



**WESTERN
PACIFIC
REGIONAL
FISHERY
MANAGEMENT
COUNCIL**

**BACKGROUND DOCUMENT IN SUPPORT OF
AMENDMENTS TO THE FISHERY MANAGEMENT PLANS
FOR THE
BOTTOMFISH AND SEAMOUNT GROUND FISH,
CRUSTACEANS, PRECIOUS CORALS, CORAL REEF
ECOSYSTEMS, AND PELAGIC FISHERIES OF THE
WESTERN PACIFIC REGION
REGARDING
FISHING ACTIVITIES IN THE PROPOSED
NORTHWESTERN HAWAIIAN ISLANDS SANCTUARY**

Western Pacific Regional Fishery Management Council
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February 16, 2006

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EXECUTIVE SUMMARY

On January 18, 2006 the Council received a letter from the Under Secretary of Commerce for Oceans and Atmosphere stating that the National Oceanic and Atmospheric Administration (NOAA) plans to publish a Draft Environmental Impact Statement (DEIS) and draft fishing regulations for the proposed Northwestern Hawaiian Islands (NWHI) sanctuary in June 2006.. The Under Secretary informed the Council that NOAA is considering three alternatives in its DEIS. The first would allow limited fishing activities within the proposed sanctuary to continue indefinitely, the second would end such fishing by 2025, and the third would end it after five years following sanctuary designation. The first two alternatives include catch levels and permit limits for the proposed sanctuary. For the five year alternative, the number of permits would be limited to those permits active at the (yet to be determined) time of designation. The Under Secretary went on to say that while a factual basis supporting the legality of establishing catch and permit limits has not been fully developed, NOAA believes that there is a credible basis for moving forward with proposing such limits through amendments to the Council's existing Fishery Management Plans (rather than as regulations under the National Marine Sanctuaries Act). However to meet NOAA's DEIS timeline, the Council was informed that it would have to take final action to adopt these amendments and corresponding regulations by April 14, 2006, with transmittal of the amendment package(s) to NOAA occurring no later than May 1, 2006. If one of the alternatives described above is selected by NOAA as a preferred alternative, the agency would review the Council's proposed MSA regulations as a potential implementation mechanism.

In response to the above proposal, this document presents three alternatives regarding fishing regulations within the proposed NWHI sanctuary for consideration by the Council. In brief, these are two versions of the "no action" alternative, and an alternative that includes measures for each of the three alternate timeframes under consideration by NOAA.

Also described are the NWHI environment and a summary of the anticipated impacts of the alternatives on the environment including fishery participants and support industries, Hawaii's broader communities, and the nation as a whole.

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1.0 CHAPTER ONE: INTRODUCTION

1.1 Purpose and Need

On December 4, 2000, President Clinton issued Executive Order (EO) 13178 establishing the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve (Reserve). President Clinton subsequently revised portions of EO 13178 and completed establishment of the Reserve in EO 13196. The Reserve is managed by the National Marine Sanctuary Program which is within the National Oceanic and Atmospheric Administration (NOAA). Pursuant to the EOs and the National Marine Sanctuaries Act (16 U.S.C. 1433, 1434), NOAA is initiating the process to designate the Reserve as a National Marine Sanctuary. Section 304(a)(5) of the National Marine Sanctuaries Act (NMSA) provides an opportunity for Regional Fishery Management Councils to develop and recommend fishing regulations for proposed sanctuaries.

Consistent with the Section 304(a)(5) process, at its 126th meeting (March 14-17, 2005 in Honolulu, Hawaii) the Western Pacific Regional Fishery Management Council (Council) took final action to recommend specific regulations regarding fishing in the proposed Northwestern Hawaiian Islands (NWHI) sanctuary. On April 14, 2005, the Council transmitted these draft regulations to NOAA for their review and consideration as to whether they were consistent with the purposes and polices of the NMSA as well as the goals and objectives of the proposed sanctuary. On October 24, 2005, NOAA advised the Council that its proposed fishing regulations “do not fulfill the purposes and polices of the NMSA and the goals and objectives of the proposed NWHI sanctuary”. NOAA’s response went on to say that the agency hoped that the Council would participate in the regulation of NWHI fishing through amendments to its existing or new fishery management plans.

More recently, NOAA has proposed that if the Council were to amend its fishery management plans to accord with NOAA’s “sideboards” regarding NWHI fishing, there would be a high likelihood that these amended plans would be accepted by for the proposed NWHI sanctuary, with associated fishing regulations promulgated under the Magnuson-Stevens Fishery Conservation and Management Act (MSA). These “sideboards” include moratoriums on the harvest of crustaceans, precious corals and coral reef ecosystem associated species, area closures, and caps on the number of participants and total harvests in the bottomfish and pelagic fisheries.

On January 18, 2006 the Council received a letter from the Under Secretary of Commerce for Oceans and Atmosphere (see Appendix A) stating that NOAA plans to publish a Draft Environmental Impact Statement (DEIS) and draft fishing regulations for the proposed NWHI sanctuary in June 2006. The Under Secretary informed the Council that NOAA is considering three alternatives in its DEIS. The first would allow limited fishing activities within the proposed sanctuary to continue indefinitely, the second would end such fishing by 2025, and the third would end it after five years following sanctuary designation. The first two alternatives include catch levels and permit limits for the proposed sanctuary. For the five year alternative, the number of permits would be limited to those permits active at the (yet to be determined) time of designation. The Under Secretary went on to say that while a factual basis supporting the legality of establishing catch and permit limits has not been fully developed, NOAA believes that there is

a credible basis for moving forward with proposing such limits through amendments to the Council's existing Fishery Management Plans (rather than as regulations under the NMSA). However to meet NOAA's DEIS timeline, the Council was informed that it would have to take final action to adopt these amendments and corresponding regulations by April 14, 2006, with transmittal of the amendment package(s) to NOAA occurring no later than May 1, 2006. If one of the alternatives described above is selected by NOAA as a preferred alternative, the agency would review the Council's proposed MSA regulations as a potential implementation mechanism.

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1.2 Responsible Agencies

The Council was established by the Magnuson-Stevens Fishery and Conservation Management Act to develop Fishery Management Plans (FMPs) for fisheries in offshore waters around American Samoa, Guam, Hawaii and Commonwealth of the Northern Mariana Islands and the U.S. possessions in the Pacific.¹ Once an FMP is approved by the Secretary of Commerce, it is implemented by federal regulations which are enforced by the National Marine Fisheries Service and the U.S. Coast Guard, in cooperation with state, territorial and commonwealth agencies. For further information contact:

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1.3 Management Objectives for the Proposed NWHI National Marine Sanctuary

The general objective of the Council is to develop appropriate fishery management measures (and associated regulations) for the proposed NWHI National Marine Sanctuary. Under the National Marine Sanctuaries Act, and the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), these measures must be consistent with the 1) the purposes and policies of the National Marine Sanctuaries Act, 2) the National Marine Sanctuary Program's Goals and Objectives for the proposed Northwestern Hawaiian Islands National Marine Sanctuary, 3) the Council's Goal and Objectives for fisheries in the proposed Northwestern

¹ Howland, Baker, Jarvis, Wake and Johnston Islands, Palmyra and Midway Atolls and Kingman Reef.

Hawaiian Islands National Marine Sanctuary, 4) the MSA's National Standards, 5) and the specific objectives of each Fishery Management Plan (FMP).

1.4 National Marine Sanctuary Act Purposes and Policies

The NMSA details the following overall purposes and policies for the establishment of the National Marine Sanctuary System as:

(1) to identify and designate as national marine sanctuaries areas of the marine environment which are of special national significance and to manage these areas as the National Marine Sanctuary System;

(2) to provide authority for comprehensive and coordinated conservation and management of these marine areas, and activities affecting them, in a manner which complements existing regulatory authorities;

(3) to maintain the natural biological communities in the national marine sanctuaries, and to protect, and, where appropriate, restore and enhance natural habitats, populations, and ecological processes;

(4) to enhance public awareness, understanding, appreciation, and wise and sustainable use of the marine environment, and the natural, historical, cultural, and archeological resources of the National Marine Sanctuary System;

(5) to support, promote, and coordinate scientific research on, and long-term monitoring of, the resources of these marine areas;

(6) to facilitate to the extent compatible with the primary objective of resource protection, all public and private uses of the resources of these marine areas not prohibited pursuant to other authorities;

(7) to develop and implement coordinated plans for the protection and management of these areas with appropriate Federal agencies, State and local governments, Native American tribes and organizations, international organizations, and other public and private interests concerned with the continuing health and resilience of these marine areas;

(8) to create models of, and incentives for, ways to conserve and manage these areas, including the application of innovative management techniques; and

(9) to cooperate with global programs encouraging conservation of marine resources.

1.5 National Marine Sanctuary Program Goals and Objectives

The National Marine Sanctuary Program has adopted the following Goals and Objectives for the proposed NWHI National Marine Sanctuary as described in the September 20, 2004 document

“Proposed Northwestern Hawaiian Islands National Marine Sanctuary - Advice and Recommendations on Development of Draft Fishing Regulations Under the National Marine Sanctuaries Act Section 304(a)(5)”:

Goal 1: Protect, preserve, maintain, and where appropriate restore the natural biological communities, including habitats, populations, native species, and ecological processes, of the Sanctuary as a public trust for current and future generations.

Objectives:

1a. Develop and implement a comprehensive management plan that integrates best practices, available science, traditional knowledge, and innovative management techniques, and addresses both short-term and long-term resource protection needs.

1b. When there is uncertainty in available information regarding the potential impacts of any activity, err on the side of resource protection.

1c. Develop and implement the necessary prohibitions, rules, regulations and penalty schedules to achieve the primary purpose of resource protection and address the needs of the Sanctuary.

1d. Develop and implement surveillance and enforcement program needed to ensure compliance with regulations.

1e. Cooperate with regional and global programs encouraging conservation of marine resources.

Goal 2: Provide for comprehensive and coordinated conservation and management that recognizes and complements existing jurisdictional boundaries and management regimes and involves stakeholder communities.

Objectives:

2a. Develop and implement regional and global approaches, interagency agreements, and processes with partners to address key cross-jurisdictional activities such as education research and monitoring, enforcement and surveillance, and access.

2b. Create a permit, notification, and tracking systems for access and use that is compatible and coordinated with partner agencies.

2c. Coordinate all activities to minimize impacts to ecosystems, avoid redundant or duplicative efforts, and to achieve efficient use of agency resources.

2d. Engage representative stakeholder communities and the public in seeking advice for effective management.

Goal 3: Manage, minimize, or prevent negative human impacts by allowing access only for those activities that do not threaten the natural character or biological integrity of any ecosystem of the region.

Objectives:

3a. Allow access only for activities consistent with long-term ecosystem protection.

3b. The management system shall continue to allow Native Hawaiian cultural, religious, and subsistence uses.

3c. Develop a marine zoning system that prescribes further limits on use to enhance ecosystem protection and ease of management and enforcement.

3d. Develop a permit and tracking system to identify, evaluate, and monitor activities, access, and uses in order to ensure consistency with long-term ecosystem protection.

3e. Develop other measures as may be necessary to ensure long-term ecosystem protection.

3f. Work with the appropriate domestic and international agencies to adopt a notification requirement for transiting non-military vessels and the designation of special maritime zones on nautical charts.

Goal 4: Enhance public awareness, understanding, and appreciation of the marine environment and cultural and maritime heritage resources.

Objectives:

4a. Develop public outreach and education programs with partners to raise public awareness of NWHI marine ecosystems and the need to protect them and to effectively communicate access and use restrictions.

4b. In order to minimize the use of and impact to the region, plan and establish programs that emphasize the concept of bringing the place to the people, rather than the people to the place.

4c. Increase awareness of marine conservation in the NWHI by emphasizing the global nature of threats to the ecosystem and the importance of the region to the state, the nation, and the world.

4d. Enhance the effectiveness of education programs and public outreach by incorporating Native Hawaiian culturally based themes and traditional approaches to learning, multiple perspectives, histories, and stories of the region.

Goal 5: Support Native Hawaiian cultural, religious, and subsistence practices that are consistent with the long-term conservation and protection of the region.

Objectives:

5a. Build capacity within the Sanctuary program to develop a working relationship with Native Hawaiians to facilitate their participation in the management of the Sanctuary.

5b. Develop a plan for Native Hawaiian access and use in the NWHI collaboratively with Native Hawaiians and regional partners.

5c. Increase understanding of Native Hawaiian histories and cultural practices in the NWHI through research and oral traditions.

5d. Integrate Native Hawaiian traditional knowledge, values, and perspectives into management and education programs.

Goal 6: Support, promote, and coordinate research and long-term monitoring that improves management decision-making and is consistent with the conservation and protection of the region.

Objectives:

6a. Identify, assess, prioritize, and authorize ecological, historical, cultural, and socioeconomic research and monitoring necessary for effective management of the region.

6b. Coordinate with regional and national agencies to make vessels and other resources available for conservation and research activities.

6c. Compile existing research and avoid duplication by collaborating and coordinating with jurisdictional partner agencies and universities.

6d. Develop the ability to quickly assess and response to unexpected, rapid ecological changes that have occurred as a result of storm events, dramatic climate and temperature shifts, and other occurrences.

6e. Establish criteria for cultural research activities through consultation with Native Hawaiians.

6f. Work with partners and researchers to make NWHI research available and accessible to the public in a timely manner.

Goal 7: Maintain ecosystem integrity by limiting and controlling fishing activities using an ecosystem-based management approach. Maximize ecosystem protection while minimizing adverse socioeconomic impacts. Limit fishing activities to areas that minimize or prevent interactions with corals, seabirds, endangered Hawaiian monk seals, and other protected wildlife, or that do not threaten the natural character or biological integrity of any ecosystem of the region.

Objectives: As appropriate to maintain the natural character or biological integrity of any ecosystem of the region:

7a. Prohibit non-subsistence crustacean fishing.

7b. Prohibit commercial precious coral fishing.

7c. Prohibit harvest of all coral species, live rock, all aquaria species and live fish trade species, and algae, sponges, and other invertebrates.

7d. Allow recreational fishing for pelagic species except within sensitive habitats.

7e. Allow bottomfishing to continue except within sensitive habitats.

7f. Allow commercial pelagic fishing using handline, pole and line and trolling gear except within sensitive habitats.

7g. Prohibit subsistence use within the sanctuary except for Native Hawaiian subsistence use

7h. Allow sustenance fishing for pelagic and bottomfish species using pole and line, trolling and handline methods within the Sanctuary except within sensitive habitats.

7i. Allow spearfishing without the use of SCUBA for pelagic species except within sensitive habitats.

7j. All fishing not specifically allowed shall be prohibited.

7k. When there is uncertainty in available information regarding the potential impacts of any fishing activity, err on the side of resource protection.

1.6 Western Pacific Regional Fishery Management Council Goal and Objectives for Fisheries Within the Proposed NWHI Sanctuary

The Council has adopted the following Goal and Objectives for fisheries in the proposed NWHI National Marine Sanctuary (see Appendix B).

Goal: Maintain ecosystem integrity by applying ecosystem-based management and research principles to fishing activities. Sustain ecosystem protection while minimizing adverse socioeconomic impacts.

Objectives:

7a. Protect ecosystem integrity by applying a precautionary approach and continuing research on crustaceans and precious corals fisheries to determine if, and how, harvests can be allowed without damaging the integrity of the NWHI ecosystem.

7b. Protect the substrate of the NWHI ecosystem through prohibitions on the collection of reef building corals and live rock.

7c. Protect ecologically valuable areas from damage resulting from fishing activities, consistent with available biological and ecological information.

7d. Protect Hawaiian monk seals, sea turtles, seabirds and other protected wildlife by controlling fishing activities in areas where interactions are known to occur.

7e. Maintain ecosystem integrity by controlling the harvests of pelagic, bottomfish, and coral reef associated species consistent with available biological and ecological information.

7f. Maintain ecosystem integrity while minimizing adverse socioeconomic and cultural impacts.

7g. Employ principles of equity and fairness when allocating fishing rights.

7h. Protect Native Hawaiian cultural rights by promoting access for non-commercial fishing uses by Native Hawaiians to the extent possible without damaging the integrity of the NWHI ecosystem.

7i. Promote increased understanding of the NWHI ecosystem through comprehensive and coordinated research.

7j. Apply ecosystem-based principles through coordinated management with NWHI management and research partners.

1.7 Magnuson-Stevens Fishery Conservation and Management Act National Standards

The MSA National Standards are as follows:

National Standard 1 -- 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.

National Standard 2 -- Conservation and management measures shall be based upon the best scientific information available.

National Standard 3 -- 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.

National Standard 4 -- 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.

National Standard 5 -- 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.

National Standard 6 -- Conservation and management measures shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources and catches.

National Standard 7 -- Conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication.

National Standard 8 -- Conservation and management measures shall, consistent with the 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.

National Standard 9 -- 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.

National Standard 10 -- Conservation and management measures shall, to the extent practicable, promote the safety of human life at sea.

1.8 Bottomfish and Seamount Groundfish Fishery Management Plan Objectives

The objectives of the Bottomfish and Seamount Groundfish FMP are as follows:

Objective 1. Protect against overfishing and maintain long-term productivity of bottomfish stocks

Objective 2. Improve the database for future decisions through data reporting requirements and cooperative Federal/State/Territory programs.

Objective 3. Provide for consistency in Federal/State/Territory bottomfish management to ensure effective management across the range of fisheries

Objective 4. Protect bottomfish stock and habitat from environmentally destructive fishing activities and enhance habitat if possible.

Objective 5. Maintain existing opportunities for rewarding experiences by small-scale commercial, recreational, and subsistence fishermen, including native Pacific islanders.

Objective 6. Maintain consistent availability of high quality products to consumers.

Objective 7. Maintain a balance between harvest capacity and harvestable fishery stocks to prevent over-capitalization.

Objective 8. Avoid taking protected species and minimize possible adverse modifications to their habitat

Objective 9. Restore depleted groundfish stocks and to provide the opportunity to U.S. fishermen to develop new domestic fisheries for groundfish which will displace foreign fishing.

Objective 10. Monitor stock recovery of depleted stocks in the FCZ [EEZ] so that any international plan action for managing the common resource can be guided by experimental results.

1.9 Crustaceans Fishery Management Plan Objectives

The objectives of the Crustaceans FMP are as follows:

Objective 1. To ensure the long term productivity of the stock and prevent overfishing;

Objective 2. To promote the efficient contribution of the spiny lobster resource to the national economy ;

Objective 3. To collect and analyze biological and economic information about the lobster fishery and improve the basis for conservation and management in the future;

Objective 4. To prevent unfavorable impacts of the fishery on Hawaiian monk seals and other endangered and threatened species.

1.10 Precious Corals Fishery Management Plan Objectives

The objectives of the Precious Corals FMP are as follows:

Objective 1. Allow a fishery for precious coral in the EEZ in the western Pacific but limit the fishery so as to achieve the Optimum Yield on a continuing basis;

Objective 2. Prevent overfishing and wastage of resources;

Objective 3. Encourage the use of selective harvesting methods;

Objective 4. Minimize the harvest of colonies of coral which are immature;

Objective 5. Minimize the harvest of colonies of coral which have not reached their full potential for growth; and

Objective 6. Encourage the acquisition and analysis of new information concerning the distribution, abundance and ecology of precious corals.

1.11 Coral Reef Ecosystems Fishery Management Plan Objectives

The objectives of the Coral Reef Ecosystems FMP are as follows:

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.

1.12 Pelagics Fishery Management Plan Objectives

The objectives of the Pelagics FMP are as follows:

Objective 1. To manage fisheries for management unit species in the Western Pacific Region to achieve optimum yield (OY);

Objective 2. To promote, within the limits of managing at OY, domestic harvest of the management unit species in the Western Pacific EEZ and domestic fishery values associated with these species, for example, by enhancing the opportunities for:

- a. satisfying recreational fishing experiences,*
- b. continuation of traditional fishing practices for non-market personal consumption and cultural benefits,*
- c. domestic commercial fishermen, including charter boat operations, to engage in profitable fishing operations,*

Objective 3. To diminish conflicts in the EEZ, particularly in areas of concentrated domestic fishing,

Objective 4. To improve the statistical base for conducting better stock assessments and fishery evaluations thus supporting fishery management and resource conservation in the EEZ and throughout the range of the management unit species,

Objective 5. To promote the formation of a regional or international arrangement for assessing and conserving the management unit species and tunas throughout their range,

Objective 6. To preclude waste of management unit species associated with longline, purse seine, pole-and-line or other fishing operations; and

Objective 7. To promote within the limits of managing OY, domestic marketing of the management unit species in American Samoa Guam, NMI and Hawaii.

2.0 CHAPTER TWO: DESCRIPTION OF THE ENVIRONMENT

Chapters 2 through 4 of this document are being prepared in accordance with the requirements of the National Environmental Policy Act (NEPA) of 1969, to assess the impacts on the human environment that may result from the alternatives considered here.

This chapter describes components of the environment related to marine resources found in the NWHI. Where possible, trends in the condition of resources, ecosystems, fisheries, and human communities have been identified. This information provides the baseline and historical context needed to evaluate, in Chapter 4, the potential environmental consequences of each of the alternatives considered by the Council.

2.1 Physical Environment

Geographic Setting: In the central North Pacific Ocean, roughly 2,500 miles southwest of North America, lies the Hawaiian Archipelago. This 137-island chain stretches nearly 1,500 miles from Kure Atoll in the northwest to the island of Hawaii in the southwest. The NWHI comprise roughly 1000 miles of the 1,500 mile archipelago, and are composed of volcanic islands, atolls, shoals, and submerged banks. Contrary to statements that the NWHI contain 70% of US coral reefs (Executive Order 13178, 2000), recent evaluations of potential coral ecosystems in the United States have found that the NWHI contain less than 5% of the nation's potential shallow-water tropical and subtropical coral ecosystems when this area is defined as areas within the 10-fathom depth curve, and less than 10% of the nation's total when this area is defined as areas within the 100-fathom depth curve (Rohmann et al. 2005).

The closest NWHI island to the MHI is Nihoa, which lies nearly 150 miles northwest of Kauai. Nihoa is a volcanic island with two distinct peaks and steep sea cliffs. The next island to the northwest is Necker, which is volcanic island resembling the shape of a fish hook. Continuing west is French Frigate Shoals, an eighteen mile wide crescent shaped atoll. French Frigate Shoals has two exposed volcanic rocks and twelve low sandy islets. Northwest of French Frigate Shoals is Gardner Pinnacles, which consists of two emergent volcanic rocks. Next is Maro Reef, which is mostly a submerged atoll with very little emergent land.

