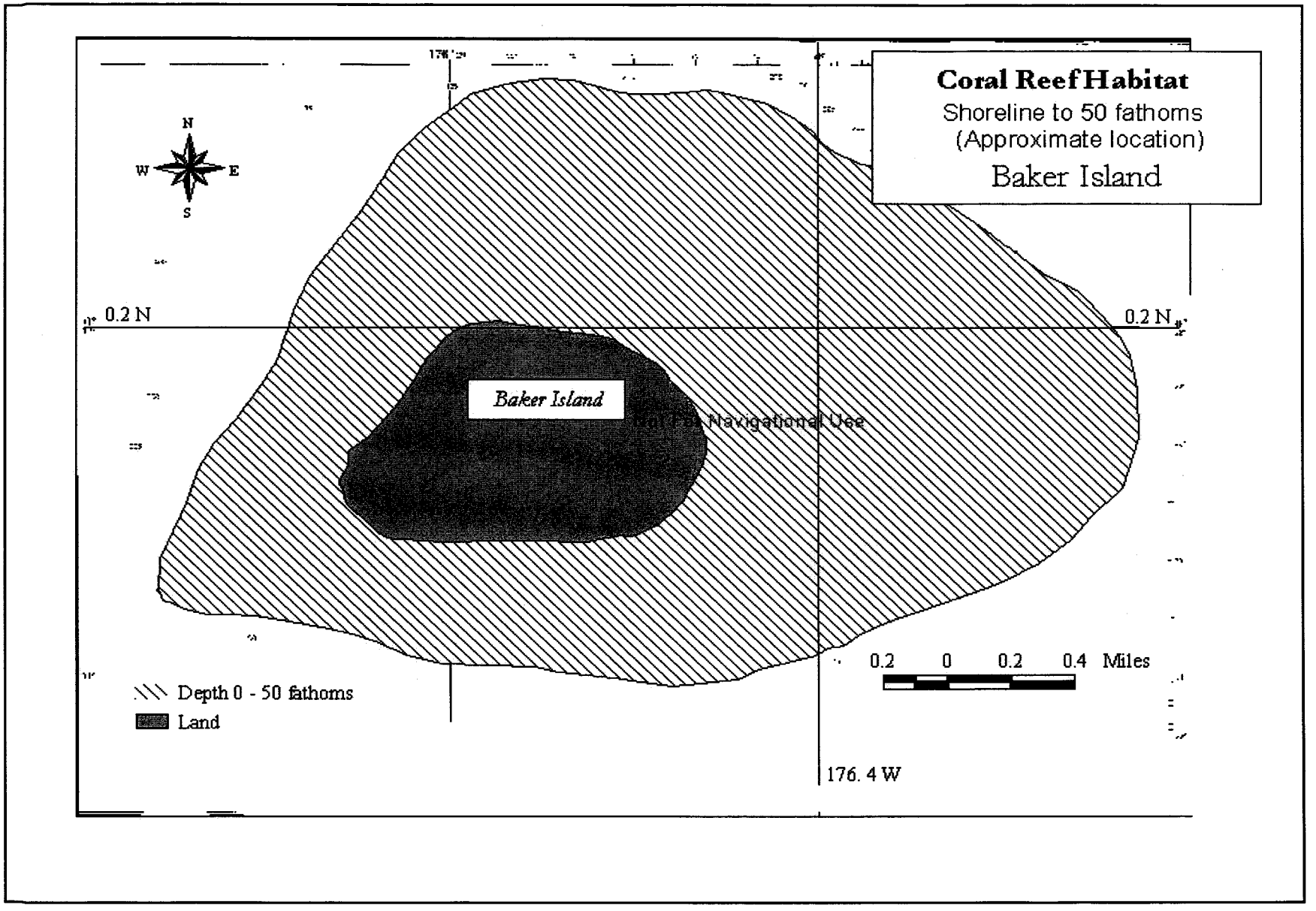

Coral Reef Habitat
All Benthic Substrate from 0-50 fathoms
French Frigate Shoals to Gardner Pinnacles
Northwestern Hawaiian Islands
N
W
E
S
Gardner Pinnacles
10 0 10 20 Miles
St Rogatien Bank
Brooks Banks
French Frigate Shoals
Land
3 Nautical Mile State Boundary around Land
Depth 0-50 Fathoms
Map No. NWRSB 2