Continuing up the chain is Laysan, the largest island in the NWHI, which is vegetated and even contains an hypersaline (extremely salty) lake. Northwest of Laysan is Lisianski Island, made up of low sand and coral, and located at northern end of a large submerged bank. Pearl and Hermes Reef, northwest of Lisianski, is a large atoll with several small islets that occasionally are submerged during storm activity. Continuing northwest is Midway Atoll, which includes three small islands surrounded by a large barrier reef. Kure Atoll, the northernmost coral atoll in the world, is surrounded by a barrier reef and contains an emergent land area known as Green Island. Between the emergent land areas described above are several submerged banks such as Brooks Bank, Raita Bank, St. Rogatien Bank, etc., which provide habitat for a variety marine resources.

Oceanographic Setting: The archipelago's position in the Pacific Ocean lies within the clockwise rotating North Pacific Subtropical Gyre (NPSG), a major surface current feature of the Pacific Ocean. Within the NPSG, the westward flowing northern edge of North Equatorial Current (NEC) grazes the Hawaiian Islands, mainly near the Big Island. The North Hawaiian Ridge Current (NHRC) can be thought of as a small part of the NEC that turns northwest to flow along the windward side of the chain instead of turning southwest to pass south of Hawaii Island (E. Firing, personal communication). Ten years of shipboard acoustic Doppler current profiler data collected by the NOAA shows a mean westward flow of the NHRC through the ridge between Oahu and Nihoa, and extending along the lee side of Nihoa and Necker to depths from 20 to 250 m (Firing and Brainerd, 2006, in press).

The Subtropical Counter Current (STCC) is an eastward flowing surface current found typically along 24°N from 130°E to 160°W. The eastward flowing Hawaiian Lee Counter Current (HLCC) is generally located along 20°N and extends from about 150°E to just west of the Hawaiian Islands (Kobashi and Kawamura 2002). The formation of the STCC and HLCC have recently been attributed to the “wake effect” that results from the combination of the westward trades winds steadily blowing over the Hawaiian Archipelago.²

Generally within the lee of the archipelago there are an abundance of mesoscale eddies created from a mixture of wind, current, and sea floor interactions. The eddies, which can rotate either clockwise or counter clockwise, have important biological impacts, and most likely play a more important role in larval transport than mean surface currents (E.Firing, per. com).. Eddies create vertical fluxes, with regions of divergence (upwelling) where the thermocline shoals and deep nutrients are pumped into surface waters enhancing phytoplankton production, and also regions of convergence (downwelling) where the thermocline deepens.

Sea surface temperatures around the Hawaiian Archipelago experience seasonal variability, but generally vary between 18°-28° C (64°-82° F) with the colder waters occurring more often in the NWHI. The NWHI are unique in that they contain the northernmost coral reef ecosystem (Kure Atoll) on the planet. The water temperatures experienced there are assumed to be the lower limit for corals to thrive and reefs to grow. Grigg (1982) suggests that Kure Atoll lies at the "Darwin Point" for reef development, a geographical limit beyond which corals and coralline algae can no longer deposit enough calcium carbonate to keep up with the subsidence of the area's volcanic base. It is theorized that reefs at latitudes higher than the Darwin Point fail to remain at sea level and sink below the photic zone within which growth can occur (Grigg 1982).

The Hawaiian Archipelago is subject to large storms and high wave energy produced from weather systems generated off the Aluetian Islands and other areas of the North Pacific. Such storms and waves can have major effects on the nearshore environment. For example, a major storm in the NWHI can break off pieces of coral, move underwater boulders, shift large volumes of sand, and erode islands. Such large perturbations in the shallow benthic habitat that result from the action of winter storms and swells are common in the NWHI.

² http://science.nasa.gov/headlines/y2002/10apr_hawaii.htm

Also due their position in the North Pacific, the NWHI act as a sink for a multitude of marine debris originating from Pacific-rim countries. Perhaps the most damaging type of this debris is in the form of derelict fishing gear such as nets and rope that are carried by ocean currents from both domestic and international North Pacific trawl fisheries. Other types of debris include materials made from rubber and plastics (e.g. lighters). Marine debris impacts the nearshore environment of the NWHI by choking and breaking coral reefs, entangling marine life, and carrying invasive species. Since 1996, NMFS has led a multi-agency cleanup effort that has removed nearly 450 mt of derelict fishing nets and other debris from the NWHI (Asher, 2005, pers. comm.) In recent years, the effort has removed over 100 tons of marine debris per year. The amount of marine debris accumulating each year in NWHI is unknown, but is thought to be substantial.

Significant sources of interannual physical and biological variation are the *El Niño* and *La Niña* events. During an *El Niño*, the normal easterly trade winds weaken, resulting in a weakening of the westward equatorial surface current and a deepening of the thermocline in the central and eastern equatorial Pacific. Water in the central and eastern equatorial Pacific becomes warmer and more vertically stratified with a substantial drop in surface chlorophyll.

Physical and biological oceanographic changes have also been observed on decadal time scales. These low frequency changes, termed regime shifts, can impact the entire ocean ecosystem. Recent regime shifts in the North Pacific have occurred in 1976 and 1989, with both physical and biological (including fishery) impacts (Polovina, 1996; Polovina et al., 1995). In the late 1980's for example, an ecosystem shift from high carrying capacity to low carrying capacity occurred in the NWHI. The shift was associated with the weakening of the Aleutian Low Pressure System (North Pacific) and the Subtropical Counter Current. The ecosystem effects of this shift were observed in lower nutrient and productivity levels and decreased abundance of numerous species including the spiny lobster, the Hawaiian monk seal, various reef fish, the red-footed booby, the red-tailed tropic bird (Polovina and Haight, 1999; Demartini et. al., 2002).

2.2 Biological Environment

The following is a general description of the life history, distribution, habitat characteristics of managed fishery stocks in the NWHI. Also discussed are the current status and impacts on essential fish habitat and protected species. A general description of Hawaii's fisheries is also provided.

2.2.1 Bottomfish and Seamount Groundfish Stocks

The bottomfish fisheries in Hawaii target an assemblage of species from the taxonomic groups Lutjanidae (Snappers), Serranidae (Groupers), Carangidae (Jacks), and Lethrinidae (Emperors). The seamount groundfish fishery when extant targeted the armorhead (*Pseudopentaceros richardsoni*) and the alfonsin (*Beryx splendens*). The following table presents the management unit species (MUS) which are listed under the Bottomfish and Seamount Groundfish FMP.

Table 1: Bottomfish and Seamount Groundfish Management Unit Species

COMMON NAME	LOCAL NAME	SCIENTIFIC NAME
Snappers:		
Silver jaw jobfish	Lehi	<i>Aphareus rutilans</i>
Grey jobfish	Uku	<i>Aprion virescens</i>
Squirrelfish snapper	Ehu	<i>Etelis carbunculus</i>
Longtail snapper	Onaga, ulaula	<i>Etelis coruscans</i>
Blue stripe snapper	Taape	<i>Lutjanus kasmira</i>
Yellowtail snapper	Palu-i Iusama	<i>Pristipomoides auricilla</i>
Pink snapper	Ōpakapaka	<i>Pristipomoides filamentosus</i>
Yelloweye snapper	Yelloweye ōpakapaka, kalekale	<i>Pristipomoides flavipinnis</i>
Snapper	Kalekale	<i>Pristipomoides sieboldii</i>
Snapper	Gindai	<i>Pristipomoides zonatus</i>
Jacks:		
Giant trevally	White ulua	<i>Caranx ignobilis</i>
Black jack	Black ulua	<i>Caranx lugubris</i>
Thick lipped trevally	Pig ulua, butaguchi	<i>Pseudocaranx dentex</i>
Groupers:		
Blacktip grouper	Fausi	<i>Epinephelus fasciatus</i>
Sea bass	Hāpuupuu	<i>Epinephelus quernus</i>
Lunartail grouper	Papa	<i>Variola louti</i>
Emperor fishes:		
Ambon emperor	Filoa-gutumumu	<i>Lethrinus amboinensis</i>
Redgill emperor	Filoa-paloomumu mafuti	<i>Lethrinus rubrioperculatus</i>
Seamount groundfish:		
Alfonsin		<i>Beryx splendens</i>
Ratfish/butterfish		<i>Hyperoglyphe japonica</i>
Armorhead		<i>Pseudopentaceros richardsoni</i>

Life History

Relatively little is known about the reproduction and early life history of deepwater bottomfish in the region. Spawning occurs over a protracted period, and peaks from July to September (Haight et al. 1993b). The eggs are released directly into the water column. The eggs hatch in 3 to 4 days, and the planktonic larval phase is thought to last at least 25 days (Leis 1987). For some species this phase may be considerably longer. For example, the pelagic stage for *ōpakapaka* is thought to be as long as six months (Moffit and Parrish 1996). While preliminary genetic work corroborates the notion of single archipelago-wide stocks of bottomfish, the extent of larval mixing between the NWHI and MHI is unclear. Larval advection simulation research indicates that larval exchange may occur throughout the Hawaiian archipelago, but that bottomfish larval transport most likely occurs from the more northerly Ho'omalū zone to the Mau zone at the southern end of the NWHI, in addition to larval transport from the MHI to the Mau zone (Kobayashi 1998). Kobayashi (1998) found that very little bottomfish larvae are transported into the Ho'omalū or MHI from other areas (most mixing is in the mid-NWHI). Experimental work at the Hawaii Institute of Marine Biology found that 'ōpakapaka eggs incubated at temperatures characteristic of adult habitat did not hatch, but those incubated in water at surface temperatures hatched and were reared for up to four months (C. Kelly, HURL, personal communication).

At the pass between the main and the Northwestern Hawaiian Islands there is often a westward flow from the region of Kauai along the lee side of the lower NWHI. This flow, the North Hawaiian Ridge Current (NHRC), is extremely variable and can also be absent at times. While the high variability of the NHRC certainly allows for the possibility of direct larval transport toward the MHI, the mean currents indicate that direct larval recruitment is more likely from the MHI to the NWHI (Firing and Brainerd, 2006, in press).

Little is known of the life history of the juvenile fish after settling out of the plankton, but research on *P. filamentosus* indicates the juveniles utilize nursery grounds well away from the adult habitat (Parrish 1989). Most of the target species have a relatively high age at maturity, long life span, and slow growth rate.

Habitat and Distribution

Generally, deepwater bottomfish inhabit the deep slopes of island coasts and banks at depths of 100 to 400 m.¹ Throughout their spatial and depth range, deepwater snappers are typically distributed in a clumped pattern, and are often associated with underwater headlands and areas of high relief. Although deepwater snappers are generally thought of as top level carnivores, several snapper species in the Pacific are known to incorporate significant amounts of zooplankton in their diets (Haight et al. 1993a).

¹*Uku* is a targeted BMUS, often caught at shallower depths than deepwater snappers using trolling methods rather than bottomfish fishing gear.

Status of the Stocks

Hawaii's bottomfish are managed as a single archipelagic-wide multi-species stock complex, however, bottomfish fisheries in the Hawaii Archipelago occur in two broad management areas, the Northwestern Hawaiian Islands and the Main Hawaiian Islands (MHI). On an archipelagic basis, targeted bottomfish stocks are generally healthy. However, MHI bottomfish stocks have shown signs of stress and overfishing. On the basis of fishery information analyzed by NMFS' Pacific Islands Fisheries Science Center (PIFSC), NMFS's Pacific Islands Regional Office (PIRO) has determined that overfishing of the bottomfish species complex is occurring within the Hawaii Archipelago. The Regional Administrator for PIRO notified the Council of this overfishing determination on May 27, 2005. Pursuant to the Magnuson-Stevens Fishery Conservation and Management Act, the Council is required to take action to amend the Bottomfish and Seamount Groundfish Fishery Management Plan (FMP) within one year following NMFS' notification of the bottomfish overfishing. NMFS has determined that the bottomfish overfishing condition is due to excess fishing effort occurring primarily in the MHI and, therefore, reducing fishing mortality (effort) in the MHI bottomfish fishery is the most effective means to end the overfishing in the Hawaii Archipelago. The Council is now considering a range of management measures that target a 15 percent or greater reduction in fishing mortality in the MHI deep-water bottomfish complex which has been determined to be the level of reduction necessary to end overfishing in the Hawaii Archipelago.

Based on 2002 fishery catch and effort data analyzed by PIFSC, Appendix 5 to the 2003 Bottomfish and Seamount Groundfish Annual Report³ indicated that overfishing is occurring in the Hawaii Archipelago because the ratio of current fishing mortality (F) to estimated fishing mortality at maximum sustainable yield (F_{MSY}) exceeded the MFMT of 1.0. Hawaii's archipelagic bottomfish F ratio is obtained by adding the weighted F contributions of the three management zones (MHI, Mau and Hoomalu) by using effort—amount of bottomfish fishing gear used over a given unit of time—as a proxy for fishing mortality. The archipelagic values also include a weighted factor based on the amount of bottomfish habitat in each management zone. These factors are 0.447, 0.124 and 0.429 for the MHI, Mau and Hoomalu Zones, respectively.

Using 2002 fishery data and the weighted factors for each zone, Appendix 5 to the bottomfish annual report stated that the archipelagic F ratio was between 1.14-1.35, above the overfishing threshold of 1.0. As reported in Appendix 5, the individual F ratios for the MHI, Mau and Hoomalu Zones were 1.86-2.33, 1.19, and 0.37, respectively. Since the completion of Appendix 5 in April 2005, PIFSC has received the full set 2003 bottomfish fishery data from the State of Hawaii's Division of Aquatic Resources. Based on 2003 bottomfish fishery statistics and the weighted factors for each zone, the archipelagic F ratio is determined to be 1.13, above the overfishing threshold of 1.0. Individual F ratios for MHI, Mau and Hoomalu Zones are 1.88, 0.96 and 0.39, respectively (see Appendix C for more information).

³ Appendix 5 to the Council's Bottomfish and Seamount Groundfish Annual Report, which also contains the status of bottomfish fisheries in the Western Pacific Region, can be obtained electronically at www.wpcouncil.org/Bottomfish/Documents/AnnualReports/2003/2003BAR-Appendix5-SatausofBott

Seamount Groundfish

Three species of seamount groundfish (armorhead, alfonso, and rat fish, respectively) are included as BMUS in the FMP. These deepwater species primarily occur at depths of 275 - 500 m at Hancock Seamount, which is located 2,800 km northwest of Honolulu. The seamount species generally occur at higher latitudes, and below the depth range of the snapper-grouper bottomfish species complex. The armorhead and alfonso spawn free-floating eggs which are dispersed by the North-equatorial and Kuroshio currents. Juvenile fish remain in the pelagic environment for up to a year, and then descend to seamount summits and begin a demersal existence. These species feed on species associated with the deep-scattering layer (euphausiids, copepods, shrimps, myctophids, etc.) and make vertical migrations at night to follow their prey.

Status of the Groundfish Stocks

Since the seamount-wide crash of the armorhead trawl fishery in 1975, CPUE values have remained depressed and typically far below the 20% SPR overfishing threshold both at the Hancocks and outside the U.S. EEZ. Although in 1992 a dramatic increase in armorhead CPUE and SPR occurred at seamounts outside the U.S. EEZ, these values declined to very low levels by 1994 and remained depressed through 2002. This 1992 event further indicates that any large seamount-wide recruitment peak are likely to be episodic and can originate even at low stock levels (the 1989 parental stock had the lowest SPR values both inside (1.0%) and outside (0.3%) the U.S. EEZ). However, this stock increase was effectively reduced, apparently by increased fishing pressure outside the U.S. EEZ, to the previous low level in a matter of two years. The Japan trawl fleet continues to trawl the SE-NHR seamounts outside the U.S. EEZ as these trawlers pass through this area on their way to and from other trawl fisheries in the Pacific. Besides Japan, other Asian nations appear to be fishing the SE-NHR seamounts outside the U.S. EEZ although information remains anecdotal.

The Hancock Seamount groundfish fishery was closed by the Council and NMFS in 1986. As the armorhead stocks near the Hancock Seamounts have yet to recover, the Council and NMFS extended the 6-year fishing moratorium at the Hancock Seamounts until August 31, 2010.

2.2.2 Crustacean Stocks

The following table lists the MUS managed under the Crustaceans FMP.

Table 2: Crustaceans Management Unit Species

COMMON NAME	SCIENTIFIC NAME
Spiny lobster	<i>(Panulirus marginatus or Panulirus penicillatus)</i>
Slipper lobster	<i>family Scyllaridae</i>
Kona crab	<i>Ranina ranina</i>

Crustacean fisheries in Hawaii primarily target lobster species of the taxonomic groups Palinuridae (spiny lobster) and Scyllaridae (slipper lobster). Historically, the majority of the lobster catch in the region is taken in the NWHI fishery which targets two species: the endemic Hawaiian spiny lobster, *Panulirus marginatus*, and the common slipper lobster *Scyllarides squammosus*. Three other species, the pronghorn spiny lobster (*Panulirus penicillatus*), ridgeback slipper lobster (*S. haanii*) and the Chinese slipper lobster (*Parribacus antarcticus*) are caught incidentally and in low abundance in the NWHI fishery.

Life History

Reproduction: The spawning period of *P. marginatus* in the NWHI extends over a broad period from early spring to late summer. Ovigerous females are found predominantly in the northern portion of the NWHI during early summer and in the central portion during late summer. But in the MHI around O‘ahu, spawning occurs throughout the year, peaking during May-August (Uchida et al. 1980; McGinnis 1972). The eggs are carried externally and hatch after 30-40 days (MacDonald and Stimson, 1980). Fecundity is positively correlated with body size, and can be expressed as $\text{Fecundity} = 6.5334(\text{CL})^{2.3706}$ (Honda 1980; DeMartini et al. 1993). It is estimated that the largest ovigerous females can carry over 1 million eggs (Honda 1984). After hatching, the larvae (phyllosoma) are planktonic for up to 12 months (Polovina and Moffitt 1995) undergoing metamorphosis through 11 discrete larval stages (Johnson 1968). The temporal distribution of late stage larvae in survey trawls in the NWHI appears to corroborate the 12-month larval cycle (Polovina and Moffitt 1995). Late-stage phyllosoma develop into a free-swimming stage known as a puerulus which actively seeks suitable benthic habitat (Cooke and MacDonald 1982). Puerulus settlement appears to occur in a series of pulses correlated with the lunar cycle, mostly during the new moon or first quarter of the lunar cycle (MacDonald 1986). Field studies in the NWHI and around Oahu indicate that puerulus settlement is oppositely seasonal at the north end of the NWHI versus Oahu, occurring sporadically throughout the year in the central portion of the NWHI (MacDonald 1986). Peak settlement around Oahu occurred during the winter months (October-April) in contrast to the summer peak at Kure Atoll (May-September); at French Frigate Shoals settlement occurred sporadically throughout the year (MacDonald 1986). After settlement the puerulus molts into a post-puerulus stage and gradually attains adult coloration.

Female lobsters of the genus *Scyllarides* have never been observed with spermatophora similar to those found in *Panulirus*, suggesting fertilization may be internal. Of 1,090 slipper lobster females collected during NWHI lobster surveys, none had a spermatophoric mass although 33% were ovigerous (Uchida and Uchiyama 1986). Research at PIFSC on reproduction in NWHI lobsters has focused primarily on spiny lobster; therefore, reproduction parameters for *Scyllarides* spp. in the NWHI are not well known. Analysis of recent research survey data indicates ovigerous female *S. squammosus* are found during the months of March through September. Peak spawning appears to occur from April to June (Haight unpubl. data).

Growth and Mortality: Several studies encompassing a variety of methods have provided basic life history parameters for spiny lobster in the NWHI. Based on analysis of recaptures of tagged lobsters at O‘ahu (McGinnis 1972) and Necker (Uchida and Tagami 1984) the growth parameter

k ranges in value from 0.269 for O'ahu males to 0.3857 for O'ahu females, and 0.26 for Necker males. Tagging at Kure Atoll and FFS resulted in k estimates of 0.27 and 0.3 for those locations (MacDonald 1984). Length frequency analysis of spiny lobster at Necker Island resulted in a k estimate of 0.3 for that location (Polovina and Moffitt 1989). The results of MacDonald's (1984) tagging study suggested that the natural mortality rate was higher for female spiny lobsters than for males at both Kure Atoll and FFS. Based on this study, the coefficient of natural mortality for both sexes combined was 0.49. Natural mortality estimates from mathematical modeling of commercial catch and effort data appear to corroborate the rate of natural mortality estimated from tagging research (Haight and Polovina 1992). Asymptotic length (L_{∞}) based on tagging and length frequency analysis ranges from 12.4 cm CL (Uchida and Tagami 1984) to 13.4 cm CL (MacDonald 1984; Polovina and Moffitt 1989). It appears that L_{∞} may fluctuate with changes in lobster density, having increased at both Maro Reef and Necker Island after the fishery reduced the population density (Polovina 1989). Based on tagging studies at Kure Atoll and FFS, MacDonald (1984) estimated the average individual lifespan of spiny lobster in the NWHI at 7.4 years.

Two different approaches have been used to estimate size at sexual maturity for spiny lobster in the NWHI. Prescott (1984) used changes in allometric growth of the walking legs as an indicator of sexual maturity for lobster at O'ahu and Necker Island. Estimates for the size at maturity were 58.6 mm CL for O'ahu females and 60.07 for Necker females. Polovina (1989) used a hyperbolic tangent function applied to size frequency from annual research trapping to determine the size at which 50% of the female lobsters were ovigerous. Based on this approach, females at Necker Island were found to attain sexual maturity at 57.9 mm CL (based on 1985-86 data), a result similar to that from the allometric growth analysis. Analysis of temporal maturity data indicates that size at sexual maturity fluctuates with changes in population density. Polovina (1989) found that the size at sexual maturity from Necker Island and Maro Reef declined from 1977 to 1987. Both of the areas received heavy fishing pressure during this time period which reduced lobster densities. The change in the size at sexual maturity seems to reflect a density-dependent response rather than genetic selection resulting from fishing pressure. Seeb et al. (1990) examined the genetic variability of the NWHI spiny lobster population and found no measurable loss of genetic variability due to fishing pressure. The sex ratio of adult spiny lobster in the NWHI appears to slightly favor males (Uchida and Tagami, 1984). MacDonald's (1984) tagging research indicated that male mortality rates were lower than those for females at the banks examined; therefore, differential mortality might account for the predominance of males in the catch. Genetics may also be a factor in the male to female ratio. Shaklee and Samollow (1980) found that of 2,060 pre-hatch embryos, 52% were male.