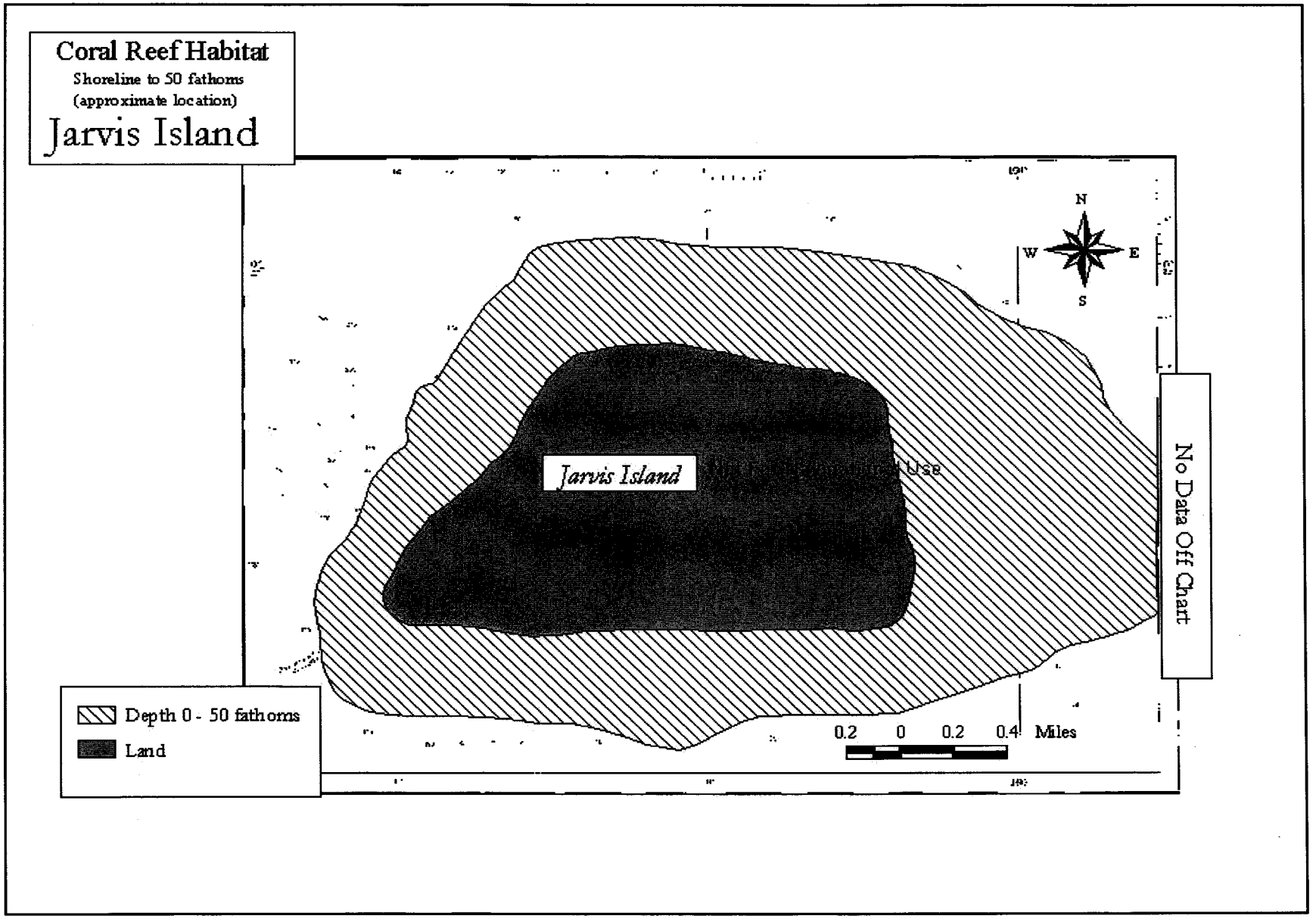

Coral Reef Habitat
All Benthic Substrate from 0-50 fathoms
Raita Bank to Laysan Island
Northwestern Hawaiian Islands
N
W
E
S
Laysan Island
Maro Reef
Raita Bank
Northhampton Seamounts
Land
3 Nautical Mile State Boundary around Land
Depth 0-50 Fathoms
20 0 20 40 Miles
Map No. NWRSB 3