Based on the size composition of the unexploited population calculated from carapace length frequency distributions, the smallest lobsters occurred at Necker Island and the largest at Kure Atoll. The same data indicated that males were larger than females in all localities except Lisianski Island where the sample size was too small to provide a statistically valid sample (Uchida and Tagami, 1984).

Habitat and Distribution

Spiny and slipper lobster occur throughout the tropical oceans of the world (Cobb and Phillips 1980). *P. marginatus* is endemic to the Hawaiian Islands and Johnston Atoll (Brock 1973) and appears to be closely related to the long-legged spiny lobster, *P. longipes*, which is widely distributed in the Indo-West-Pacific (Pollock 1992). Genetic studies indicate that a single genetically homogenous population of spiny lobster occurs in the NWHI (Shaklee and Samollow 1980); however, variation in a single gene locus between lobster populations at Necker Island and Maro Reef indicate that it is likely lobster from these two areas are somewhat reproductively isolated (Seeb et al. 1990). Larval research surveys conducted throughout the tropical Pacific during the 1950s and 1960s found late-stage phyllosoma of *P. marginatus* only in waters near the Hawaiian Archipelago and Johnston Island (Johnson 1968). The distribution of phyllosoma around the Hawaiian Archipelago appears to be relatively homogenous, and the temporal distribution of late stage larvae is indicative of a summer spawning season and a 12-month larval cycle (Polovina and Moffitt 1995).

Adult and juvenile Hawaiian spiny lobsters occur throughout the NWHI from Nihoa Island to Kure Atoll (Uchida and Tagami 1984) at depths of 4-174 m (Uchida and Uchiyama 1986). In Hawaii, adult spiny lobsters are typically found on rocky substrates in well-protected areas such as crevices and depressions in coral reef habitat. Although the Hawaiian spiny lobster inhabits waters up to 200 m in depth, most of the catch is taken from water depths less than 60 m. In an extensive resource survey conducted by the NMFS during the 1970s, populations of spiny lobster were found at 18 (69%) of the banks in the NWHI extending from Nihoa Island to Kure Atoll. No *P. marginatus* were found at the banks north of Kure Atoll (Uchida and Tagami 1984). Within the Hawaiian Archipelago, lobster abundance, size, and species ratio varies widely between islands and banks. Variations in abundance and species composition between banks is related to various environmental and biological factors including length of larval cycle, advection of larvae by oceanographic processes, availability of juvenile refuge habitat, and suitability of adult habitat.

Although adult spiny lobsters occur as deep as 174 m in the NWHI, it appears that juvenile spiny lobster do not settle onto banks with summits deeper than 30 m and that the amount of habitat with vertical relief of 5-30 cm may limit total distribution and abundance (Parrish and Polovina 1994). At Necker Island, juvenile spiny lobster (<age-3) appear to occupy the same or similar habitat as the adults (Parrish and Polovina 1994), which increases their probability of being caught in the commercial fishery. At Maro Reef, juvenile lobsters appear to utilize shallow reef areas not associated with fishing. In 1993, an area of high juvenile abundance was located during exploratory research trapping in the shallows of Maro Reef (Haight and Polovina 1993). During 1994, the same lagoonal areas were fished, and the area of high juvenile abundance was extensively surveyed. Age-specific catch per unit effort (CPUE- defined as number of lobsters per trap fished) values from inside Maro Reef were significantly higher than the CPUE values from outside the reef. Of the shallow lagoon areas trapped in 1994, only the northwestern reef spur exhibited high juvenile CPUE values. It appears that the juvenile lobster are associated with the northern portion of the reef spur and are more abundant in shallow waters next to the spur (Haight 1998).

Unlike many other species of Panulirid lobster, juveniles of the Hawaiian spiny lobster do not recruit to distinctive “nursery” areas but instead utilize areas within the adult habitat. Adult spiny lobster in Hawaii release eggs into the water column beginning in the early spring of each year, with spawning reaching a peak in the middle of the summer. The planktonic larval phase of *P. marginatus* may last up to 12 months, during which time oceanic processes act to disperse and/or concentrate the larval pool. The dynamics of this advection process and the oceanographic and physiographic features which result in the retention of lobster larvae within the Hawaiian Archipelago are poorly understood. Recent research suggests that meso-scale oceanographic features such as eddies, gyres and geostrophic currents are critical components in determining if the larvae will be transported to areas suitable for recruitment (Polovina et al. 1999). These oceanographic features vary from year to year and may be influenced by cyclic, large-scale oceanographic processes as well (Polovina and Haight 1999). Because adult lobster are benthic and the islands and banks in the archipelago are separated by water depths of over 1000 m, each individual sub-population of lobster is effectively isolated from the sub-populations at other banks and islands in the Hawaiian Archipelago. The total lobster population in the archipelago therefore exists as a series of isolated spawning populations which all contribute to the total larval pool. The function of each island or bank as a source or sink for population production is important in the understanding of the dynamics of the population as a whole. Unfortunately, these aspects of lobster population biology are not well known.

Scyllarides squammosus is found in localized areas throughout the Indo-West-Pacific region. Resource surveys conducted by the NMFS documented the presence of *S. squammosus* at 17 (65%) of the NWHI banks from Nihoa Island to Kure Atoll at depths of 13-137 m (Uchida and Uchiyama 1986). During the initial research survey, slipper lobster catch was higher than spiny lobster catch at Brooks Bank, Northampton Seamounts, Lisianski Island, and Salmon Bank. However, slipper lobster comprised only 16% of the resource survey catch for the NWHI as a whole (Uchida and Uchiyama 1986).

Status of the Stocks

The relative distributional abundance of spiny lobster in the NWHI remained fairly constant from 1976 to 1989. Although lobsters were commercially trapped at up to 15 separate locations in the NWHI, five areas (Necker Island, Gardner Pinnacles, Maro Reef, St. Rogatien Bank, Brooks Bank) produced the majority of the catch throughout the period. After 1990, however, only Necker Island, Maro Reef and Gardner Pinnacles appeared to have lobster abundances suitable for commercial exploitation.

Data on the size structure of the NWHI lobster population since fishery exploitation began were collected by the PIFSC on annual assessment cruises from 1985 to 1995. By using age-specific CPUE values as an indicator of relative abundance, recruitment of spiny lobster to specific banks can be examined. At Maro Reef from 1985 through 1988, CPUE was highest for age-3 spiny lobster. Commercial effort at Maro Reef remained fairly constant during 1985-89 (average effort = 350,000 trap-hauls); the associated high CPUE values of age-3 lobsters at Maro Reef indicates recruitment remained stable during the time period. By 1990 a dramatic decrease in CPUE for all age classes at Maro Reef was apparent. The CPUE values for age-2 and age-3 spiny lobster

dropped 90% from 1988 to 1990. In 1991, CPUE values for age-2 and age-3 lobsters declined another 80% and 67%, respectively. The low CPUE values during 1990-91 were not caused by commercial exploitation alone, as commercial effort at Maro Reef dropped 45% from 1988 to 1990 and another 80% in 1991. The dramatic reduction in CPUE of all age classes at Maro Reef in 1990 may be attributed to poor post-larval recruitment of spiny lobster to Maro Reef beginning in 1986, which was compounded by commercial fishing harvest. Further reduction in age-specific CPUE of age-2 and age-3 spiny lobster in 1991, and the associated very low commercial CPUE prior to the 1991 research cruise, indicate poor recruitment of spiny lobster to Maro Reef continued during the years of 1987-88. The depressed CPUE continued from 1991 through 1995. This trend has persisted despite significant reductions in commercial fishing effort at Maro Reef during 1991-92 and 1994, and a fishery closure in 1993.

A similar trend was observed 70 nm to the northwest at Laysan Island (Haight and Polovina 1992), which has been closed to commercial harvest since the beginning of the commercial fishery. In contrast, recruitment of age-2 lobster to Necker Island, 360 nm southeast of Maro Reef, remained fairly constant throughout the time series. Polovina and Mitchum (1992) found recruitment of spiny lobster to Maro Reef to be correlated with the strength of the subtropical countercurrent, suggesting that mesoscale oceanographic features may impact the transport and survival of lobster larvae during their 11- to 12-month pelagic larval cycle. Continued recruitment of spiny lobster to Necker Island suggests that the lower southeastern end of the NWHI is not linked to the same oceanographic or recruitment processes as the northwestern end of the archipelago. The genetic variation in lobster from the two different areas appears to corroborate this hypothesis (Seeb et al. 1990). Because the oceanographic processes which appear to affect recruitment at the northwestern portion of the NWHI occur in approximately decadal cycles (Polovina and Mitchum 1992; Polovina et al. 1995), the spiny lobster stocks may remain at the present level of production for several years.

The Crustaceans FMP has defined overfishing using SPR values and the 20% critical threshold. In 1997, when the last SPR values were calculated for this fishery, the SPR values were 74 %, well above the 0.20 overfished threshold. However, the productivity of lobster stocks appears to have substantially decreased from the level when the fishery began. For example, NMFS research surveys at Necker Island indicate more than 80% drop in mature spiny lobster CPUE, from 4.2 to 0.5 between 1988 and 1999. Changes in environmental conditions compounded by fishery harvest are believed to have contributed to this decline (Polovina and Haight 1999). PIFSC is working on a new stock assessment model which will allow for more accurate lobster population estimates. Currently, slipper lobsters occur in greater abundance in the NWHI than do spiny lobsters (Dinardo, 2005)

2.2.3 Precious Coral Stocks

Precious corals MUS include any coral of the genus *Corallium* and the species listed in the following table.

Table 3: Precious Corals Management Unit Species

COMMON NAME	SCIENTIFIC NAME
Pink coral	<i>Corallium secundum</i> , <i>Corallium regale</i> , or <i>Corallium laauense</i>
Gold coral	<i>Narella spp.</i> , <i>Gerardia spp.</i> , or <i>Calyptraphora spp</i>
Bamboo coral	<i>Lepidisis olapa</i> or <i>Acanella spp</i>
Black coral	<i>Antipathes dichotoma</i> , <i>Antipathes grandis</i> , or <i>Antipathes ulex</i>

Life History

In general, precious corals share several ecological characteristics: they lack symbiotic algae in tissues (they are ahermatypic) and most are found in deep water below the euphotic zone; they are filter feeders; and many are fan shaped to maximize contact surfaces with particles or microplankton in the water column. Because precious corals are filter feeders, most species thrive in areas swept by strong to moderate currents (Grigg 1993). Although precious corals are known to grow on a variety of hard substrate, they are most abundant on substrates of shell sandstone, limestone, or basaltic rock with a limestone veneer.

All precious corals are slow growing and are characterized by low rates of mortality and recruitment. Natural populations are relatively stable, and a wide range of age classes is generally present. This life history pattern (longevity and many year classes) has two important consequences with respect to exploitation. First, the response of the population to exploitation is drawn out over many years. Second, because of the great longevity of individuals and the associated slow rates of turnover in the populations, a long period of reduced fishing effort is required to restore the ability of the stock to produce at the maximum sustainable yield (MSY) if a stock has been over exploited for several years.

Because of the great depths at which they live, precious corals should be insulated from some short-term drastic changes in the physical environment. For the same reason, it is difficult to imagine circumstances in which man-made pollution would affect their environment, except in the unlikely event that large quantities of heavy material, such as waste from manganese nodule refining, were dumped directly on a bed. Nothing is known of the long-term effects of changes in environmental conditions, such as water temperature or current velocity, on the reproduction, growth, or other life activities of the precious corals.

Taxonomy, Biology and Ecology: Precious corals MUS are taxonomically classified as members of the phylum Cnidaria, which includes all of the corals, hydroids, jellyfish and sea anemones. Its members are characterized by the presence of:

1. a sac-like body with only one opening for the gut;
2. only two tissue layers, an outer protective layer of epidermis and an inner digestive layer, the gastrodermis, lining the gut cavity;

3. an intermediate layer called the “mesoglea” or “middle jelly” consisting mostly of protein fibers and generally lacking cells; and
4. stinging devices called nematocysts used in either prey capture or defense.

Within the *Cnidaria*, precious corals are placed in the class *Anthozoa*, which includes the corals, soft corals and sea anemones, all characterized by having a relatively complicated gut, compared with other cnidarians. Living tissues are composed of polyps, each with a mouth surrounded by tentacles. Some species are composed of a single polyp while others are colonies of many polyps.

Within the *Anthozoa*, precious corals are members of three orders in two subclasses: 1) subclass *Octocorallia* (or *Alcyonaria*), order *Gorgonacea*, and 2) subclass *Hexacorallia* (or *Zoantharia*), orders *Zoanthidae* and *Antipathidae*.

Members of the subclass *Octocorallia* are characterized by their eight tentacles. All octocorals are colonial, with each colony consisting of numerous polyps growing out of, and constituting the body of, the animal. These are all connected by a complicated system of internal tubing running through the colonial mesoglea. Octocoral MUS include the pink corals of the genus *Corallium* and the bamboo corals of the genera *Lepidisis* and *Acanella*.

Other anthozoans have their tentacles in multiples of six and are thus termed the *Hexacorallia*, or hexacorals. Hexacoral MUS include gold corals of the order *Zoanthidea* and black corals of the order *Antipathidae*.

Red, pink and bamboo octocorals of the Order *Gorgonacea* are commonly called fan corals because their growth resembles that of a plant, with a main trunk fastened to the substrate, and lateral branching stems which may be in the same plane, hence the name “fan corals.” Their internal skeleton is decidedly different in structure and composition from the hard skeleton of the stony, reef-building, corals. Gorgonian skeletons contain a much larger proportion of organic material, much of it proteinaceous. This gives them much more flexibility than reef-building corals. They also tend to deposit a significant amount of pigmented material into the skeleton, resulting in some skeletons being highly colored. Brown, red, pink or gold are common colors found in gorgonian skeletons. Precious coral jewelry is made from the cut and polished skeletons of large gorgonians and similar corals.

Gorgonian colonies are all derived from one another and they are all one gender. The age at reproductive maturity is 12-13 years for *Corallium secundum*. Gorgonians of both sexes release gametes into the sea. Fertilization occurs in the sea and a small planula larva develops that chooses a place of settlement. Planula larvae of most corals are not usually dispersed very far from parent colonies. The larva then metamorphoses into a juvenile and the first polyp of the colony is formed. From this point the colony is fastened to the substrate and is immobile. In colonial species, a sexual reproduction also occurs through budding of the primary polyp. The duration of the larval stage is unknown for most species, but Mediterranean studies of *Corallium rubrum* suggest that their larvae remain competent for several weeks.

Corallium species live below the euphotic zone at depths between 100 and 1500 m where temperature varies between 3° and 18°C. These larvae may avoid settling deeper, where lower temperatures may prevent reproduction. As the colony grows, it generally differentiates so the “fan” is perpendicular to the prevalent currents. Growth of many octocorals is slow and they may require over 100 years to reach maximum size.

Little information is available on the ecological associations of the precious corals or their significance to the lives of other organisms. Gorgonians are predatory, suspension-feeding, animals that catch and kill small planktonic animals with their tentacles. Particulate organic matter is also important in the diets of Gorgonians, and like other Anthozoan species, they are associated with numerous kinds of commensal invertebrates.

Gorgonians have few predators. They are, however, the food of some polyp-plucking fish, such as filefish, and of grazing snails, several types of nudibranchs and at least one polychaete annelid. Eucidarid sea urchins are known to prey on precious corals. Gorgonians also provide vertical structure in a habitat where such structure is often lacking. Consequently, they are often settled on by barnacles and other epifauna. Gorgonians, in turn, have developed strong chemicals to deter fouling and predation.

Zoanthidea are a small group of hearty, solitary, sometimes colonial, anemone-like anthozoans that lack a skeleton. There is a large amount of morphological variability in this order, with most species being shallow-water and mat-forming. Some species are encrusting, and may overgrow other octocorals or hexacorals. They are unlike any other anthozoans internally, having a large number of paired and unpaired septa. Zoanthid polyps can occur as single individuals in large groups or they can be joined together by a thin stolon, a thin coenenchyme or a very thick coenenchyme from which only the mouths and tentacles are visible. The coenenchyme is a gelatinous mat of fibrous protein that develops from the mesoglea and supports the polyps.

Gold coral (*Gerardia* sp.) are Zoantharian corals that belong to the family *Parazoanthus*. Many are parasitic species that commonly overgrow other gorgonian corals. *Gerardia* seems to prefer overgrowing the bamboo corals (*Acanella* spp.). In fact, this association may be almost obligate as few colonies of *Gerardia* have been found without an *Acanella* base within the holdfast of the gold coral colony. In Hawaii, *Gerardia* sp. is found at depths between about 350 and 450 meters and prefers steep drop-offs. Typically it settles at the very top of drop-offs within this depth range where the current appears to be enhanced.

In the NWHI, monk seals have been observed (radio telemetry) to dive in areas where gold coral and arrowtooth eels may occur, suggesting that monk seals forage among precious corals because they provide structural relief for various fish assemblages. In 2000, the National Undersea Research Laboratory conducted a study using manned and unmanned submersibles in known beds of the Western Pacific region. The objective of the study was to test the hypothesis that gold coral provided habitat for deep-water arrowtooth eels. Results of the study found that gold coral did not seem to aggregate arrowtooth eels or any other significant fish assemblage. At the Cross Seamount, the study found arrowtooth eels in areas adjacent to the beds, but without the presence of gold corals (Parrish 2001).

In a study to test the possibility that NWHI precious corals beds aggregate fish assemblages, Parrish (2005, pers. comm.) found that in areas with taller colonies of precious corals (e.g. *Gerardia*) there were twice the fish density of adjacent areas without the corals, but the statistics of the study suggest that this was due to co-occurrence of corals and fish in areas of high relief and high current flow. The Parrish (2005, pers. comm.) study indicates that it is unlikely that fish depend on the corals for habitat, and that monk seal visitation to precious corals beds is thought to be incidental to the seals' targeting high-relief features where fish and precious corals co-occur.

Adult pink, bamboo and gold corals are found in deep water (100-1500 m) on solid substrate where bottom currents are strong. This is in contrast to black corals, discussed below, which also typically occur on solid substrate, but generally at depths between 30 and 110m.

Antipatharia contain the well known precious black or "thorny" coral. These tree-like corals have a thin axial skeleton with distinctive small thorns. A thin veneer of animal tissue, called the *cenosarc*, secretes the tightly-layered central skeleton of horn-like protein. Depending upon the species, the living tissue may be black, red, orange, brown, green, yellow or white. The gelatinous polyps located in this living "bark" are short and cylindrical, their six, non-retractable tentacles are armed with stinging cells.

More than 150 species of black corals have been described. Some, like the wire corals, grow as a single, spiral coil. Many others have a dendritic growth form, creating a fan shape or elaborate tangle of tree-like branches. At least 14 species of black corals are currently known from Hawaii.

Relatively little is known about the life cycle and reproduction of black corals. Like other cnidarians, black corals have life cycles that include both asexual and sexual reproduction. Asexual reproduction (budding) builds the colony by adding more living tissue that, in turn, secretes more skeleton. Regular growth rings laid down as the skeleton thickens can be used to estimate the age of the colony. Sexual reproduction involves the production of eggs and sperm to create young that can disperse and settle new areas. The larvae of several black coral species are negatively phototactic, and are most abundant in dimly lit areas, such as beneath overhangs and ledges in waters deeper than 30m. All species require firm, hard substrates free of sediment. Polyps are either male or female. The larval stage, called a planula, can drift with currents until a suitable surface is found. Once the larva settles, it metamorphoses into a polyp form and secretes skeletal material that attaches it to the seafloor. Then it begins budding, creating more polyps that will form a young colony. In one Hawaiian species that has been studied (*Antipathes dichotoma*, a MUS), the colony may grow about 2.5 inches (6.4 cm) per year. The age at reproductive maturity is 12-13 years for *Antipathes dichotoma*. Reproduction may occur annually. A large six-foot (1.8 m) tall coral tree is estimated to be between 30 and 40 years old. The oldest corals observed in the Maui Auau Channel Bed are thought to be 75 years old, and it is believed that black corals may live even longer (Grigg 1983).

Western Pacific precious coral larvae are more affected by light and temperature than are adults. Larvae of *Antipathes* species occurring in Hawaii are known to be negatively phototactic, which is why they are not found shallower than 30 m. The lower limit of the *A. dichotoma* and *A.*

grandis black corals coincides with the top of the thermocline in the high Hawaiian Islands (Grigg 1993).

Habitat and Distribution

Precious corals are known to exist in the EEZ around Hawaii and very likely exist in the EEZ around American Samoa, Guam, the Northern Mariana Islands and the remote U.S. Pacific Island possessions, but virtually nothing is known of their distribution and abundance in these areas outside of Hawaii. In America Samoa, there are three known areas with pink coral: near Upolu and Falealupo, and at Tupuola Bank (Grigg 1993). In the Northern Mariana Islands, Japanese fishermen have reported pink coral north of Pagan Island and near Rota and Saipan. Since these areas remain unsurveyed, no information is available regarding the abundance of coral present.

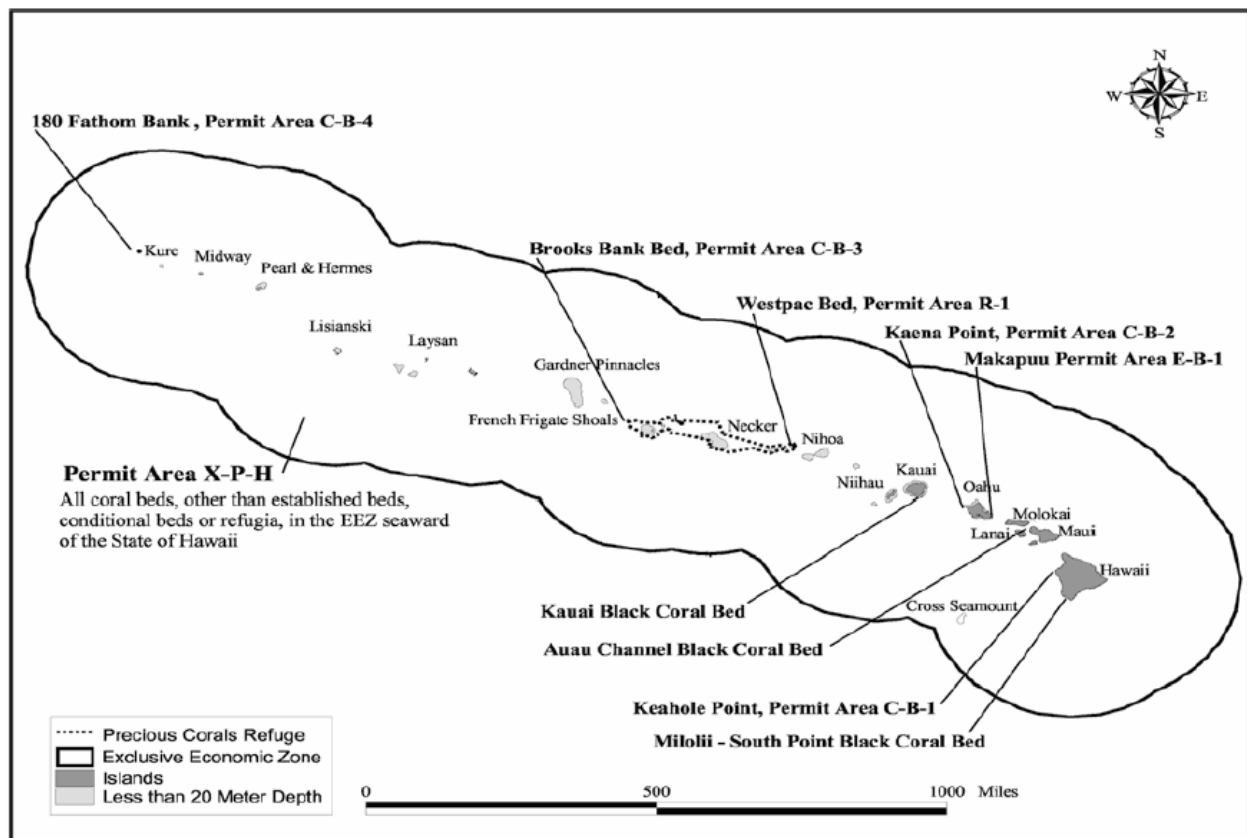


Figure 1: Precious Coral Beds in Hawaii

To date, beds of pink, gold and/or bamboo corals have been found eight locations in the EEZ around Hawaii. This number includes two recently discovered beds, one near French Frigate Shoals in the NWHI, and a second on Cross Seamount, approximately 150 nm south of Oahu (Figure 1). The approximate areas of six of these eight beds have been determined. These beds

are small; only two of them have an area greater than 1 km², and the largest is 3.6 km² in size. The Keahole Bed off Hawaii's Kona coast, however, is substantially larger than originally thought. Scientists and industry are currently assessing its actual size. Initial calculations appear to increase its size twenty-fold. There are also three known major black coral beds in the Western Pacific Region, in addition to several minor beds (Grigg 1998a). Most of these are located in Hawaii's state waters (0-3 nm). However the largest (the Auau Channel Bed) extends into federal waters of the EEZ.

There are undocumented and unconfirmed reports that precious corals have been observed or exploited in widely scattered locations in the Western Pacific Region: off American Samoa, Guam, the Northern Mariana Islands, and Wake Island, but no details are available. In some cases attempts at scientific surveys in areas referred to in such reports have failed to turn up any evidence of precious corals. Undocumented reports of large past commercial production by Japanese vessels on the Milwaukee Banks, some 500 miles beyond the northwestern extreme of the NWHI, and the large physical area of those banks, lead to conjecture that at some locations precious corals may occur in much larger aggregations than have as yet been demonstrated by scientific surveys. Asian coral fishers, who have roamed the western and central Pacific for decades, undoubtedly have undocumented and unorganized information on precious corals beds which has yet to be revealed to U.S. researchers and or resource managers. In general, the available information on precious corals occurrence and distribution is fragmentary and very incomplete, and there is a high probability that further surveying and prospecting will reveal significant additional precious corals resources in areas under U.S. jurisdiction.

Status of the Stocks

Precious Corals stocks in the NWHI are believed to be in relatively healthy condition. In 1965, Japanese coral fishermen discovered a large pink coral bed (*Corallium* spp.) on the Milwaukee Banks in the Emperor Seamount Chain near the northwestern end of the NWHI (Grigg 1993). Intermittently over the next two decades, dozens of foreign vessels employed tangle-net dredges to harvest precious corals in the waters around the NWHI. During the 1980's, Japanese and Taiwanese coral vessels frequently fished illegally in the EEZ near the Hancock Seamounts (Grigg 1993). In 1985, Taiwanese vessels reportedly poached about 100 mt of pink coral from north of Gardner Pinnacles and Laysan Island (Grigg 1993). The following are standing stock estimates of known precious coral beds in the NWHI.

Brooks Bank Conditional Bed: The harvest quota listed in the FMP for pink coral at Brooks Bank is 444 kg/yr.² This figure was calculated using the a formula provided in the FMP for setting the quota for Conditional Beds for which site specific data are unavailable. According to the Precious Corals FMP, the estimated MSY for pink coral at Makapu'u Bed is 1,000 kg/yr, the estimated area of Makapu'u Bed is 3.6 km² and the estimated area of Brooks Bank is 1.6 km². This bed was surveyed in September 1998. On this survey, 2.1 km-long transects were conducted at a depth of 350-505 m. Red coral (*C. regale*) was observed to be very abundant, with thousands

² The final rule implementing the Precious Corals FMP published on 20 August 1983 lists the harvest quota for pink coral at Brooks Bank as 17 kg. This is a typographical error.

of colonies present. Colonies occurred in 1-5 m² patches, and were located at depths of 430-517 m. These colonies were up to 50 cm in height and averaged 1 cm in diameter.

Extrapolation of these data suggests that a conservative standing crop of 8,000 kg of *C. regale* exists at this bed (Grigg 1998b). If it is assumed that this species of precious coral has the same natural mortality rate as *C. secundum* at the Makapu'u Bed (6.6%), an estimate of the MSY can be derived from the formula provided by Gulland (1970): $MSY = 0.4MB$, where M is the natural mortality rate and B is the standing crop biomass. Rounding down, it is estimated that 200 kg of *C. regale* could be harvested annually on a sustainable basis, based on these data and assumptions. Pink coral (*C. secundum*) was observed to be moderately abundant on the east side of the bank at

depths of 363-427 m, but colonies were generally small (less than 20 cm in height). Gold coral was abundant with 250 large colonies found between 392-467 m. It was estimated that there was a standing stock of 2,000 kg of live gold coral, with an equal amount observed dead.

Observations of finfish in the area were rare, and there was no evidence of predation by sea urchins at this bed.

Westpac Conditional Bed: This bed was also surveyed in 1998, using 3.2 km-long transects at depths of 360-500 m. No red coral was observed, however, pink coral was abundant, with thousands of colonies in 0.3-1.0 m² patches. Gold coral was rare, with only two colonies observed. Finfish (mostly *Polymixia*) were abundant, and there was high predation by Eucidarid sea urchins, with 50% of colonies showing signs of predation.

French Frigate Shoals-Gold Pinnacles Exploratory Bed: The 1998 survey also located a previously unknown bed near French Frigate Shoals, which has been named the FFS-Gold Pinnacles Bed. No red coral (*C. regale*) was found along 2.9 km-long transects at depths of 360-575 m, and pink coral (*C. secundum*.) abundance was low. Observed pink coral was generally small, averaging less than 12 cm in height (Grigg 1998b). Both live and dead gold coral were found in abundance, and 300 colonies were observed in scattered patches at depths of 365-406 m. Extrapolation of the transect data suggests that the gold coral standing crop at the FFS-Gold Pinnacles Bed is 3,000 kg. If it is assumed that this species of precious coral has the same natural mortality rate as *C. secundum* at the Makapu'u Bed (6.6%), an estimate of the MSY can be derived from the same formula provided by Gulland (1970) and given above. Rounding down, it is estimated that 80 kg of gold coral could be harvested annually on a sustainable basis based on these data and assumptions.

2.2.4 Coral Reef Ecosystem Associated Stocks

Coral reefs are carbonate rock structures at or near sea level that support 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 some of the most diverse and complex ecosystems on earth. 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 structure and function of all coral reef ecosystems are controlled by the prevailing oceanographic conditions (Maragos and Gulko, 2002).

As coral health and growth rates are dependant on water temperature, the highly variable water temperature of NWHI 18°-28° C (64°-82° F) can affect the coral reef ecosystem. The NWHI are unique in that they contain the northernmost coral reef ecosystem (Kure Atoll) on the planet. The water temperatures experienced there are assumed to be the lower limit for corals to thrive and reefs to grow. Kure Atoll may lie near the "Darwin Point" for reef development, a geographical limit beyond which corals and coralline algae can no longer deposit enough calcium carbonate to keep up with the subsidence of the area's volcanic base. Reefs at latitudes higher than the Darwin Point fail to remain at sea level and sink below the photic zone within which growth can occur Maragos and Gulko 2002).

The distribution of organisms found with coral reef ecosystems (e.g. corals, seagrasses, algae, sponges, and associated animals) are generally influenced by nutrient availability, salinity, light, substrate, wave forces, sediment and temperature (Maragos and Gulko 2002). A coral reef ecosystem generally occurs in water less than 30 m deep, but some coral and algal species that do not depend light to grow can be found in waters of 300 m or more (Grigg and Epp, 1989); Maragos and Jokiel, 1986)

The coral reef ecosystems of the NWHI were once thought to represent nearly 70 percent of the total coral reef area (0-100 fm) under U.S. jurisdiction (Hunter 1995). Recent research, however, estimates that the NWHI represents nearly 5 percent of the total U.S. coral reef area from 0-100 fm (Rohmann et. al., 2005). This large discrepancy is due to Florida's potential coral reef habitat being significantly underestimated in the mid-1990's. It is now thought that the potential coral reef habitat off of Florida composes nearly 80 percent of coral reef habitat in the U.S. (Rohmann et. al., 2005).

The coral reef ecosystems of the NWHI has been found to be pristine condition (Maragos and Gulko, 2002). As opposed to coral reef ecosystems in other regions, the coral reef ecosystem of the NWHI generally has low biodiversity and high endemism. This is due the Hawaii Archipelago's isolation in the Pacific compounded by a general east to west surface current flow and lack of close coral reef ecosystems "upstream" of the Hawaiian Islands (Maragos and Gulko, 2002).

Management Unit Species

The following tables illustrate the MUS contained within the Coral Reef Ecosystems FMP. Because the NWHI portions of FMP were unapproved, there is currently no management system in place in the NWHI for coral reef associated species.

Table 4: Currently Harvested Coral Reef Taxa (CHCRT)

Currently Harvested Coral Reef Taxa	
Acanthuridae (Surgeonfishes)	Orange-spot surgeonfish (<i>Acanthurus olivaceus</i>) Yellowfin surgeonfish (<i>Acanthurus xanthopterus</i>) Convict tang (<i>Acanthurus triostegus</i>) Eye-striped surgeonfish (<i>Acanthurus dussumieri</i>) Blue-lined surgeon (<i>Acanthurus nigroris</i>) Whitebar surgeonfish (<i>Acanthurus leucopareius</i>) Blue-banded surgeonfish (<i>Acanthurus lineatus</i>) Blackstreak surgeonfish (<i>Acanthurus nigricauda</i>) Whitecheek surgeonfish (<i>Acanthurus nigricans</i>) White-spotted surgeonfish (<i>Acanthurus guttatus</i>) Ringtail surgeonfish (<i>Acanthurus blochii</i>) Brown surgeonfish (<i>Acanthurus nigrofusus</i>) Elongate surgeonfish (<i>Acanthurus mata</i>) Mimic surgeonfish (<i>Acanthurus pyroferus</i>) Yellow-eyed surgeonfish (<i>Ctenochaetus strigosus</i>) Striped bristletooth (<i>Ctenochaetus striatus</i>) Twospot bristletooth (<i>Ctenochaetus binotatus</i>) Bluespine unicornfish (<i>Naso unicornus</i>) Orangespine unicornfish (<i>Naso lituratus</i>) Humpnose unicornfish (<i>Naso tuberosus</i>) Black tongue unicornfish (<i>Naso hexacanthus</i>) Bignose unicornfish (<i>Naso vlamingii</i>) Whitemargin unicornfish (<i>Naso annulatus</i>) Spotted unicornfish (<i>Naso brevirostris</i>) Humpback unicornfish (<i>Naso brachycentron</i>) Barred unicornfish (<i>Naso thynnoides</i>) Gray unicornfish (<i>Naso caesi</i> us)
Balistidae (Triggerfishes)	Titan triggerfish (<i>Balistoides viridescens</i>) Clown triggerfish (<i>B. conspicillum</i>) Orangestriped triggerfish (<i>Balistapus undulatus</i>) Pinktail triggerfish (<i>Melichthys vidua</i>) Black triggerfish (<i>M. niger</i>) Blue Triggerfish (<i>Pseudobalistes fucus</i>) Picassofish (<i>Rhinecanthus aculeatus</i>) Wedge Picassofish (<i>B. rectangulus</i>) Bridled triggerfish (<i>Sufflamen fraenatus</i>)
Carangidae (Jacks)	Bigeye scad (<i>Selar crumenophthalmus</i>) Mackerel scad (<i>Decapterus macarellus</i>)

Currently Harvested Coral Reef Taxa	
Carcharhinidae (Sharks)	<i>Grey reef shark (Carcharhinus amblyrhynchos)</i> <i>Silvertip shark (Carcharhinus albimarginatus)</i> <i>Galapagos shark (Carcharhinus galapagenis)</i> <i>Blacktip reef shark (Carcharhinus melanopterus)</i> <i>Whitetip reef shark (Triaenodon obesus)</i>
Holocentridae (Soldierfish/Squirrelfish)	<i>Bigscale soldierfish (Myripristis berndti)</i> <i>Bronze soldierfish (Myripristis adusta)</i> <i>Blotcheye soldierfish (Myripristis murdjan)</i> <i>Bricksoldierfish (Myripristis amaena)</i> <i>Scarlet soldierfish (Myripristis pralinia)</i> <i>Violet soldierfish (Myripristis violacea)</i> <i>Whitetip soldierfish (Myripristis vittata)</i> <i>Yellowfin soldierfish (Myripristis chryseres)</i> <i>Pearly soldierfish (Myripristis kuntzei)</i> <i>(Myripristis hexagona)</i> <i>Tailspot squirrelfish (Sargocentron caudimaculatum)</i> <i>Blackspot squirrelfish (Sargocentron melanospilos)</i> <i>File-lined squirrelfish (Sargocentron microstoma)</i> <i>Pink squirrelfish (Sargocentron tieroides)</i> <i>Crown squirrelfish (Sargocentron diadema)</i> <i>Peppered squirrelfish (Sargocentron punctatissimum)</i> <i>Blue-lined squirrelfish (Sargocentron tiera)</i> <i>Ala'ihī (Sargocentron xantherythrum)</i> <i>(Sargocentron furcatum)</i> <i>(Sargocentron spiniferum)</i> <i>Spotfin squirrelfish (Neoniphon spp.)</i>
Kuhliidae (Flag-tails)	<i>Hawaiian flag-tail (Kuhlia sandvicensis)</i> <i>Barred flag-tail (Kuhlia mugil)</i>
Kyphosidae (Rudderfish)	<i>Rudderfish (Kyphosus biggibus)</i> <i>(Kyphosus cinerascens)</i> <i>(Kyphosus vaigienses)</i>

Currently Harvested Coral Reef Taxa	
Labridae (Wrasses)	<p>Saddleback hogfish (<i>Bodianus bilunulatus</i>)</p> <p>Napoleon wrasse (<i>Cheilinus undulatus</i>)</p> <p>Triple-tail wrasse (<i>Cheilinus trilobatus</i>)</p> <p>Floral wrasse (<i>Cheilinus chlorourus</i>)</p> <p>Harlequin tuskfish (<i>Cheilinus fasciatus</i>)</p> <p>Ring-tailed wrasse (<i>Oxycheilinus unifasciatus</i>)</p> <p>Bandcheek wrasse (<i>Oxycheilinus diagrammus</i>)</p> <p>Arenatus wrasse (<i>Oxycheilinus arenatus</i>)</p> <p>Razor wrasse (<i>Xyrichtys pavo</i>)</p> <p>Whitepatch wrasse (<i>Xyrichtes aneitensis</i>)</p> <p>Cigar wrass (<i>Cheilio inermis</i>)</p> <p>Blackeye thicklip (<i>Hemigymnus melapterus</i>)</p> <p>Barred thicklip (<i>Hemigymnus fasciatus</i>)</p> <p>Threespot wrasse (<i>Halichoeres trimaculatus</i>)</p> <p>Checkerboard wrasse (<i>Halichoeres hortulanus</i>)</p> <p>Weedy surge wrasse (<i>Halichoeres margaritaceus</i>)</p> <p>(<i>Halichoeres zeylonicus</i>)</p> <p>Surge wrasse (<i>Thalassoma purpureum</i>)</p> <p>Redribbon wrasse (<i>Thalassoma quinquevittatum</i>)</p> <p>Sunset wrasse (<i>Thalassoma lutescens</i>)</p> <p>Longface wrasse (<i>Hologymnosus doliatus</i>)</p> <p>Rockmover wrasse (<i>Novaculichthys taeniourus</i>)</p>
Mullidae (Goatfishes)	<p>Yellow goatfish (<i>Mulloidichthys spp.</i>)</p> <p>(<i>Mulloidichthys Pfleugeri</i>)</p> <p>(<i>Mulloidichthys vanicolensis</i>)</p> <p>(<i>Mulloidichthys flaviolineatus</i>)</p> <p>Banded goatfish (<i>Parupeneus spp.</i>)</p> <p>(<i>Parupeneus barberinus</i>)</p> <p>(<i>Parupeneus bifasciatus</i>)</p> <p>(<i>Parupeneus heptacanthus</i>)</p> <p>(<i>Parupeneus ciliatus</i>)</p> <p>(<i>Parupeneus ciliatus</i>)</p> <p>(<i>Parupeneus cyclostomas</i>)</p> <p>(<i>Parupeneus pleurostigma</i>)</p> <p>(<i>Parupeneus indicus</i>)</p> <p>(<i>Parupeneus multifasciatus</i>)</p> <p>Bantail goatfish (<i>Upeneus arge</i>)</p>
Mugilidae (Mullet)	<p>Stripped mullet (<i>Mulgil cephalus</i>)</p> <p>Engel's mullet (<i>Moolgarda engeli</i>)</p> <p>False mullet (<i>Neomyxus leuciscus</i>)</p> <p>Fringelip mullet (<i>Crenimugil crenilabis</i>)</p>

Currently Harvested Coral Reef Taxa	
Muraenidae (Moray eels)	Yellowmargin moray (<i>Gymnothorax flavimarginatus</i>) Giant moray (<i>Gymnothorax javanicus</i>) Undulated moray (<i>Gymnothorax undulatus</i>)
Ocotpodidae	Octopus (<i>Octopus cyanea</i> ; <i>O. ornatus</i>)
Polynemidae	Threadfin (<i>Polydactylus sexfilis</i>) -Moi
Pricanthidae (Bigeye)	Glasseye (<i>Heteropriacanthus cruentatus</i>) Bigeye (<i>Priacanthus hamrur</i>)
Scaridae (Parrotfishes)	Humphead parrotfish (<i>Bulbometapon muracatum</i>) Parrotfishes (<i>Scarus spp.</i>) Pacific longnose parrotfish (<i>Hipposcarus longiceps</i>) Stareye parrotfish (<i>Catolomus carolinus</i>)
Scombirdae	Dogtooth tuna (<i>Gymnosarda unicolor</i>)
Siganidae (Rabbitfish)	Forktail rabbitfish (<i>Siganus aregentus</i>) Golden rabbitfish (<i>Siganus guttatus</i>) Gold-spot rabbitfish (<i>Siganus punctatissimus</i>) Randall's rabbitfish (<i>Siganus randalli</i>) Scribbled rabbitfish (<i>Siganus spinus</i>) Vermiculate rabbitfish (<i>Signaus vermiculatus</i>)
Sphyraenidae (Barracuda)	Heller's barracuda (<i>Sphyraena helleri</i>) Great Barracuda (<i>Sphyraena barracuda</i>)
Turbinidae (turban shells/green snails)	Green snails (<i>Turbo spp.</i>)

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

Table 5: Potentially Harvested Coral Reef Taxa (PHCRT)

(Note: Several taxa in the CHCRT list appear below. As noted in the table, all species in these taxa that are not listed as CHCRT or other FMP MUS are by default PHCRT).