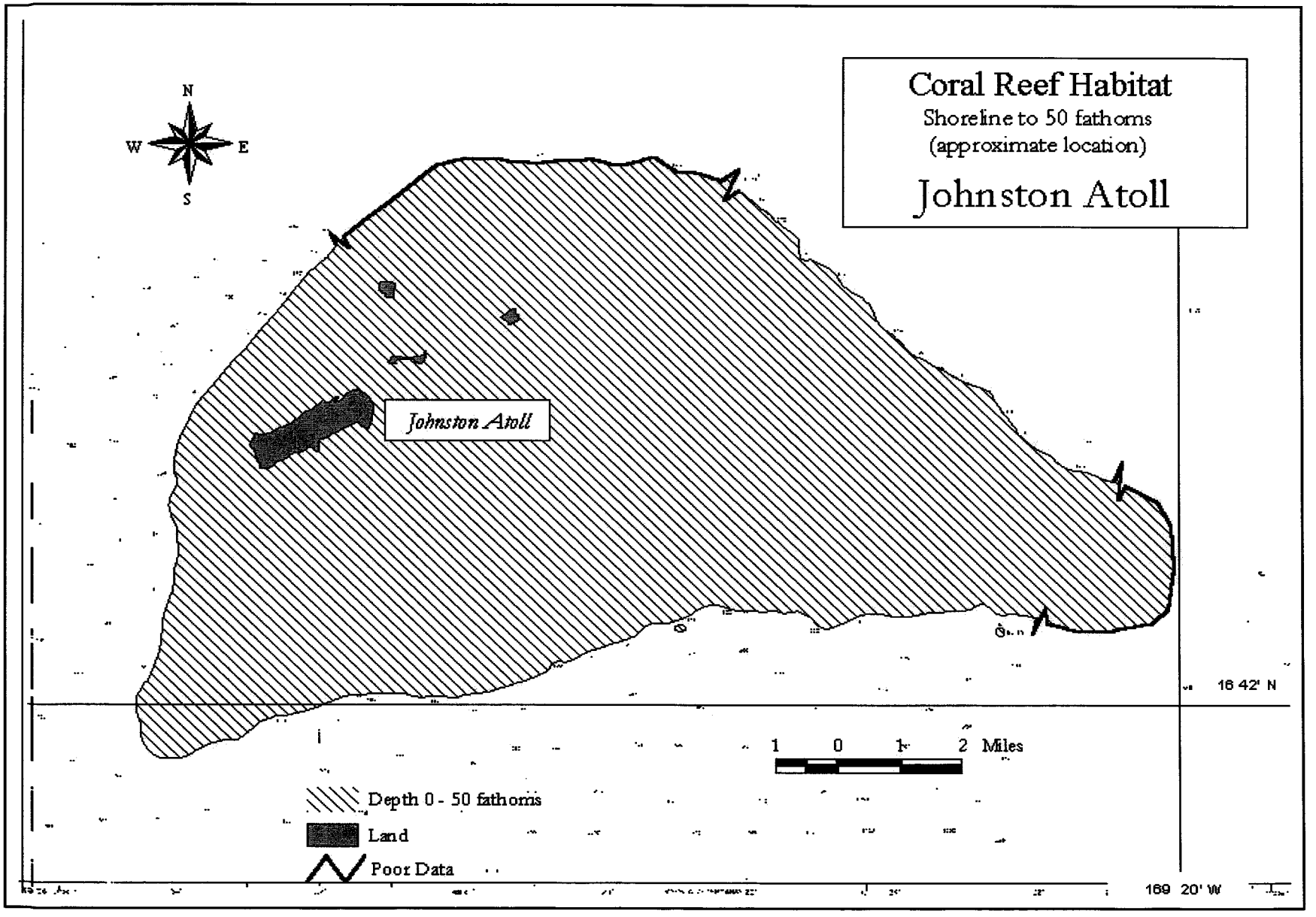

Coral Reef Habitat
All Benthic Substrates from 0-50 fathoms
Lisianski Island
Northwestern Hawaiian Islands
N
W
E
S
shoal
Pioneer Bank
Lisianski Island
Land
3 Nautical Mile State Boundary around Land
Depth 0-50 Fathoms
5 0 5 10 Miles
Map No. NWRSB 4