Potentially Harvested Coral Reef Taxa	
Other Labridae spp. (wrasses) (Those species not listed on CHCRT list)	<i>Ephippidae</i> (batfish)
Other Carcharhinidae, Sphyrnidae (Those species not listed on CHCRT list)	<i>Monodactylidae</i> (mono)
Dasyatidae, Myliobatidae, Mobulidae (rays)	<i>Haemulidae</i> (sweetlips)
Other Serranidae spp. (groupers)	<i>Echineidae</i> (remoras)
Carangidae (jacks/trevallies)	<i>Malacanthidae</i> (tilefish)
	<i>Acanthoclinidae</i> (spiny basslets)
Other Holocentridae spp. (soldierfish/squirrelfish) (Those species not listed on CHCRT list)	<i>Pseudochromidae</i> (dottybacks)
Other Mullidae spp. (goatfish) (Those species not listed on CHCRT list)	<i>Plesiopidae</i> (prettyfins)

Potentially Harvested Coral Reef Taxa	
Other Acanthuridae spp. (surgeonfish/unicornfish) (Those species not listed on CHCRT list)	<i>Tetrarogidae</i> (waspfish)
Other Lethrinidae spp. (emperors)	<i>Caracanthidae</i> (coral crouchers)
Chlopsidae, Congridae, Moringuidae, Ophichthidae (eels) Other Muraenidae (morays eels) (Those species not listed on CHCRT list)	<i>Grammistidae</i> (soapfish)
Apogonidae (cardinalfish)	<i>Aulostomus chinensis</i> (trumpetfish)
Other Zaclidae spp. (moorish idols)	<i>Fistularia commersoni</i> (coronetfish)
Other Chaetodontidae spp. (butterflyfish)	<i>Anomalopidae</i> (flashlightfish)
Other Pomacanthidae spp. (angelfish)	<i>Clupeidae</i> (herrings)
Other Pomacentridae spp. (damselfish)	<i>Engraulidae</i> (anchovies)
Scorpaenidae (scorpionfish)	<i>Gobiidae</i> (gobies)
Blenniidae (blennies)	<i>Lutjanidae</i>
Other Sphyraenidae spp. (barracudas)	<i>Other Ballistidae/Monocanthidae spp.</i> (Those species not listed on CHCRT list)
Pinguipedidae (sandperches)	<i>Other Siganidae spp.</i> (Those species not listed on CHCRT list)
Gymnosarda unicolor	<i>Other Kyphosidae spp.</i>
Bothidae/Soleidae/Pleuronectidae (flounder/sole)	<i>Caesionidae</i>
Ostraciidae (trunkfish)	<i>Cirrhitidae</i>
Tetradontidae/Diodontidae (puffer/porcupinefish)	<i>Antennariidae</i> (frogfishes)
	<i>Syngnathidae</i> (pipefishes/seahorses)
Stony corals	<i>Echinoderms</i> (e.g., sea cucumbers, sea urchins)
Heliopora (blue)	<i>Mollusca</i>
Tubipora (organpipe)	<i>Sea Snails</i> (gastropods)
Azooxanthellates (non-reefbuilders)	<i>Trochus spp.</i>

Potentially Harvested Coral Reef Taxa	
Fungiidae (mushroom corals)	<i>Opistobranchs (sea slugs)</i>
Sm/Lg Polyped Corals (endemic spp.)	<i>Pinctada margaritifera (black lipped pearl oyster)</i>
Millepora (firecorals)	<i>Tridacnidae</i>
Sot corals and Gorgonians	<i>Other Bivalves</i>
Anemones (non-epifaunal)	<i>Cephalopods</i>
Zooanthids	<i>Crustaceans (Lobsters, Shrimps/Mantis, True Crabs and hermit crabs) (Those species not managed under the Crustacean FMP)</i>
Sponges (non-epifaunal)	<i>Stylasteridae (lace corals)</i>
Hydrozoans	<i>Solanderidae (hydroid fans)</i>
Bryozoans	<i>Annelids</i>
	<i>Algae</i>
Tunicates (solitary/colonial)	<i>Live rock</i>
All other coral reef ecosystem associated marine plants, invertebrates and fishes not listed under existing FMPs.	

NWHI Coral Reef Communities: 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. Coral species richness tends to be higher in the NWHI, where the genus *Acropora*, not found in the MHI, is present. A peak in coral species diversity occurs in the middle of the Hawaiian Archipelago at FFS and Maro Reef (Grigg 1983). Many reefs in the NWHI are comprised of calcareous algae (Green 1997). 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 significantly higher in the NWHI. Fish communities in the NWHI are dominated by apex predators (sharks and jacks), whereas those in the MHI are not (Friedlander and DeMartini 2002). Some fish species are common in parts of the NWHI that are rare elsewhere in the archipelago (Green 1997).

Life History of Coral Reef Fish

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 (1997). 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).

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 harem 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).

Population Dynamics: 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 $0.5\text{--}5\text{ t/km}^2\text{yr}^{-1}$, based on limited data (Marten and Polovina 1982; Stevenson and Marshall 1974). Much higher yields of around $20\text{ t/km}^2\text{yr}^{-1}$, 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 $16 \text{ t/km}^2\text{yr}^{-1}$ based on 43 yield estimates where the proxy for fishing effort was population density.

However, Birkeland (1997) 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), 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 (1997) 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.

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.

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 study of climatic and oceanographic events and their effect on productivity in the NWHI, Polovina et al. (1994) found declines of 30 to 50% in a wide variety of species from various trophic levels, from the early 1980s to the present, could be explained by a shift in oceanographic conditions. Prior to this time period, oceanographic conditions that lasted from the late 1970s until the early 1980s moved nutrient-rich deep ocean water into the euphotic zone, resulting in higher densities of reef fish, crustaceans, Hawaiian monk seals and seabirds.

Habitat and Distribution of Coral Reef Fish

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).

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. For example, sea grass 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.

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.

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, excess fishing may alter the age-structure of the population and may also lead to stock depletion.

At Laysan Island, where lobster fishing is prohibited, the 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.

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). In 2002, several areas of the NWHI (Kure, Midway, Pearl and Hermes) were found to have experienced some coral bleaching (Kenyon, 2004, pers. comm).

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). 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.

Status of the Stocks

NWHI coral reef associated fish stocks are believed to be in healthy condition as compared to the MHI. For example, the overall standing stock of the Spectacled Parrotfish (*Chlorurus perspicillatus*) is 1160 percent greater in NWHI than in the MHI (Maragos and Gulko, 2002). Average fish biomass is three times higher in the NWHI than in the MHI. This is due to 54 percent of biomass is comprised of top-level predators, whereas top-level predators in the MHI comprise only 3 percent of the fish biomass (Friedlander and DeMartini 2002). While the abundance of herbivores in the NWHI is similar to MHI coral reefs, the size and weight of these fish are higher in the NWHI than in the MHI (Maragos and Gulko, 2002). Studies conducted at French Frigate Shoals and Midway found that reef fishes declined by about one-third from the early eighties to early nineties. Such declines are thought to be associated with interdecadal regime shifts in productivity (Demartini et. al, 2002). As with many marine organisms, relative abundance of reef fish species are linked to fluctuations in environmental conditions that result in changes to productivity levels, larval transport, and recruitment.

2.2.5 Pelagic Stocks

Fishing for pelagic species within the proposed NWHI sanctuary is done primarily by bottomfish permit holders trolling to and from bottomfish grounds, in addition to small-scale handline

fisheries towards the southern end of the NWHI. Regulations promulgated under the Pelagics FMP prohibit Hawaii-based longline vessels from fishing within 50 nm of the NWHI. The extent of recreational or subsistence pelagic fishing is unknown, but is thought to be low.

The following table lists the MUS contained in the Pelagics FMP.

Table 6: Pelagic Management Unit Species

Temperate species complex:	Striped Marlin (<i>Tetrapturus audax</i>)
	Bluefin Tuna (<i>Thunnus thynnus</i>)
	Swordfish (<i>Xiphias gladius</i>)
	Albacore tuna (<i>Thunnus alalunga</i>)
	Mackerel (<i>Scomber</i> spp)
	Bigeye tuna (<i>Thunnus obesus</i>)
	Pomfret (family Bramidae)
Tropical species complex:	Yellowfin tuna (<i>Thunnus albacares</i>)
	Kawakawa (<i>Euthynnus affinis</i>)
	Skipjack tuna (<i>Katsuwonus pelamis</i>)
	Frigate and bullet tunas (<i>Auxis thazard</i> , <i>A. rochei</i>)
	Blue marlin (<i>Makaira mazara</i>)
	Slender tunas (<i>Allothunnus fallai</i>)
	Black marlin (<i>Makaira indica</i>)
	Dogtooth tuna (<i>Gymnosarda unicolor</i>)
	Spearfish (<i>Tetrapturus</i> spp.)
	Sailfish (<i>Istiophorus platypterus</i>)
	Mahimahi (<i>Coryphaena hippurus</i> , <i>C. equiselas</i>)
	Wahoo (<i>Acanthocybium solandri</i>)
	Opah (<i>Lampris guttatus</i>)
	Snake mackerels or oilfish (family Gempylidae)
	Crocodile sharks (<i>Pseudocarcharias kamoharai</i>)
	Requiem sharks (family Carcharhinidae)
	Mackerel sharks (family Lamnidae)
	Hammerhead sharks (family Sphyrnidae)

Life History

Pelagic species are closely associated with their physical and chemical environment. Suitable physical environment for these species depends on gradients in temperature, oxygen or salinity, all of which are influenced by oceanic conditions on various scales. In the pelagic environment, physical conditions such as isotherm and isohaline boundaries often determine whether or not the surrounding water mass is suitable for pelagic fish, and many of the species are associated with specific isothermic regions. Additionally, areas of high trophic transfer as found in fronts and eddies are an important habitat for foraging, migration, and reproduction for many species (Bakun, 1996).

Oceanic pelagic fish such as skipjack and yellowfin tuna, and blue marlin prefer warm surface layers, where the water is well mixed by surface winds and is relatively uniform in temperature and salinity. Other fish such as albacore, bigeye tuna, striped marlin and swordfish, prefer cooler, more temperate waters, often meaning higher latitudes or greater depths. Preferred water temperature often varies with the size and maturity of pelagic fish, and adults usually have a wider temperature tolerance than sub-adults. Thus, during spawning, adults of many pelagic species usually move to warmer waters, the preferred habitat of their larval and juvenile stages. Large-scale oceanographic events (such as *El Niño*) change the characteristics of water temperature and productivity across the Pacific, and these events have a significant effect on the habitat range and movements of pelagic species. Tunas are commonly most concentrated near islands and seamounts that create divergences and convergences which concentrate forage species, also near upwelling zones along ocean current boundaries, and along gradients in temperature, oxygen and salinity. Swordfish and numerous other pelagic species tend to concentrate along food-rich temperature fronts between cold, upwelled water and warmer oceanic water masses.

These fronts represent sharp boundaries in a variety of physical parameters including temperature, salinity, chlorophyll, and sea surface height (geostrophic flow) (Niiler and Reynolds, 1984; Roden, 1980; Seki *et al.*, in press). Biologically, these convergent fronts appear to represent zones of enhanced trophic transfer (Bakun, 1996; Olsen *et al.*, 1994). The dense cooler phytoplankton-rich water sinks below the warmer water creating a convergence of phytoplankton (Roden, 1980). Buoyant organisms, such as jellyfish as well as vertically swimming zooplankton, can maintain their vertical position in the weak down-welling, and aggregate in the front to graze on the down-welled phytoplankton (Bakun, 1996). The increased level of biological productivity in these zones attracts higher trophic-level predators such as swordfish, tunas, seabirds, and sea turtles, and ultimately a complete pelagic food web is assembled.

Habitat and Distribution

Near Hawaii, there are two prominent frontal zones. These frontal zones are associated with two isotherm (17°C and 20°C), and they are climatologically located at latitudes 32° - 34°N . (the Subtropical Front or STF) and latitudes 28° - 30°N . (the South Subtropical Front or SSTF) (Seki *et al.*, 2002). Both the STF and SSTF represent important habitats for swordfish, tunas, seabirds

and sea turtles. Variations in their position play a key role in catch rates of swordfish and albacore tuna, and distribution patterns of Pacific pomfret, flying squid, loggerhead turtles (Seki *et al.*, in press), and seabirds. Hawaii-based longline vessels targeting swordfish set their lines where the fish are believed to be moving south through the fronts following squid, the primary prey of swordfish (Seki *et al.*,). Squid is also the primary prey item for albatross (Harrison *et al.*, 1983), hence the albatross and longline vessels targeting swordfish are often present at the same time in the same area of biological productivity.

These frontal zones have also been found to be likely migratory pathways across the Pacific for loggerhead turtles (Polovina *et al.*, 2000). Loggerhead turtles are opportunistic omnivores that feed on floating prey such as the pelagic cnidarian *Velella velella* (“by the wind sailor”), and the pelagic gastropod *Janthina sp.*, both of which are likely to be concentrated by the weak downwelling associated with frontal zones (Polovina *et al.*, 2000). Data from on-board observers in the Hawaii-based longline fishery indicate that incidental catch of loggerheads occurs along the 17° C front (STF) during the first quarter of the year and along the 20° C front (SSTF) in the second quarter of the year. The interaction rate, however, is substantially greater along the 17° C front (Polovina *et al.*, 2000).

Species of oceanic pelagic fish live in tropical and temperate waters throughout the world’s oceans. They are capable of long migrations that reflect complex relationships to oceanic environmental conditions. These relationships are different for larval, juvenile and adult stages of life. The larvae and juveniles of most species are more abundant in tropical waters, whereas the adults are more widely distributed. Geographic distribution varies with seasonal changes in ocean temperature. In both the Northern and Southern Hemispheres, there is seasonal movement of tunas and related species toward the pole in the warmer seasons and a return toward the equator in the colder seasons. In the western Pacific, pelagic adult fish range from as far north as Japan to as far south as New Zealand. Albacore, striped marlin and swordfish can be found in even cooler waters at latitudes as far north as latitude 50° N. and as far south as latitude 50° S. As a result, fishing for these species is conducted year-round in tropical waters and seasonally in temperate waters.

Migration patterns of pelagic fish stocks in the Pacific Ocean are not easily understood or categorized, despite extensive tag-and-release projects for many of the species. This is particularly evident for the more tropical tuna species (e.g., yellowfin, skipjack, bigeye) which appear to roam extensively within a broad expanse of the Pacific centered on the equator. Although tagging and genetic studies have shown that some interchange does occur, it appears that short life spans and rapid growth rates restrict large-scale interchange and genetic mixing of eastern, central and far-western Pacific stocks of yellowfin and skipjack tuna. Morphometric studies of yellowfin tuna also support the hypothesis that populations from the eastern and western Pacific derive from relatively distinct sub-stocks in the Pacific. The stock structure of bigeye in the Pacific is poorly understood, but a single, Pacific-wide population is assumed. The movement of the cooler-water tuna (e.g., bluefin, albacore) is more predictable and defined, with tagging studies documenting regular and well-defined seasonal movement patterns relating to specific feeding and spawning grounds. The oceanic migrations of billfish are poorly understood,

but the results of limited tagging work conclude that most billfish species are capable of transoceanic movement, and some seasonal regularity has been noted.

In the ocean, light and temperature diminish rapidly with increasing depth, especially in the region of the thermocline. Many pelagic fish make vertical migrations through the water column. They tend to inhabit surface waters at night and deeper waters during the day, but several species make extensive vertical migrations between surface and deeper waters throughout the day. Certain species, such as swordfish and bigeye tuna, are more vulnerable to fishing when they are concentrated near the surface at night. Bigeye tuna may visit the surface during the night, but generally, longline catches of this fish are highest when hooks are set in deeper, cooler waters just above the thermocline (275-550 meters or 150-300 fathoms). Surface concentrations of juvenile albacore are largely concentrated where the warm mixed layer of the ocean is shallow (above 90 m or 50 fm), but adults are caught mostly in deeper water (90-275 m or 50-150 fm). Swordfish are usually caught near the ocean surface, but are known to venture into deeper waters. Swordfish demonstrate an affinity for thermal oceanic frontal systems which may act to aggregate their prey (Seki *et al.*, 2002) and enhance migration by providing an energetic gain by moving the fish along with favorable currents (Olsen *et al.*, 1994).

Status of the Stocks

Pacific-wide stock assessments are conducted annually for the major commercial tuna species (bigeye, yellowfin, skipjack and albacore). Bigeye is experiencing high levels of fishing mortality (e.g. longline, purse seine fisheries) from overfishing, however the population has yet to be determined as overfished. The future stock depends on the future fishing mortality and future recruitment (SCTB 2004). Yellowfin stocks are also believed to be experiencing overfishing. The yellowfin stock assessment estimates that the tropical stocks (Indonesia) are being fully exploited, whereas the temperate region (Hawaii) stocks are likely being lightly exploited (SCTB 2004).

The Council was notified by letter on December, 15, 2004, that the Secretary of Commerce had determined on June 14, 2005 that overfishing of bigeye tuna was occurring Pacific-wide. As indicated in the MSA, the Council was requested by the Secretary to take remedial action (i.e. recommend to NMFS an amendment to its Pelagics Fishery Management Plan) within one year of the identification by the Secretary. More recently in August 2005, the Science Committee of the Western & Central Pacific Fishery Commission reviewed a stock assessment that indicated that yellowfin tuna in the Western and Central Pacific also appears to be subjected to overfishing. Yellowfin have been included in this draft amendment in anticipation that an official communication to this effect will be received from the Secretary in the near future, and that the Council will be required to take action to address this situation. The Council has taken final action to recommend to NMFS a range of non-regulatory measures for the domestic and international management of these stocks, in addition to those measures being promulgated by regional fishery management organizations for longline and purse seine vessels. Regarding Hawaii-based non-longline pelagic fishing vessels, the Council has recommended that all commercial vessel operators be required to obtain federal permits and submit federal logbooks of

their catch and effort. The Council also recommended that targeted surveys be conducted of recreational fishermen to collect data on their catch and effort.

Although skipjack stocks experience high levels of fishing mortality, the stocks appear to be in healthy condition due higher levels of recruitment. Currently, there is not a stock assessment of the North Pacific albacore stock, however it is believed to healthy. South Pacific albacore stocks are believed to be healthy and at 60 percent of unfished levels (SCTB 2004).

Stock assessments of other important pelagic fish such as mahi mahi and ono are not available. Both of these populations, however, are thought to be in healthy condition. Most studies suggest that Pacific billfish stocks are healthy but there is considerable uncertainty because of the quality of data and differences in the methods used to evaluate the trends. Blue marlin stocks, however, may currently be fully exploited and facing high fishing mortality from various fisheries in the Central and Western Pacific.

2.2.6 Essential Fish Habitat

For each FMP and list of MUS, the Council has declared Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC). The Council and NMFS must ensure that any activities conducting in such areas do not adversely affect, to the extent possible, EFH of HAPC for any MUS. The following table represents the EFH and HAPC for all Western Pacific MUS.

Table 7: EFH and HAPC for all Western Pacific MUS

FMP	EFH (Juveniles and Adults)	EFH (Eggs and Larvae)	HAPC
Pelagics	Water column down to 1,000 m	Water column down to 200 m	Water column above seamounts and banks down to 1,000 m
Bottomfish and Seamount Groundfish	Bottomfish: Water column and bottom habitat out to a depth of 400 m Seamount Groundfish: (adults only) water column and bottom from 80 to 600 m, bounded by 29°-35°N and 171°E-179°W	Bottomfish: Water column to a depth of 400 m Seamount Groundfish: (including juveniles) epipelagic zone (0-200m) bounded by 29°-35°N and 171°E-179°W	Bottomfish: All escarpments and slopes between 40-280 m, and three known areas of juvenile <i>opakapaka</i> habitat Seamount Groundfish: not identified

FMP	EFH (Juveniles and Adults)	EFH (Eggs and Larvae)	HAPC
Precious Corals	Keahole Point, Makapuu, Kaena Point, Westpac, Brooks Bank, 180 Fathom Bank deep water precious corals (gold and red) beds and Milolii, Auau Channel and S. Kauai black coral beds	Not applicable	Makapuu, Westpac, and Brooks Bank deep water precious corals beds and the Auau Channel black coral bed
Crustaceans	Bottom habitat from shoreline to a depth of 100 m	Water column down to 150 m	All banks within the NWHI with summits less than 30 m
Coral Reef Ecosystem	Water column and benthic substrate to a depth of 100 m	Water column and benthic substrate to a depth of 100 m	All MPAs identified in FMP, all PRIAs, many specific areas of coral reef habitat

Note: All areas are bounded by the shoreline and the outer boundary of the EEZ, unless otherwise indicated.

As the above table shows, Western Pacific EFH and HAPC fall into two categories: either the water column above the ocean bottom, or the ocean bottom itself. Water column EFH and HAPC have been designated for pelagic, bottomfish, precious corals, crustacean and coral reef ecosystem MUS.

Areas of ocean bottom have been designated EFH and HAPC for precious corals, crustaceans, bottomfish and coral reef ecosystem MUS. The use of explosives, poisons, trawl nets, and other destructive gears which may adversely affect any EFH or HAPC in the Western Pacific Region is prohibited. No fishery under Council jurisdiction has been found to adversely affect the EFH or HAPC of any Western Pacific Region MUS. Kelley and Moffitt (2004) found that bottomfishing does not affect habitat or other marine resources on Raita and West St. Rogation Banks of the NWHI.

2.2.7 Protected Species

Protected species are generally considered to include those species listed as endangered or threatened under the Endangered Species Act (ESA), all marine mammals, listed or not, as they are protected under the Marine Mammal Protection Act (MMPA), and all seabirds. Appropriate information on the species' life history, habitat and distribution, and other factors necessary to its survival, is presented below.

On March 8, 2002, NMFS completed a formal consultation under section 7 of the ESA and released a Biological Opinion (BiOp) for the Bottomfish FMP. The BiOp concluded that the bottomfish fisheries of the Western Pacific Region are not likely to jeopardize the continued existence of any threatened or endangered species under NMFS' jurisdiction or destroy or adversely modify critical habitat that has been designated for them.

The most recent BiOp for the Crustaceans FMP was issued by NMFS on May 24, 1996. In 2000 it was found to be “inadequate” by the Hawaii District Court. The NWHI fishery has been essentially closed since that time (NMFS has not issued any harvest guidelines for the fishery) and no new BiOp has been prepared to date.

The most recent BiOp for the Precious Corals FMP was issued by NMFS on October 4, 1978. It concluded that, considering the methods utilized for harvesting precious corals (which at that time included non-selective gears that have since been prohibited), the fishery did not constitute a threat to endangered or listed species or their critical habitat. Since that time several informal consultations have reached the same conclusion.

No formal consultations have been deemed necessary for the Coral Reef Ecosystems FMP. An informal consultation was conducted on the implementation of the FMP on March 7, 2002. NMFS concluded that fishing activities conducted under that FMP are not likely to adversely affect endangered or threatened species or critical habitat under NMFS’ jurisdiction. On May 22, 2002, the USFWS concurred with this determination as regards species under its jurisdiction.

NMFS has conducted a series of formal and informal consultations on the Pelagics FMP. The majority of these have focused on the region’s longline fisheries and all have concluded that these fisheries are not likely to jeopardize the continued existence of any threatened or endangered species under NMFS’ jurisdiction or destroy or adversely modify critical habitat that has been designated for them. NMFS’ February 23, 2004 BiOp included a review and examination of the region’s small boat (non-longline) fisheries and came to the same conclusion regarding their activities.

2.2.7.1 Marine Mammals

Protected marine mammals fall into two categories: species listed under the ESA and those species which are not listed, but otherwise protected under the MMPA. Cetaceans and pinnipeds are discussed separately in the sections below.

Listed Cetaceans

The six species of cetaceans listed under the ESA that occur within the Hawaiian Archipelago are found in the following table. Although these whales may be found within the proposed sanctuary boundaries, there are no reported or observed interactions with the fisheries which may operate within the NWHI sanctuary.

Table 8: ESA listed Cetacea of the Hawaiian Archipelago

Common Name	Scientific Name
Blue whale	<i>Balaenoptera musculus</i>
Fin whale	<i>Balaenoptera physalus</i>
Humpback whale	<i>Megaptera novaeangliae</i>
Sei whale	<i>Balaenoptera borealis</i>
Sperm whale	<i>Physeter macrocephalus</i>
Right whale	<i>Eubalaena glacialis</i>

Other Cetaceans

Species of whales that are not listed under the ESA but are protected under the MMPA and occur around the Hawaiian Archipelago are listed in the following table.

Table 9: Non-ESA listed Cetacea of the Hawaiian Archipelago

Common Name	Scientific Name
Blainsville beaked whale	<i>(Mesoplodon densirostris)</i>
Bottlenose dolphin	<i>(Tursiops truncatus)</i>
Bryde's whale	<i>(Balaenoptera edeni)</i>
Cuvier's beaked whale	<i>Ziphius cavirostris</i>
Dwarf sperm whale	<i>Kogia simus</i>
False killer whale	<i>Pseudorca crassidens</i>
Killer whale	<i>Orcinus orca</i>
Melon-headed whale	<i>Peponocephala electra</i>
Pygmy killer whale	<i>Feresa attenuata</i>
Pygmy sperm whale	<i>Kogia breviceps</i>
Risso's dolphin	<i>Grampus griseus</i>
Rough-toothed dolphin	<i>Steno bredanensis</i>
Short-finned pilot whale	<i>Globicephala macrorhynchus</i>
Spinner dolphin	<i>Stenella longirostris</i>
Spotted dolphin	<i>Stenella attenuata</i>

Common Name	Scientific Name
Striped dolphin	<i>Stenella coeruleoalba</i>
Pacific white-sided dolphin	<i>Lagenorhynchus obliquidens</i>
Minke whale	<i>Balaenoptera acutorostrata</i>
Dall's porpoise	<i>Phocoenoides dalli</i>
Fraser's dolphin	<i>Lagenodelphis hosei</i>
Longman's beaked whale	<i>Indopacetus pacificus</i>

From the list above, only the bottlenose dolphin (*Tursiops truncatus*) has been documented to interact with a NWHI fishery. Bottlenose dolphins have been observed stealing hooked fish off of bottomfish lines, the extent of such interactions are not known and are believed to be low. Bottlenose dolphins are widely distributed throughout the world in tropical and warm-temperate waters (Reeves et al. 1999). Average size at birth is 0.9 to 1.2 m and 8 - 9 kg. Maximum size reported is 3.9 m and 275 kg. Males are sexually mature at 10 - 12 years of age, females between 5 and 12 years. Once reproductively active, females bear a single calf every second or third year. Gestation is about 12 months. Calves are nursed for a year or more. Maximum age appears to be 46 - 48 years, based on tooth growth analysis of both wild and captive dolphins.

The bottlenose dolphin is primarily coastal, but populations also occur in offshore waters. The species is common throughout the Hawaiian archipelago, usually within five miles of emergent land or shallow banks (Shallenberger 1981). School sizes range from single animals and small groups (3-10 individuals) to aggregations of more than 100 individuals. A combined aerial and vessel survey indicated at least 430 individuals in the shallow waters around the MHI (Nitta and Henderson 1993). Data suggest that the bottlenose dolphins in Hawai'i belong to a separate stock from those in the eastern tropical Pacific (Scott and Chivers 1990). The status of bottlenose dolphins in Hawaiian waters relative to their optimum sustainable population (OSP) is unknown, and there are insufficient data to evaluate trends in abundance or carrying capacity of the region (Forney et al. 2000). The relative impact of the bottomfish fishery on the behavior or foraging success of bottlenose dolphins is unknown, but thought to be minimal.

Although the other species listed above may be found within the action area and could interact with NWHI fisheries, no reported or observed interactions have ever been reported or observed.

Listed Pinniped: The Hawaiian Monk Seal

In 1976, the Hawaiian monk seal was listed as endangered under the ESA following a 50% decline in beach counts from the late 1950s to the mid-1970s (41 FR 33922). It was also designated a depleted species in 1976 under the MMPA, and its population is considered to be below sustainable levels. 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 (Marine Mammal Commission 1999). The Hawaiian monk seal is also the only endangered marine mammal that exists wholly within the jurisdiction of the U.S.

The Hawaiian Monk Seal Recovery Team (HMSRT), appointed pursuant to the ESA in 1980, is a forum, supported by NMFS, in which issues involving recovery planning and implementation are discussed and recommendations for actions forwarded to NMFS. In 1982, the HMSRT completed the Hawaiian Monk Seal Recovery Plan. The highest priority activities identified by that report are those that support the following recovery-related objectives: 1) Determine the ultimate and proximate factors influencing population dynamics at each of the six major breeding locations; 2) Enhance survival of female Hawaiian monk seals and their pups to maximize reproductive potential and population growth; 3) Facilitate recovery of the depleted populations; and 4) Mitigate human impacts (HMSRT 1999).

Under the ESA, critical habitat may be designated to afford protection or special management consideration to physical or biological features essential to the conservation of a listed species. In May 1988, NMFS designated critical habitat for the Hawaiian monk seal out from shore to 20 fathoms in 10 areas of the Northwestern Hawaiian Islands. Critical habitat for this species includes “all beach areas, sand spits and islets, including all beach crest vegetation to its deepest extent inland, lagoon waters, inner reef waters, and ocean waters out to a depth of 20 fathoms around the following: Pearl and Hermes Reef, Kure Atoll, Midway Islands, except Sand Island and its harbor, Lisianski Island, Laysan Island, Maro Reef, Gardner Pinnacles, French Frigate Shoals, Necker Island, and Nihoa Island” (53 FR 18990, May 26, 1988, 50 CFR § 226.201). Critical habitat was designated in order to enhance the protection of habitat used by Hawaiian monk seals for pupping and nursing, areas where pups learn to swim and forage, and major haul-out areas where population growth occurs.

Biology and Distribution

Monk seals are phocids, and are one of the most primitive genera of seals. They are brown to silver in color, depending upon age and molt status, and can weigh up to 270 kg. Adult females are slightly larger than adult males. Monk seals are solitary, and it is thought they can live up to 30 years. Females reach breeding age at about 5 to 10 years of age, depending on their condition, and can give birth about once every year. An estimated 40-80% of adult females give birth in a given year (NMFS unpub. data. 2001). After birth, pups nurse for 5-6 weeks, during which time the mother rarely, if at all, leaves the pup to feed. At weaning, the mother leaves and the pup must subsequently forage independently. Newly weaned pups tend to stay in the reef shallows, entering into more diverse and deeper waters to forage as they gain experience. Monk seals may stay on land up to about two weeks during their annual molt. Hawaiian monk seals are nonmigratory, but recent studies show their home ranges may be extensive (Abernathy and Siniff 1998). Counts of individuals on shore compared with enumerated subpopulations at some of the NWHI indicate that Hawaiian monk seals spend about one-third of their time on land and about two thirds in the water (Forney et al. 2000).

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 percent of all known pups are born at six NWHI breeding colonies which include 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 Nihoa Islands and in the main Hawaiian Islands. NMFS researchers have also observed Hawaiian monk seals at Gardner Pinnacles and Maro Reef. Although Hawaiian monk seals occasionally move between islands, females generally return to their natal colony to pup. Since 1990, there has been an apparent increase in the number of Hawaiian monk seal sightings and births in the main Hawaiian Islands (HMSRT 1999; Johanos 2000). A 2001 aerial survey determined a minimum abundance of 52 seals in the MHI (Baker and Johanos, 2003). Table 10 shows that monk seal births in recent years are increasing.

Table 10: Known Hawaiian Monk Seal Births in the MHI

Year	Niihau	Kauai	Oahu	Molokai	Maui	Kahoolawe	Hawaii	Total
1962	?	1	0	0	0	0	0	1
1988	?	1	0	0	0	0	0	1
1991	1	1	1	0	0	0	0	3
1992	?	1	0	0	0	0	0	1
1996	?	0	1	1	0	0	0	2
1997	?	0	1	1	1	0	0	3
1998	?	0	2	1	1	0	0	4
1999	?	1	0	1	1	0	0	3
2000	2	4	0	1	0	0	0	7
2001	5	3	0	2	0	1	1	12
2002	?	1	0	2	0	0	1	4
2003	?	2	1	4	0	1	2	10

(Source: PIFSC 2003)

Hawaiian monk seals feed on a wide variety of teleosts, cephalopods and crustaceans, indicating that they are highly opportunistic feeders (Rice 1964; MacDonald 1982; Goodman-Lowe 1998). Research to identify prey species is currently underway using several methods: collection of potential prey items and blubber samples for fatty acid analysis; Crittercam³ recording of foraging behavior; correlation of dive/depth/location profiles with potential prey species habitat; and analysis of Hawaiian monk seal scat and spew samples for identifiable hard parts of prey.

³A Crittercam is a self-contained video camera that has been mounted on a Hawaiian monk seal to record its foraging behavior.

Table 11 identifies adult male Hawaiian monk seal prey families as indicated by Crittercam studies at French Frigate Shoals.

Table 11: Crittercam Study-Prey Items Eaten by Free Swimming Adult Male Hawaiian Monk Seals at French Frigate Shoals

FAMILY	NUMBER SEEN
Anthiinae	2
Balistidae	1
Bothidae	1
Cheilinninae	2
Congridae	1
Pentacerotidae (groundfish)	1
Pomacentridae	1
Tetradontidae	1
Unidentified Eels	2
Unidentified fish	8
Octopus	2

(Source: Parrish et al. 2000; WPRFMC 2000a)

In a study at five of the principle breeding sites for the Hawaiian monk seal (FFS, Laysan Island, Lisianski Island, Pearl and Hermes Reef, and Kure Atoll) focused on identifying items eaten by Hawaiian monk seals, Goodman-Lowe (1998) analyzed scat and spew samples to identify prey, and to obtain size estimates of the more common cephalopod prey species.⁴ This study also examined the temporal differences in diet among years. The frequency of occurrence (FO) was calculated as the number of samples in which an identified prey type was found. The percent frequency of occurrence (percent FO) was calculated as the FO divided by the total number of scat and spew samples analyzed (n=940)(Table 7-12).

⁴Scat and spew analysis is known to be biased due to differential digestion of various prey types. However, scat and spew analysis is, at this time, the best available scientific information for investigating Hawaiian monk seal diets.

Table 12: Goodman-Lowe Results of Prey found in Scat and Spew samples

FAMILY	FO/%FO n=940
Unidentified Eels	207/22.0
Labridae	194/20.6
Holocentridae	135/14.4
Balistidae	123/13.1
Scaridae	99/10.5
Acanthuridae	71/7.6
Pomacentridae	44/4.7
Tetradontidae	41/4.4
Kyphosidae	32/3.4
Monacanthidae	29/3.1
Synodontidae	25/2.7
Pomocanthidae	17/1.7
Kuhliidae	14/1.5
Cirrhitidae	12/1.3
Chaetodontidae	10/1.1
Diodontidae	10/1.1
Bothidae	9/0.9
Cheilodactylidae	6/0.6
Scorpaenidae	5/0.5
Ostraciidae	1/0.1
Muraenidae	53/5.6
Congridae	52/5.5
Priacanthidae	40/4.3
Apogonidae	9/0.9
Opichthidae	6/0.6

FAMILY	FO/%FO n=940
Mullidae	58/6.2
Lutjanidae	24/2.6
Carangidae	11/1.1
Polymixiidae	9/1.0
Serranidae	5/0.5
Belonidae	1/0.1
Unidentified remains	330

Source: Goodman-Lowe 1998

The results indicated that Hawaiian monk seals are opportunistic predators that feed on a wide variety of available prey as compared to the case of other seals in which the bulk of the diet is 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 eels (22.0%), Labridae (20.6%), Holocentridae (14.4%), Balistidae (13.1%) and Scaridae (10.5%). All teleost families found include 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 bycatch species. Evidence of target species such as snapper and grouper appeared infrequently in fecal and regurgitate samples.

An ongoing study contracted by NMFS is using 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 Hawaiian monk seals. The first report detailing the collection and fatty acid analyses of prey specimens is expected in FY05. A final report should be completed in early FY06. Preliminary findings of the fatty acid study suggest that there are variations in diets among individual Hawaiian monk seals as well as diet variation among demographic groups and groups in different locations (Antonelis, 2005 pers. comm.).

Information about the foraging activities of Hawaiian monk seals is available through the dive/depth/location profiles and the correlation with the habitat of potential prey families. The foraging and dive patterns of Hawaiian monk seals and the availability of prey items to Hawaiian monk seals are important to understand when determining the potential impact of fisheries in terms of areas fished, potential for gear interactions, and prey competition. The foraging range of the Hawaiian monk seal extends to areas managed under the all FMPs. Various studies have been undertaken to determine the habitat use patterns of Hawaiian monk seals (Schlexer 1984; DeLong et al. 1984; Abernathy and Siniff 1998; Stewart 1998; Parrish et al. 2000). These studies used various technologies, including radio tags, dive depth recorders,

Crittercams, and satellite telemetry, to study the foraging behavior of Hawaiian monk seals. The results of these studies vary by location.

DeLong et al. (1984) instrumented seven Hawaiian monk seals at Lisianski Island with radio transmitters and multiple depth of diving recorders and recorded movements for an aggregate of 94 days in which 4,817 dives were recorded. Most dives (59 percent) were in the 10-40 m depth range, and the remainder of dives were to deeper depths. Thirteen dives were recorded to depths of at least 121 m. The outer edge of the reef around Lisianski Island is generally delineated by the 40 m isobath. The study concluded that during breeding season at Lisianski Island males depend entirely upon the food resources on the coral reefs, sandy beach flats and deeper reef slopes around that island.

Schlexer (1984) also recorded diving patterns of Hawaiian monk seals at Lisianski Island. In that study, eight Hawaiian monk seals (five adult males, one juvenile male, one subadult female, and one juvenile female), tracked with radio transmitters and multiple depth of diving recorders, were recorded diving within the 0 - 70 m range. One subadult female and one juvenile female dove in the shallow range of 10 - 40 m, with some dives recorded from 150 - 180 m. None of the adult males instrumented dove to depths greater than 70 m.

Stewart (1998) investigated diving patterns of 24 Hawaiian monk seals at Pearl and Hermes Reef using satellite-linked radio transmitters to record dive depth and duration. That study concluded that the Hawaiian monk seals at Pearl and Hermes Reef foraged in relatively shallow waters, and that foraging activity was different for males and females and among age classes. At Pearl and Hermes Reef, juveniles foraged almost exclusively within the fringing reef, adult males foraged mostly on the inside and outer edge of the fringing reef, and adult females foraged mostly within the center of the atoll and near the atoll's southwestern opening (Stewart 1998). Adult males generally dove within the 8 - 40 m range, with a secondary mode at 100 - 120 m. Male juveniles generally dove within the 8 - 40 m range. Adult females rarely dove deeper than 40 m, although one female made a number of dives to 60 - 140 m.

Abernathy and Siniff (1998) instrumented adult seals at FFS with satellite-linked time depth recorders. Data showed that instrumented adult male Hawaiian monk seals appeared to utilize the banks to the northwest, with a daytime diving range between 50 - 80 m and a nighttime range between 110 - 190 m. The study also suggested that seals that did not leave the vicinity of FFS rarely dove deeper than 80 m during the day, but made more dives closer to 80 m at night. The study also identified a few seals that were extremely deep divers. These seals' daytime dives reached depths > 300 m on a ridge to the east of the atoll. The researchers modeled the home range of individuals and concluded that the average home range was 6,467 km² (n=28, SE=3,055 km²). For example, individuals were documented traveling between FFS and Gardner Pinnacles, St. Rogatien Bank, Brooks Bank, and Necker Island. The conclusion was that Hawaiian monk seals forage on benthic (bottom) and epibenthic (near bottom) species, in addition on other prey items in the fringing reef complex.

Parrish et al. (2000) provided further information that Hawaiian monk seal foraging behavior and range are extensive. Twenty-four Hawaiian monk seals were outfitted with Crittercams. The

Crittercam recorded the habitat depth and bottom type at locations where Hawaiian monk seals were identified as successful in the capture of prey items. It was found that the diurnal pattern of foraging by male adults occurred mainly at the 60 m isobath. A few seals foraged at depths >300 m. Some of these areas were outside the critical habitat area and overlapped with areas fished by both lobster and bottomfish fisheries.

Since 1995, the abundance of shallow water (<20 m) reef fish has been surveyed at FFS and Midway. The data are checked as a potential indicator of changes in the abundance of Hawaiian monk seal prey. The surveys are conducted annually by NMFS and are designed to detect changes of 50 percent or greater in fish densities (Lauri 2000). The surveys have not indicated any statistically significant changes in prey abundance at either site (DeMartini and Parrish, 1996; DeMartini et al. 1999; DeMartini et al. 2002).

Recent information suggests Hawaiian monk seals may forage in beds of precious corals, some of which are habitat for known Hawaiian monk seal prey items such as arrowtooth eels (Parrish et al. 2002). In 2000, the National Undersea Research Laboratory conducted a study using manned and unmanned submersibles in known beds of the Western Pacific region. The objective of the study was to test the hypothesis that gold coral provided habitat for deep-water arrowtooth eels. Results of the study found that gold coral did not seem to aggregate arrowtooth eels or any other significant fish assemblage. At the Cross Seamount, the study found arrowtooth eels in areas adjacent to the beds, but without the presence of gold corals (Parrish 2001). A recent study using a submersible was conducted in the NWHI and MHI to evaluate the possibility that precious coral beds aggregate fish. The study found that it is unlikely that fish aggregations at such depths are dependant up precious corals for habitat and relief, but that precious corals and fish share habitat that has high relief and high nutrient flow, i.e. co-occurrence and not a dependancy of fish on corals (Parrish, 2005 pers. comm).

Overall, the science of the Hawaiian monk seal diet and foraging preferences indicate the monk seals eat a variety of prey species and forage at varying depths. There is not one single prey item that has been determined to be essential in the success of monk seals. Hawaiian monk seals are a high level predatory mostly foraging within coral reef ecosystems that support a variety of prey species.

Population Status and Trends

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 Lavine 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 (NMFS 1997; Marine Mammal Commission 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 FFS. 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 (NMFS 1997; Marine Mammal Commission 2000).

When monk seal population measurements were taken in the 1950s, the population was already considered to be in a state of decline. The minimum population estimate (N_{MIN}) for monk seals is 1378 individuals (based on a 2001 enumeration of individuals of all age classes at each of the subpopulations in the NWHI, derived estimates based on beach counts for Nihoa and Necker, and estimates for the MHI) (Draft 2003 Stock Assessment Report). The PIFSC estimates the population to be 1300 to 1400 individuals (PIFSC 2003). Figure 7-5 illustrates the long-term trend in total non-pup population size.

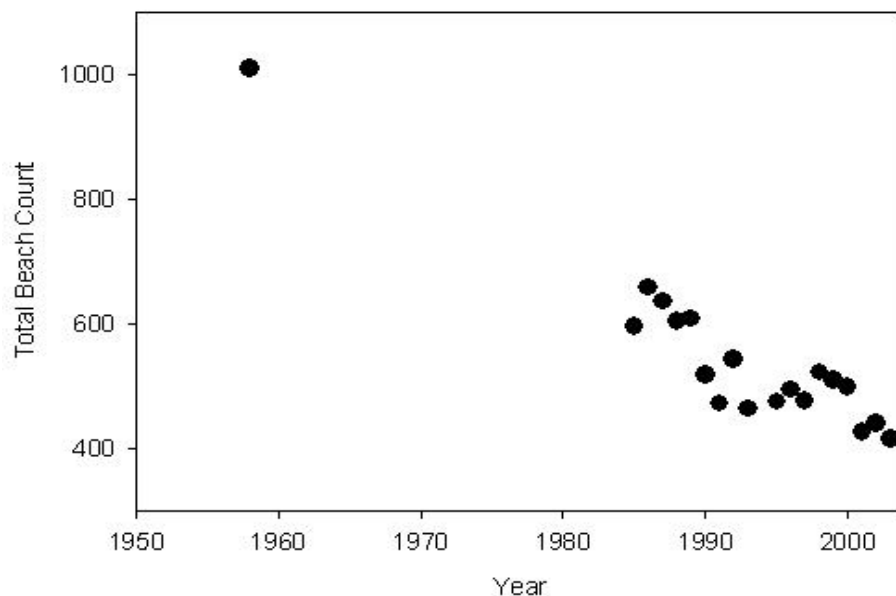


Figure 2: Historical Trend in Beach Counts (non-pups) of the Six Main Reproductive Subpopulations of Hawaiian Monk Seals
(Source: PIFSC 2003)

Various surveys of the islands and atolls in the NWHI that support the main monk seal breeding subpopulations indicate that the NWHI non-pup population (juveniles, sub-adults and adults) declined 60% between the years 1958 and 1999. Trends in subpopulations are measured by beach counts for each of these subpopulations. Trends vary within the NWHI. For example, from 1990 to 1998, the subpopulation at Lisianski Island decreased slightly, and the Laysan Island subpopulation increased slightly. The subpopulation at Kure Atoll increased at about 5% per year from 1983 to 1998. The subpopulation at Pearl and Hermes Reef experienced the highest increase of 7% per year between 1983 and 1998. Researchers have been able to establish the minimum count of individuals in the main breeding subpopulations, and in 2001 the count of monk seals was 182 at Lisianski Island, 300 at Laysan Island, 122 at Kure Atoll, 322 at FFS, 259

at Pearl and Hermes Reef and 64 at Midway Atoll (NMFS, unpub. data). Figure 7-6 illustrates trends in beach counts (a relative measure of population size) of Hawaiian monk seals for each of the principle Hawaiian monk seal breeding areas in the NWHI.