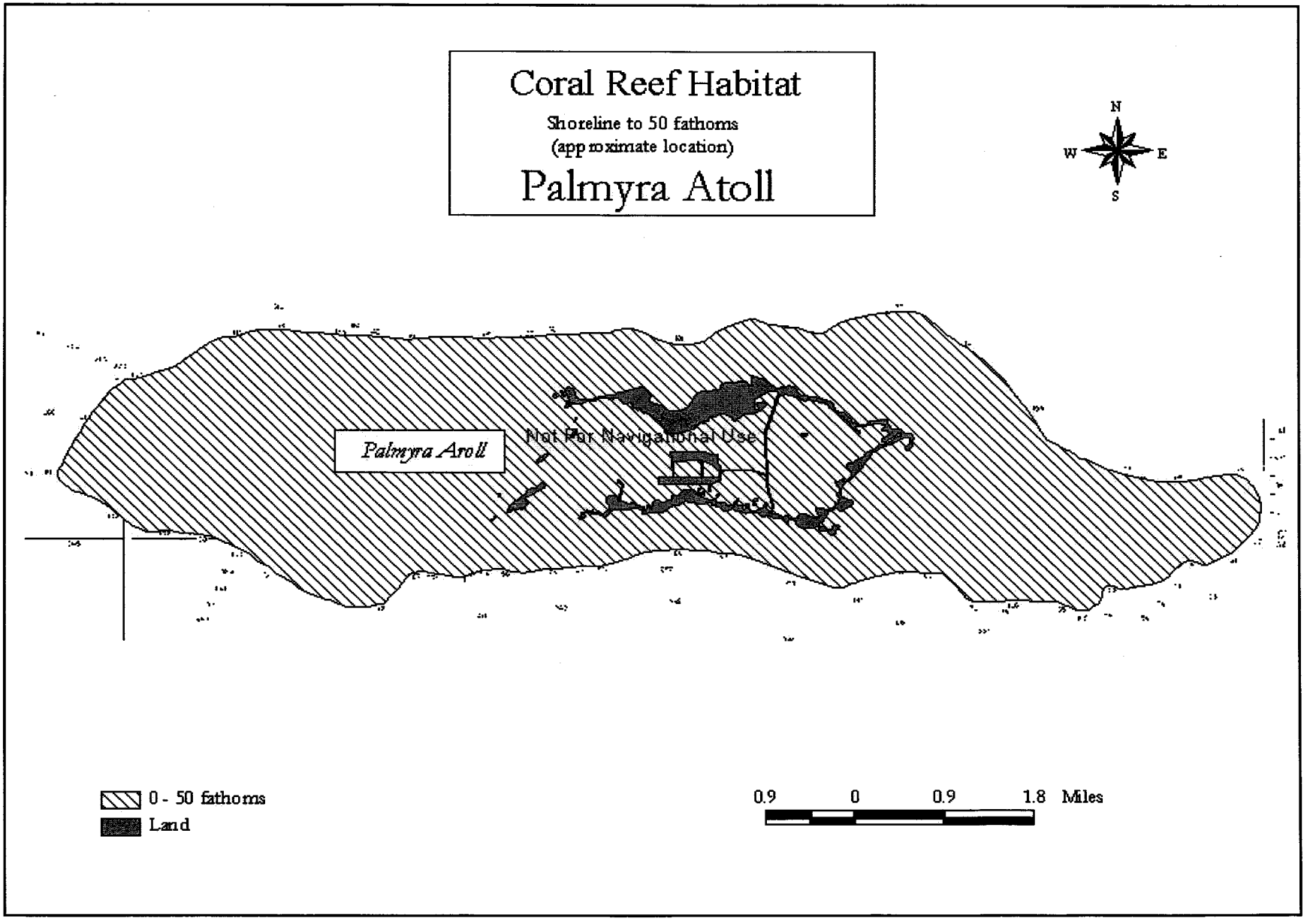

Coral Reef Habitat
All Benthic Substrate from 0-50 fathoms
Pearl and Hermes Reef to Kure Atoll
Northwestern Hawaiian Islands
Ladd Seamount
Kure Atoll
Midway Atoll
Gambia Shoal
Nero Seamount
Pearl and Hermes Reef
N
W
E
S
Land
3 Nautical Mile State Boundary around Land
Depth 0-50 Fathoms
10 0 10 20 Miles
Salmon Bank
Map No. NWRSB 5