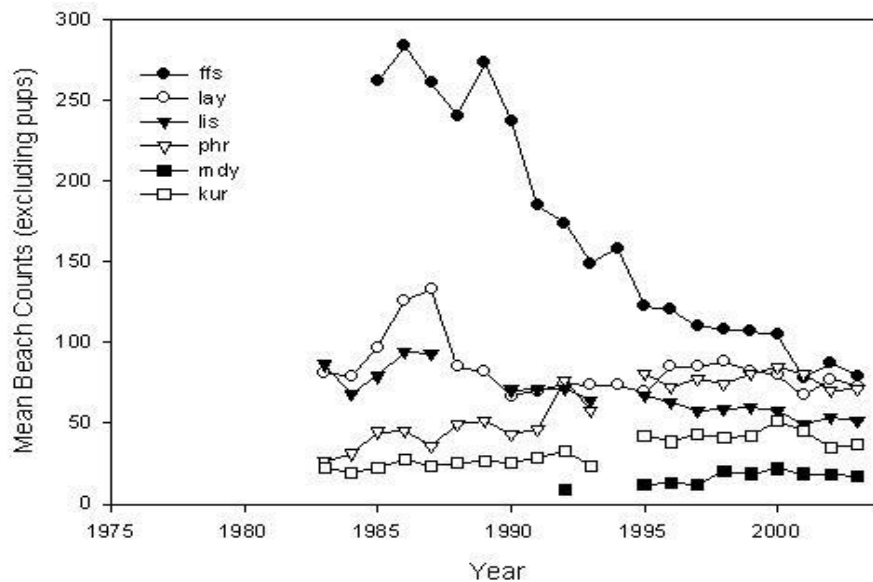


Figure 3: Trends in Beach Counts (non-pups) of Hawaiian Monk Seals at the Major NWHI Breeding Areas
(Source: PIFSC 2003)

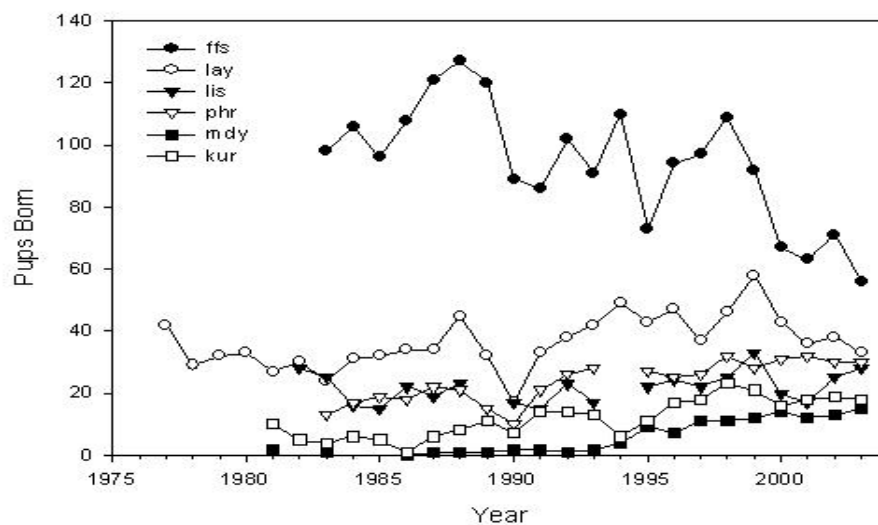


Figure 4: Mean Beach Counts of Pups Born at the Major NWHI Breeding Areas
(Source: PIFSC 2003)

The overall population decline is primarily attributable to low reproductive recruitment and high juvenile mortality at the largest of the subpopulations at FFS. At this site, the average beach count of animals older than pups is now less than half the count in 1989. In the late 1990's, poor survival of pups resulted in a relative paucity of young seals, so that further decline is expected

for this subpopulation as adults die and there are few immature seals to replace them. The recent trend in mean beach counts for births can be found in Figure 4. Over the last decade, the causes of the survival for these age classes at FFS have been related to poor condition from starvation, shark predation, and male aggression. A decrease in prey availability may be the result of decadal scale fluctuations in productivity and corresponding or other changes in local carrying capacity for seals at FFS or a combination of factors (Craig and Ragen 1999; Polovina et al. 1994; Polovina and Haight 1999). While other subpopulations of monk seals in the Northwestern Hawaiian Islands are stable, increasing or declining slightly, the overall population status is being driven by the FFS population, which comprises about 25% of the total monk seal population. However, the girth of weaned pups at FFS, which may correlate with prey availability to females during gestation and resulting increased ability to nourish pups, has increased in recent years. Mean girth of pups at the other major breeding subpopulations has remained stable or increased in recent years (PIFSC 2003).

Population trends for this species are determined by the highly variable dynamics of the six main reproductive subpopulations. At the species level, demographic trends over the past decade have been driven primarily by the dynamics of the FFS subpopulation. In the near future, the general population trends for the species will depend on the gains and losses at FFS, the other major reproductive subpopulations, and small subpopulation in the MHI.

Factors Influencing Population Size

This section is a summary of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat (including designated critical habitat) and ecosystem within the NWHI and the MHI, together with Johnston Atoll the only areas within the Western Pacific Region harboring Hawaiian monk seals..

During the past four decades the Hawaiian monk seal population has been affected by human and natural factors (Marine Mammal Commission 1999). Natural factors have included shark predation, disease, attacks by aggressive adult male Hawaiian monk seals on females and immature seals of both sexes (called “mobbing”), and reduced prey availability. Human factors have included various types of interactions with humans, their structures, contaminants and debris, fishing operations and vessel traffic. 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 (Marine Mammal Commission 2000). The reported causes of relatively recent changes in Hawaiian monk seal abundance are described in greater detail below.

Mobbing: Male aggression, including singular or multiple adult males attacking another seal (mobbing), can lead to Hawaiian monk seal injury and death. 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. Mobbing of females and immature seals by adult males is a source of mortality at FFS, Laysan Island and Lisianski Island. Evidence suggests that during the mid- to late-1990s, male Hawaiian monk seal aggression and shark predation contributed significantly to the mortality of weaned and pre-weaned pups at FFS (HMSRT

1999). At FFS, individual adult males have presented more of a problem than groups of males. Individuals which were directly observed injuring or killing pups were removed, either by translocation or euthanasia. At Laysan Island, injuries and deaths have tended to result from massed attacks, or mobbings, by large numbers of adult males. The primary cause of mobbing is thought to be an imbalance in the adult sex ratio, with males outnumbering females (NMFS 1998). Males that were removed from Laysan Island included seals which had been observed participating in mobbings, as well as other animals whose behavioral profile matched that of known “mobbers.” Removal was effected either by translocation or by transfer into permanent captivity. Ten males were removed in 1984, 5 in 1987, and 22 in 1994.

Removal of individual male seals from French Frigate Shoals markedly decreased the number of injuries and deaths attributable to adult male aggression. The results of removing adult males from Laysan Island are less clear. Injuries and deaths from adult male aggression at Laysan Island have diminished, but it is not known how much male removal has contributed to this decline.

Shark Predation: Predation by Galapagos sharks (*Carcharhinus galapagensis*) and perhaps tiger sharks (*Galeocerdo cuvieri*) of Hawaiian 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 FFS in 1997, 1998 and 1999, respectively (HMSRT 1999). In 1999, shark predation may have accounted for the deaths of 51% (23 of 45) of the pups born at Trig Island in FFS (2002 Biological Opinion). Overall, 9.4 percent (25 out of 244) of pups born in the NWHI were inferred or known to be preyed upon by sharks in 1999. The PIFSC infers shark related mortality whenever a newborn to approximately three week old pup disappears at FFS, especially during periods when large sharks are observed patrolling near pupping beaches. Shark predation is inferred to be the primary cause of disappearance of these pups because attacks by male adults (the other possible primary cause of mortality) are unlikely because nursing pups are defended by their mothers. However, sharks have been observed killing pups in this age category despite their mother’s defense tactics against shark predation. According to the HMSRT (1999), a preliminary analysis of the impacts of shark predation on the recovery of the FFS population of Hawaiian monk seals indicates that the mitigation of this interaction is essential to the recovery of this population. The HMSRT recommended that NMFS undertake a program to remove Galapagos and/or tiger sharks observed patrolling beaches where Hawaiian monk seal pups are present within the FFS atoll. One shark was removed pursuant to a shark removal plan implemented by NMFS in 2000 to improve pup survival and possibly slow the FFS population decline.

The dramatic increase in deaths and disappearances from shark attacks at FFS has been the result of an increased number of Galapagos sharks (*Carcharhinus galapagensis*) in the immediate vicinity of Hawaiian monk seal pupping areas. The occurrence and escalation of Galapagos shark predation on pups may be related to an episode of adult male Hawaiian monk seal aggression against pups, which resulted in pup deaths and the presence of carcasses remaining in the waters surrounding the pupping area. These carcasses may have attracted sharks to the new prey resource of nursing seal pups. Also, the erosion of Whale-Skate Island (FFS), which had been a large pupping site, may have resulted in more pups being born at Trig Island (FFS) where sharks can easily approach the shoreline.

Disease: Although some information concerning medical conditions affecting the Hawaiian monk seal is available, the etiology and impact of disease on wild animals at the population level is far from clear. There are substantial data gaps regarding the prevalence of disease conditions in populations of Hawaiian monk seals in the wild, and thus their potential impact on population dynamics is unknown. In the wild, even massive epizootics in remote locations may pass undetected (Aguirre et al 1999).

There have been periods of unusually high mortalities in subpopulations located in the NWHI. A die-off occurred in 1978 at Laysan Island (Johnson and Johnson 1981). More than 50 seal carcasses were found in an advanced state of decomposition, and although the cause of the mortality was not identified, it may have been disease related. Also, survival of immature seals severely declined at FFS after 1987, and the reproductive potential of the species was being seriously compromised by the loss of young females. The cause has been attributed to emaciation/starvation; however, the role of endoparasites or disease is unknown. During 1992-93, undersized pup and juvenile seals from FFS were rehabilitated and released at Midway Atoll with poor success.

Health assessment and collection of baseline information on diseases is considered important to the recovery of the Hawaiian monk seal population (Gilmartin 1983; Aguirre et al. 1999). Banish and Gilmartin (1992) summarized pathological conditions found in 42 carcasses recovered from 1981 to 1985. Frequent findings included parasites, trauma, cardiovascular disease, and respiratory infections. Emaciation was a common condition. Banish and Gilmartin (1992) did not assess causes of death from any of their samples, but nonetheless concluded that there was no evidence of any disease phenomenon affecting the population in a manner which would significantly hinder recovery of the species. A series of examinations of 23 dead seals collected from 1989 to 1995 (Work unpubl. data) ascribed causes of death as follows: emaciation (7); emaciation compounded by senescence (1); trauma (2); foreign body aspiration (1); and euthanasia(1). Cause of death was not determined in 11 animals.

The relative significance of disease and related factors and their effect on population trends are poorly understood. Disease processes may be important determinants of population trends through long-term low levels of mortality, or through episodic die-offs. Table 13 describes the findings of health and disease studies on Hawaiian monk seals between 1925 and 1997.

Table 13: Health and Disease Studies in Hawaiian Monk Seals

YEAR	HEALTH CONDITION AND REFERENCE
1925	Internal parasites were first reported (Chapin 1925).
1952	Diphyllbothriid cestodes were first reported (Markowski 1952).
1959	The Acanthocephalan <i>Corynosoma</i> sp. was first reported (Golvan 1959).
1969	Diphyllbothriid cestodes were reported (Rausch 1969).
1978	Known as the Laysan epizootic, ≥50 Hawaiian monk seals were found dead. Specimens from 19 dead and 18 live seals were collected. All carcasses found with stomach ulceration and heavy parasite burdens and in severe state of emaciation. Livers from two carcasses tested positive to ciguatoxin and maitotoxin. There was serologic evidence of caliciviruses but serum specimens were negative for <i>Leptospira</i> . <i>Salmonella sieburg</i> was isolated from a rectal swab. Many parasite ova and products in coprologic exams were identified. Diagnosis was inconclusive (Johnson and Johnson 1981; Gilmartin et al. 1980).
1979	<i>Contracecum</i> ulceration of a young seal was first reported (Whittow et al. 1979).
1980	Lung mites from the family Halarechnidae were first reported (Furman and Dailey 1980).
1980	The Hawaiian monk seal die-off response plan was developed with the support of the Marine Mammal Commission (Gilmartin 1987).
1983	The Recovery Plan for the Hawaiian Monk Seal addressed the importance of disease investigations (Gilmartin 1983).
1988	A coprologic survey for parasites was performed from field scats collected in 1985 (Dailey et al. 1988).
1988	The hematology and serum biochemistry of 12 weaned pups collected between 1984 and 1987 for their rehabilitation in Oahu were reported (Banish and Gilmartin 1988).
1992	Pathology of 42 seals collected between 1981-85 was summarized (Banish and Gilmartin 1992).
1992	The FFS relocation of 19 immature seals was initiated. Basic hematology, serum biochemistry, serology for leptospirosis and calicivirus infection, virus isolation, fecal culture for <i>Salmonella</i> and coproparasitoscopic examination were performed for their disease evaluation. Two of seven seals died of bacterial and aspiration pneumonia on Oahu, with positive titers to <i>Leptospira</i> . Detection of calicivirus by cDNA hybridization probe in 13 seals with viral particles seen by electron microscopy occurred in five seals. It was concluded that endemic disease agents identified in those seals were <i>Salmonella</i> and endoparasites (Gilmartin 1993a; Poet et al. 1993).

YEAR	HEALTH CONDITION AND REFERENCE
1993	Inoculation of four Hawaiian monk seals with a killed virus distemper vaccine was experimentally performed on three seals at the Waikiki Aquarium (Gilmartin 1993b; Osterhaus unpubl. data 1997).
1995	An eye disease of unknown etiology was first diagnosed in 12 female Hawaiian monk seal pups that were transported to Oahu for rehabilitation. To date the cause remains unknown (NMFS files 1995-97 unpubl. data).
1996	Histopathology of selected tissues collected from 23 seals between 1989 and 1995 was performed by personnel of the National Wildlife Health Research Center, Honolulu Station (Work unpubl. data 1996).
1997	Two captive seals died of causes unrelated to the eye disease. One seal was diagnosed with <i>Clostridium</i> septicemia and another seal with hepatic sarcocystosis (Yantis et al. 1998).
1997	The Monk Seal Captive Care Review Panel developed recommendations to evaluate the health assessment and future disposition of 10 captive seals and the future of captive care and release efforts to enhance the recovery of the species (NMFS unpubl. data 1997).

Source: Aguirre et al. 1999

In April, 2001, an “Unusual Mortality Event⁵” was declared on the basis of four juvenile Hawaiian monk seal deaths within nine days at Laysan Island, a death of a yearling at Midway, discovery of three decomposed carcasses (one subadult, one pup, and two juveniles) and one fresh dead carcass at Lisianski Island, a death of a yearling at FFS, and lethargic, thin juvenile Hawaiian monk seals observed at Laysan and Midway Islands. The relationship of these deaths and observed conditions of the seals is not known at this time (NMFS unpub. data 2001). The Working Group on Unusual Mortality Events (WGUME) reviewed the available information and recommended on February 5, 2002, to close the event. Necropsies and sample analyses have revealed no unusual findings, and there have been no new reports of juveniles exhibiting abnormal behavior or thin body conditions. The WGUME also recommended that measures should be taken so that field teams are fully trained in proper sample collection techniques should any dead seals be found in 2002, to ensure that all possible information can be collected and preserved. The group also recommended performing as many necropsies as possible on fresh carcasses to collect essential data. A report summarizing the event and the results of the subsequent investigation are expected in the near future.

⁵The MMPA defines an Unusual Mortality Event (UME) to be an occurrence which: 1) is unexpected; 2) involves a significant die-off of a marine mammal population; and 3) demands an immediate response. In addition to the above conditions, an immediate response is warranted under two other circumstances: 1) mass stranding of an unusual species of cetacean; and 2) small numbers of a severely endangered species of marine mammal are affected.

Reduced Prey Availability: One of the potential explanations of the poor juvenile survival at FFS from 1989 to the mid-1990s 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. 2000. NMFS-HL). 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 FFS 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; Marine Mammal Commission 2000).

Further evidence of limited prey availability at FFS 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 six juvenile and 18 adult Hawaiian monk seals 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 to 40 m, though there was a secondary mode at 100 to 120 m. In contrast, Hawaiian monk seals studied at FFS, where the population of seals is considerably larger, exhibited more variation in their habitat use (Abernathy and Siniff 1998; Parrish et al. 2000; Parrish et al. 2002). Abernathy and Siniff (1998) recorded that the most prevalent pattern, particularly among males, was utilization of the banks to the northwest (some of which are more than 200 km from FFS), with daytime diving in the 50 to 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 FFS and rarely dived deeper than 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 FFS as some individuals are forced to venture to new areas and alter their prey base.

The decrease in prey at FFS may have been the result of large-scale natural perturbations in ecosystem productivity and corresponding or other changes in local carrying capacity for seals at FFS or a combination of factors. 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 Hawaiian 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.⁶ As this system deviates from its long-term average position, productivity may be more or less affected in the waters around the NWHI.

⁶There 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).

Polovina et al. (1994) suggested that the average position of the Aleutian low-pressure system moved northward in the mid- to late-1980s. Thus, the “declines” in productivity observed at Midway and FFS after 1988 may actually represent returns to more “normal,” lower levels of productivity (Mundy undated). Productivity may have been most affected at FFS, 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 Hawaiian monk seal reproduction and survival could presumably have been greater at FFS because that island’s Hawaiian monk seal population was closer to carrying capacity (Ragen and Lavigne 1999).

Goodman-Lowe (1998) examined inter-island variation in the diet of mature and juvenile Hawaiian monk seals and concluded that Hawaiian monk seals are opportunistic foragers. The fact that seals at FFS were apparently unable to find sufficient prey during the late 1980s and early 1990s suggests the occurrence of a phenomenon capable of affecting the seals’ entire prey base. For example, changes in the sizes of NWHI populations of reef fish, a known prey of Hawaiian monk seals (Goodman-Lowe 1998), may be linked to the interdecadal changes in ecosystem productivity in the central Pacific (DeMartini and Parrish, 1996). In 1992-1993, there was a general decrease in reef fish abundance observed at Midway Atoll and FFS. In 1995, however, a dramatic increase in recruitment and availability of reef fish was detected at the two sites (DeMartini and Parrish 1996). 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 Hawaiian monk seal pups at weaning and in pup births at FFS and other major island populations. Trends in pup girth measurements indicate that prey resources may have increased during the early 1990s, most notably at Laysan Island, Lisianski Island and FFS (HMSRT 1999). Using recent data from Crittercam deployments, Littnan *et al.* (2005 pers. comm.) suggest that cryptic benthic fauna (bothids or flounders) inhabiting open sand fields are a target prey item for young monk seals, and that these prey items are likely important for early monk seal survivorship.

Fisheries may also affect the forage base of Hawaiian monk seals. Hawaiian monk seals have the capability to dive to depths at which many species targeted by the bottomfish fishery occur. In addition, Hawaiian monk seals have been reported to remove hooked bottomfish from handlines and consume them (Nitta 1999). Seals appear to prefer *ōpakapaka* but will also steal and eat *onaga*, *butaguchi* and *kāhala*. Monk seals also eat spiny and slipper lobsters, which are targeted in the (inactive) NWHI lobster fishery. However, the results of dietary studies suggest that bottomfish MUS and Crustacean MUS do not constitute a significant component of the natural diet of Hawaiian monk seals (Goodman-Lowe, 1998). In addition, the importance of French Frigate Shoals to the NWHI lobster fishery is minimal, as only 1.2 percent of the total historical effort was conducted at French Frigate Shoals.

Human Interactions: Human interactions with Hawaiian monk seals range from unintentional disturbances at haul-out sites to inflicting intentional injuries on seals, and include a variety of interactions by scientists and resource managers. Human disturbance was probably the principal cause of Hawaiian monk seal population declines before the 1980s. Between 1958 and the mid-1970s, Hawaiian monk seal colonies at the western end of the archipelago between Kure Atoll and Laysan Island declined by at least 60 percent, and the colony at Midway Atoll all but

disappeared (Marine Mammal Commission 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, and in 1960 the Coast Guard established a LORAN station at Kure Atoll that was occupied year-round. Ownership of Midway Atoll was transferred from the Navy to the U.S. Fish and Wildlife Service in 1996, and the atoll is now managed as the Midway Atoll National Wildlife Refuge. The Coast Guard closed the LORAN station at Kure Atoll in 1992 and removed most of the manmade structures by 1993.

The human population at Midway Atoll has decreased substantially in the last two decades, but year-round human habitation of the atoll has continued. From 1996 until 2001, there was limited eco-tourism 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 business 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 was limited to reduce impacts to wildlife. A dispute between the contractor and the USFWS has suspended the visitor program. Nevertheless, the HMSRT (1999) 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 Hawaiian monk seal population has increased since the atoll was transferred to the USFWS.

As Hawaiian monk seal haul-outs increase in the MHI, human interactions are becoming more frequent (Ragen 1999). Hawaiian monk seals hauled-out on beaches are viewed by tourists and residents who are often unfamiliar with the take prohibitions and/or the normal behavior of Hawaiian monk seals. NMFS receives at least two reports per week of “stranded” Hawaiian monk seals. Some people attempt to haze the animal back into the water. Most often, the animal reported is exhibiting normal haul-out behavior. Another common harassment is people approaching too closely to take photographs of the seal on land or in the water. One female Hawaiian monk seal was intentionally harassed when a resident threw coconuts at it (Henderson pers. comm. 2001). On Kauai, a Hawaiian monk seal was bitten by a pet dog (Honda pers. comm. 2001). In 2004, a tourist was bit after he got too close to a pupping female monk seal. Disturbance to Hawaiian monk seals may result in modified behavior making them unpredictable, more susceptible to predators when forced to enter the water or causing an unnecessary expenditure of energy required for thermal homeostasis or catching prey.

Hawaiian monk seal research activities have also inadvertently resulted in some seal mortality. Since 1982, Hawaiian monk seals have been removed from the wild or translocated between locations by the Marine Mammal Research Program (MMRP) of the NMFS-HL as part of research and management to facilitate recovery of the species.