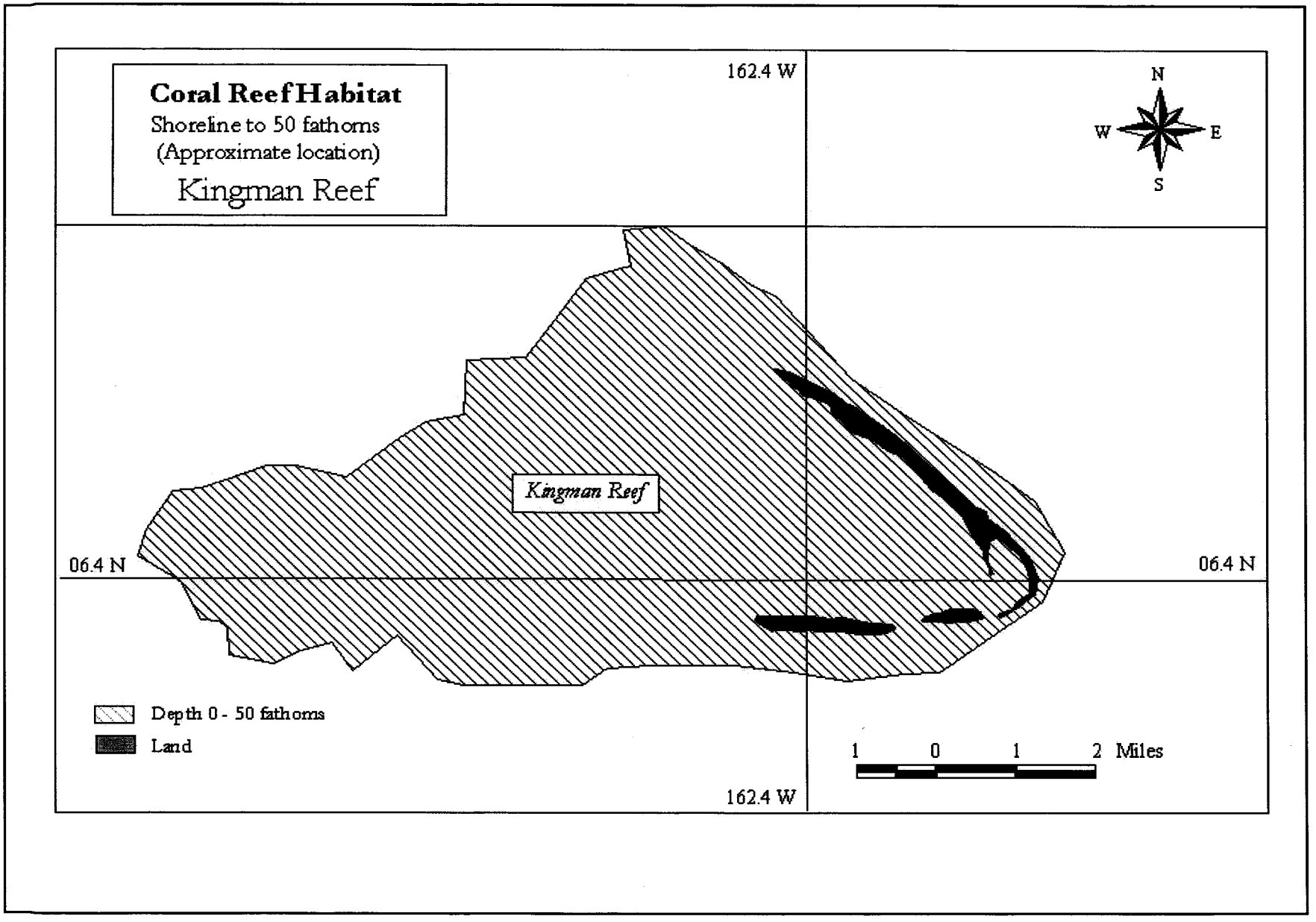

N
W
E
S
Coral Reef Habitat
Shoreline to 50 fathoms
(approximate location)
Howland Island
Howland Island
Not for Navigational Use
0.8 N
0.8 N
Depth 0-50 fathoms
Land
1
0
1 Miles
176.7 W

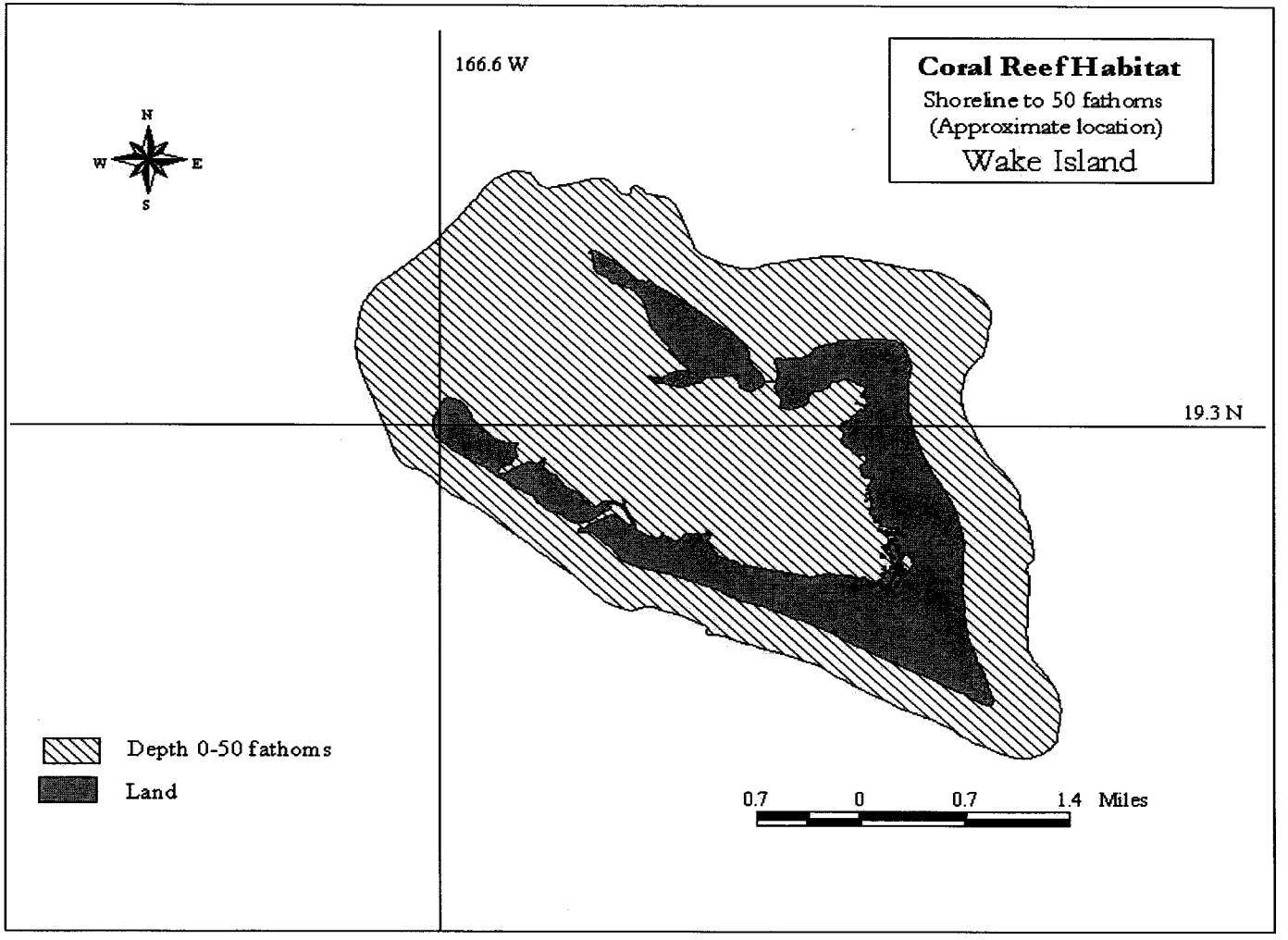

Coral Reef Habitat
Shoreline to 50 fathoms
(Approximate location)
Baker Island
N
W
E
S
0.2 N
0.2 N
Baker Island
Not For Navigational Use
0.2 0 0.2 0.4 Miles
Depth 0 - 50 fathoms
Land
176. 4 W


Coral Reef Habitat
Shoreline to 50 fathoms
(approximate location)
Jarvis Island
N
W
E
S
Jarvis Island
Use
No Data Off Chart
Depth 0 - 50 fathoms
Land
0.2 0 0.2 0.4 Miles


Coral Reef Habitat
Shoreline to 50 fathoms
(approximate location)
Johnston Atoll
N
W
E
S
Johnston Atoll
16 42' N
169 20' W
1 0 1 2 Miles
Depth 0 - 50 fathoms
Land
Poor Data


Coral Reef Habitat
Shoreline to 50 fathoms
(approximate location)
Palmyra Atoll
N
W
E
S
Palmyra Atoll
Not For Navigational Use
0 - 50 fathoms
Land
0.9
0
0.9
1.8
Miles


Coral Reef Habitat
Shoreline to 50 fathoms
(Approximate location)
Kingman Reef
162.4 W
N
W
E
S
Kingman Reef
06.4 N
06.4 N
Depth 0 - 50 fathoms
Land
1 0 1 2 Miles
162.4 W


166.6 W
Coral Reef Habitat
Shoreline to 50 fathoms
(Approximate location)
Wake Island
N
W
E
S
19.3 N
Depth 0-50 fathoms
Land
0.7
0
0.7
1.4 Miles