Pups which wean prematurely from their mothers may be in poor condition, and are known to have a minimal probability of surviving their first year. Some of these animals, as well as emaciated juvenile Hawaiian monk seals, have been collected for rehabilitation and release back into the wild. A total of 104 seals (mostly females) have been so taken: 68 were successfully rehabilitated and released into the wild, 22 died during rehabilitation, and 14 were judged to be unsuitable for release and were placed into public aquaria and oceanaria for research. Of the 68

Hawaiian monk seals which were rehabilitated and released from 1984 through 1993, 19 were alive as of 1999. Some of the surviving 19, most of which are located at Kure Atoll, are pupping. However, the precise number of pups born to these released Hawaiian monk seals is unknown (NMFS unpub. data, 2001; Johanos and Baker 2001).

Of the remaining 49 Hawaiian monk seals that were rehabilitated and released, the following information has been gathered: 5 were found dead within one year of release, 29 disappeared within one year of release, and 15 disappeared from 2-11 years after release.

Adult male Hawaiian monk seals have been documented to injure and kill other Hawaiian monk seals, including adult females, immature Hawaiian monk seals of either sex, and weaned pups. Some of the attacks have been made by groups of adult males, while others were by individual males. To reduce injuries and mortalities, NMFS has removed aggressive adult males from some sites. A total of 40 adult male seals have been taken. Thirty-two were translocated to locations distant from the site where the attacks had occurred (21 were moved to the MHI in 1994 and 11 were moved to Johnston Atoll, 9 in 1984 and 2 in 1998). Five were placed into permanent captivity. Two died while being held in temporary pens for translocation. One was euthanized. Although there is no systematic sighting effort for the 21 adult males translocated to the MHI, one sighting was made on Kauai in April, 2001.⁷ None of the adult Hawaiian monk seals translocated to Johnston Atoll have been resighted since the year in which they were translocated.

Hawaiian monk seals have been moved between populations for reasons other than mitigation of adult male attacks. A total of ten seals have been so taken; five healthy female weaned pups were translocated from FFS to Kure Atoll in an effort to bolster the population and increase the reproductive potential at Kure, and four healthy seals born in the MHI were translocated, after having weaned, to areas less utilized by humans to minimize the potential of human harassment.

Of the five Hawaiian monk seals translocated from FFS to Kure Atoll in 1990, two were known to be alive at Kure as of 1999. Of the four Hawaiian monk seals relocated from sites in the MHI, one was observed alive at Kure Atoll in 1999, two were observed alive on Kauai in 2000, and one that was translocated to Niihau was reported to have been killed sometime after 1994 by a boat propellor, although this report is unconfirmed (Henderson, pers. comm., 2001).

In addition to using unsuccessfully rehabilitated Hawaiian monk seals or aggressive males as captive research animals, some Hawaiian monk seals have been collected from the wild and placed directly into captivity. From 1983 to 1991 a total of four animals were taken; two Hawaiian monk seals were collected from the NWHI, and two Hawaiian monk seals found badly injured in the MHI were treated and placed into permanent captivity (NMFS unpub. data 2001).

⁷Salt Pond County Beach Park, Kauai. A Hawaiian monk seal with a red tag # 4A0 was reported acting aggressively toward another Hawaiian monk seal (Freeman pers. comm. 2001). That tag number was confirmed by NMFS to be the tag number of an adult Hawaiian monk seal relocated from Laysan in 1994 (Henderson pers. comm. 2001).

In 1995, twelve Hawaiian monk seal pups were taken into captivity by NMFS for the purposes of rehabilitation and eventual return to the wild population. At the time of capture, some of the pups exhibited clinical signs associated with conjunctivitis, red eyes, blepharism, blepharospasm, and photosensitivity. Of the twelve Hawaiian monk seals pups, nine later developed corneal opacities and subsequent cataracts, and one developed cataracts (with no corneal opacities), and two of these total of ten Hawaiian monk seals later died (due to causes unrelated to blindness) (NMFS unpub. data). The remaining 10 Hawaiian monk seals (eight blind and two sighted) were transferred to Sea World of Texas where they are research animals.

The MMRP handles Hawaiian monk seals in the wild as part NMFS' research to monitor the population and facilitate recovery. Takes have included tagging, instrumentation, and sampling for health assessment. The MMRP has handled seals 3,343 times as part of its research activities since 1981. Three seals died during research handling. All three individuals were adult males. Results of necropsies on these seals varied, but in general all three were older seals whose health had been compromised by chronic illness.

Some researchers have expressed concern that continuous human habitation of research field camps in the NWHI could have an adverse effect on Hawaiian monk seals if not carefully controlled (Spalding 2000). Currently, all Hawaiian monk seal research is monitored and regulated under several federal permit systems. A recent assessment of the possible impact of field research activities on Hawaiian monk seals evaluated 4,800 seals handled between 1982 and 1999 and found no significant deleterious effects on the seals' health or behavior (Baker and Johanos 2000).

There is no recent evidence of intentional injuries from acts such as clubbing or shooting of Hawaiian monk seals in the NWHI. The MMRP annually monitors all major breeding populations of Hawaiian monk seals, and collects data on any injuries or other events which could affect the survival of individual seals. The program has not documented any injuries or mortalities in the NWHI that could be attributed to clubbing, shooting, or other intentional wounding of Hawaiian monk seals since the establishment of the Protected Species Zone in 1991 by Amendment 3 to the Pelagics FMP (Johanos and Ragen, 1996a, 1996b, 1997, 1999a, 1999b; Johanos and Baker 2000). Although a Court Order⁸ found that intentional acts to Hawaiian monk seals have occurred in the NWHI, ongoing NMFS' monitoring of Hawaiian monk seal populations indicates that intentional acts in the NWHI have not occurred since the late 1980's.

Tern Island Sea Wall Entrapment: Hawaiian monk seals at Tern Island, FFS, have been entrapped behind a deteriorating sea wall. During World War II, the Navy enlarged Tern Island, one of several small islets at FFS, from its original 4.5 hectares (11 acres) to about 16.2 hectares (40 acres) to accommodate a landing strip (Marine Mammal Commission 1999). To do so, the Navy constructed a sheet metal bulkhead around most of the island and backfilled behind the

⁸The Order Granting in Part and Denying In Part Plaintiffs' Motion for Summary Judgement, Granting in Part and Denying in Part Defendants' Cross-Motion for Summary Judgement, and Granting in Part Plaintiffs' Motion for a Permanent Injunction Motion for Summary Judgement in Greenpeace Foundation, et. al., v. Norman Mineta, et. al. Civil No. 00-00068SPKFIY. U.S. District Court of Hawaii, November 15, 2000, p. 30.

structure with dredged spoil and coral rubble from the surrounding lagoon. The Coast Guard took over the island from 1952 to 1979 to operate a LORAN station. Since then, it has been used by the U.S. Fish and Wildlife Service 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 (Marine Mammal Commission 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 Hawaiian monk seals and other wildlife.

Since recordkeeping began in 1988, a number of Hawaiian monk seals have been entrapped behind the seawall (Table 14). Most of these Hawaiian monk seals have been redirected to the water by FWS and NMFS personnel. Two subadult male Hawaiian monk seals have died as a result of becoming entrapped behind the sea wall.

Table 14: Incidence of Hawaiian Monk Seal Entrapments and Deaths on Tern Island from 1988-2000

#	YEAR												
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
E	1	3	1	6	4	2	3	3	0	0	5	4	4
M	1	0	0	1	0	0	0	0	0	0	0	0	0

Notes: E - entrapped; M - mortalities; Source: USFWS 2001

In 1999, the U.S. Fish and Wildlife Service received \$1 million as an initial investment for sea wall construction at Tern Island. The total cost of the project is estimated to be about \$15 million (Marine Mammal Commission 1999). At the 123rd Council meeting (June 21-24, 2004), the USFWS reported that the project began in March 2004 and is 35% complete, and is focused on the most damaged and vulnerable sections. NMFS has conducted an ESA consultation on the project and, together with the FWS, has devised monitoring and other measures designed to avoid any take by harassment or otherwise of Hawaiian monk seals and other protected species during the construction activities. The completed restoration of the sea wall is expected to eliminate any future entrapment hazards to Hawaiian monk seals and turtles (USFWS 2001).

Contaminants: Contaminants in the marine and terrestrial environment also pose a potential but unknown risk to monk seal recovery and survival. Effects on monk seals are unknown at this time. The analysis of tissue samples from monk seals at FFS indicate that PCB levels and specific forms (congeners) known to be toxic were found to be lower than PCB levels in other pinnipeds, and the values at FFS are below similar samples obtained from monk seals at Midway Islands (NMFS unpub. Preliminary data, 1999). The significance of these levels to monk seals health is unknown at this time. However, the ecological effects of contaminant clean-up operations at Tern Island (FFS), Johnston Atoll, and Midway Island may have short-term adverse effects on the surrounding corals, fish and invertebrates if an exposure event were to occur.

Reductions in prey abundance due to clean-up efforts could reduce foraging success and survival rates of monk seals near these areas.

Fisheries: Several fisheries operate or have operated in the areas utilized by the Hawaiian monk seal. Some of the fisheries are federally managed. These are: the bottomfish fishery, the pelagic longline fishery (transit only), the crustacean fishery (currently suspended), and the deep water precious corals fishery (no participants currently). Other fisheries that operate in areas utilized by the Hawaiian monk seal include fisheries managed by the State of Hawai'i. These fisheries include the state-managed MHI bottomfish fishery, commercial and recreational nearshore fisheries (including gillnet fisheries), recreational *ulua* fishery, coastal *opelu* and *akule* fisheries, and collection for the aquarium trade.

The Hawaii-based pelagic longline fishery targets pelagic species of tunas and swordfish. Under the Fishery Management Plan for the Pelagic Fisheries in the Western Pacific Region (Pelagics FMP), NMFS permits up to 164 vessels, but only about 100 vessels have been active during the past two years.

There was some evidence in the early 1990s that longline operations were adversely affecting the Hawaiian monk seals, as indicated by the sighting of a few animals with hooks and other non-natural injuries. Amendment 2 to the Pelagics FMP required longline permit holders to notify NMFS if intending to fish within 50 miles of any NWHI and required all vessel operators to attend a training session. These measures were later deemed insufficient. In 1991, Amendment 3 established a permanent 50-mile Protected Species Zone around the NWHI that closed the area to longline fishing. Establishment of this zone appears to have eliminated Hawaiian monk seal interactions with the longline fleet. Since 1993, no interactions with Hawaiian monk seals in the pelagic longline fishery have been reported. Longline observers recorded only one sighting of a Hawaiian monk seal during transit through the Protected Species Zone near Nihoa Island in 1995 (NMFS unpubl. data).

The NWHI lobster fishery began in the 1970s and annual landings peaked at 1.92 million lobsters in 1985. Since then, landings have decreased. The number of vessels participating in the lobster fishery has ranged from 0 to 17, with only five and six vessels participating during 1998 and 1999, respectively (A. Katekaru pers. comm. 2001. NMFS-PIRO).

Historically, effort has been concentrated near the islands and atolls of the NWHI where Hawaiian monk seals occur, however FFS, the area with the most observed monk seals represented only 1.2 percent of the total effort of the lobster fishery (Table 21). Observer reports⁹ show no Hawaiian monk seal entanglements or other interactions. However, in 1986 near Necker Island, one Hawaiian monk seal died as a result of entanglement with a bridle rope from a lobster

⁹The lobster fishery was "observed" on a voluntary basis starting in 1997. NMFS scientific data collectors were dispatched on each of the lobster trips during 1997 through 1999. In 2000 and 2001 the lobster fishery was closed.

trap. In 1983 a precautionary measure was taken to redesign the entrance cone to ensure that Hawaiian monk seals could not get caught in lobster trap entrances.¹⁰

Lobster is a known prey item of the Hawaiian monk seal, but the importance of lobster in their diet has not been quantified. Ongoing foraging and prey identification studies will help understand the effect, if any, of the lobster fishery on Hawaiian monk seal populations in the NWHI. It has been theorized that octopus are an important monk seals prey item and that the lobster fishery has depleted NWHI octopus populations. Recent studies by NOAA regarding this issue have found that only 83 individuals were captured during the entire 1986-2003 study period and examination of the data shows no significant decline or increase in octopus abundance over time. Based on the data, the study found that it is unlikely that lobster trapping activities have lowered octopus abundance to such a degree that monk seal populations would be negatively impacted (Dinardo 2005, Moffit 2005).

The lobster fishery was closed in 1993 based on the harvest quota set for the fishery under Amendment 7 of the Crustaceans FMP. The fishery re-opened in 1994 with five vessels participating in the fishery. In 1995 the fishery was again closed; however, one vessel was allowed to fish under an experimental fishing permit issued by NMFS to obtain scientific information on the lobster stock. From 1996 through 1999 the fishery had five, nine, five, and six vessels participating, respectively. Although the lobster fishery was not overfished, NMFS closed the fishery in 2000 through 2001 because of an increased level of uncertainty in the model assumptions used to estimate the lobster harvests (65 FR 39314). Harvest guidelines for the 2001 through 2005 fisheries were not issued by NMFS (66 FR 11156, Feb. 22, 2001; 67 FR 11678, March 15, 2002; 68 FR 8490, Feb. 21, 2003; 69 FR 12303, March 16, 2004; 70 FR 8544, Feb 22, 2005).

Precious corals are harvested under the Fishery Management Plan for Precious Corals Fisheries of the Western Pacific Region (Precious Corals FMP). NMFS has determined that the harvest would not adversely affect the Hawaiian monk seal (NMFS 2000). Regulatory changes to the Precious Corals FMP recommended by the WPRFMC in 2000 are intended to, among other things, protect precious coral beds that provide foraging habitat for some Hawaiian monk seals in the NWHI (65 FR 53692).

The contribution of coral beds to prey aggregation and prey availability for Hawaiian monk seals remains unclear. As discussed previously, Hawaiian monk seal diet studies indicate that Hawaiian monk seals are opportunistic and feed on a wide variety of prey (Goodman-Lowe 1998). Research from Parrish et al. (2000) and Abernathy and Siniff (1998) indicate that some seals forage at depths where precious coral beds occur. However, the absence of deep diving activity at Pearl and Hermes Reef suggests that Hawaiian monk seals at French Frigate Shoals may vary their foraging behavior depending on the availability of prey resources.

¹⁰Plastic dome-shaped single-chambered traps with two entrance funnels or cones located on opposite ends are employed in the lobster fishery. All traps are required to have escape vents (for smaller lobster). The traps are usually set in strings of about one hundred, with several strings fished at a time.

Until recently, a U.S. Fish and Wildlife Service concessionaire operated an ecotourism station at Midway Island. Recreational fishing was allowed in the lagoon and waters around the island. No adverse interactions (e.g., entanglements or hookings) with Hawaiian monk seals in this recreational fishery have been reported. However, a study conducted in 1998 recorded Hawaiian monk seal interactions at six locations during fishing activities (Bonnet and Gilmartin 1998). Inquisitive, newly weaned pups sometimes approach fishing activities, presumably to investigate human activity (Shallenberger pers. comm. 2001. FWS). However, three Hawaiian monk seals were reported to have been hooked as a result of recreational fishing during the operation of the U.S. Coast Guard station at Kure Atoll, which closed in 1993 (Forney et al. 2000).

The fisheries for big game (*ulua*) and small game (*papio* and other smaller fish) are two of the largest components of the shore-based recreational fisheries in Hawaii. The term *ulua* mainly refers to two species: the white *ulua* (*Caranx ignobilis*) and the black *ulua* (*C. lugubris*). *Ulua* can also be used to refer to any larger *Caranx* (ten or more lbs). The term *papio* can refer to *Caranx ignobilis* and *C. lugubris* under 10 lbs as well as to six to eight other smaller Carangids commonly found in near-shore waters. The two fisheries differ more in the gear used than the target species. Any of the species can be and are taken in both fisheries. The two predominant fishing methods employed are the “slide-bait” and “shore casting” fisheries.

Big game shorefishing, primarily targeting large *ulua* (jacks), usually utilizes slide-baiting techniques. Slide bait rigs have a large hook tied or crimped to a short length of wire or heavy monofilament leader which is in turn tied or crimped to a “slide bait” swivel. The slide-bait fishery almost exclusively employs circle hooks of sizes corresponding to Mustad #14/0 and larger. This leader and hook set up is independent of the wired weight set up. These two independent sets of gear combine to make a whole slide bait rig. The weight is cast out and anchored before the slide bait hook rig is attached to the mainline and allowed to “slide” down and out to its final fishing position. The preferred baits are moray eels, “white eel” or “tohei” (conger eel), and octopus. Live reef fish of all kinds are also among the preferred baits.

The mainline (line on the fishing reel) used in slide baiting varies according to the individual, but is generally heavy line in the 80-100 lb plus test weight. The fishing weights generally have 4-5 inch soft wires extending from the terminal end. These wires are bent into a grapnel shape to snag onto rocks and coral to provide a solid anchoring point from which to suspend the large baits off the bottom and prevent the rig from moving with the current or swell. The limited movement prevents tangling with other rigs. The wires used are malleable enough to be straightened with pressure from the rod. The line connecting the weight to the swivel is of a lesser strength than the mainline and designed to break should the weight become inextricably stuck on the bottom.

Small game fishing uses a rig in which a hook(s) and lead is attached to a swivel and is cast as a single unit. It uses smaller hooks and lighter leaders. The major differences between big game fishing and small game fishing are the kind of rig used, the size of the gear, and the general kinds of areas that are preferred by each. The slide-bait fishery is generally associated with close proximity of deep water (20-100 ft) because the technique depends on gravity or the live bait to take the bait down the mainline to the strike zone. Shorecasting for small game is done anywhere along the shoreline.

The third shore based fishery is locally referred to as “whipping.” Whipping involves standing on the shore, usually a rocky area, and casting and quickly retrieving an artificial lure into breaking waves headed towards shore. The lure usually has treble or double hooks attached. Fishing line in the 20-50 lb test weight range is commonly used in this fishery. Often the leader, the first few feet of line directly attached to the lure, is a thicker line for protection from chafing on the fish’s teeth or the reef and rocks. Whipping is also successfully done from boats.

Ulua are also fished from boats. A variety of gear may be employed; typical are the trolling set-up, with down riggers or trolling planes, and surface plugs or casting jigs. Artificial lures, e.g., plugs and lead-head jigs, are used just outside the breaking surf.

The gear used in these recreational fisheries varies, but the most popular gear composition is a circle hook with a slide bait swivel on a wire leader. There is some overlap with the type of hook used (circle hooks) in the bottomfish fishery although the size of the *uluua* circle hook tends to be larger than that used in the bottomfish fishery. Some of the hooks embedded in Hawaiian monk seals have been identified as gear used in the state *uluua* fishery based on gear, size of hook, and location of the Hawaiian monk seal when discovered, while other hooks have been identified as potential bottomfish fishery hooks. There is only one report of a hooking of a Hawaiian monk seal on bottomfish gear being actively fished.

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. Between 1982 (the year NMFS first began to collect information on marine debris entanglement) and 2000 a total of 204 entanglements were documented. In 1999, a record 25 Hawaiian monk seals were reported to have been found entangled in marine debris (HMSRT 1999). 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 this debris has been transported by ocean currents from distant fisheries around the rim of the North Pacific Ocean (Marine Mammal Commission 2000).

In 1998, NMFS organized a multi-agency cleanup effort to remove derelict fishing nets and other debris from the reefs surrounding FFS and Pearl and Hermes Reef. NMFS was able to remove only a small proportion of this debris and estimated that 38,000 pieces of netting remained in the waters surrounding each of these locations (Marine Mammal Commission 2000). In 1999 the NMFS-HL led a multi-agency effort to survey and remove derelict fishing gear from Lisianski Island and Pearl and Hermes Atoll (Donohue et al. 2001). Reef debris density ranged from 3.4 to 62.2 items/km². Fourteen tons of debris were removed from these two islands. The 2000 data include the first examination of marine debris at Kure Atoll, as well as estimations of accumulation rates at Lisianski Island and Pearl and Hermes Atoll. These three locations were resurveyed in 2001 allowing refinement of accumulation rate estimates. Additionally, in 2001 a fleet of three chartered vessels again worked to clean the reefs around Kure Atoll and Pearl and Hermes Atoll. About 62 tons of debris was removed from the two sites, with Kure essentially

cleaned of derelict fishing gear during this effort (Laurs 2002). These efforts continued in 2002 and 2003, and are underway in the summer of 2004. To date, five sites have been surveyed: FFS, Lisianski Island, Pearl and Hermes, Kure and Midway Atolls. Approximately 330 tons of marine debris have been removed from NWHI reefs during these surveys. Net samples collected from the NWHI between 1998 and 2002 were about 86% trawl/seine nets. These types of fisheries do not exist in Hawaii, and it is presumed that this debris originates in various fisheries in the northern Pacific. Gillnet made up about 8% of the total. Longline gear comprised about 1.4%.

Information on marine debris entanglement and injuries, including mortalities, has been collected by NMFS since 1982. Seven categories of debris have been defined: nets (of fishery origin), lines or ropes (not necessarily of fishery origin), net/line combinations (of fishery origin), cones (from hagfish traps), rings (circular items of unknown origin), plastic packing straps (of fishery and non-fishery origin), and other /unknown. A total of 204 entanglements was documented, 96 by fishery items (5.05 per year), 96 by non-fishery items (5.05 per year), and 12 by unknown items (0.64 per year). From the total number of entanglements, 47 serious injuries were documented, including 27 by fishery items (1.42 per year), 8 by non-fishery items (0.42 per year), and 12 by unknown items (0.64 per year). Seven mortalities from entanglement were documented: 6 from fishery items (0.32 per year) and 1 from a non-fishery item (0.05 per year) (Table 15). Five of the seven debris-related mortalities were caused by trawl netting and the other from unidentified line. Trawl fishing does not occur in areas under Council jurisdiction.

Table 15: Known Marine Debris Related Monk Seal Mortalities: 1982-2000

YEAR AND LOCATION	DESCRIPTION
1986– FFS	Weaned male tangled in wire which was relic of USCG or Navy occupation; in water
1987–Lisianski Is.	Pup (uncertain if nursing or weaned) dead in net/line aggregate onshore
1987–FFS	Juvenile dead in net/line aggregate onshore
1988–Lisianski Is.	Weaned pup dead in large trawl net onshore
1995–Pearl and Hermes Reef	Bones of adult found scattered in line awash onshore
1997–FFS	Subadult dead in trawl net on reef
1998–Laysan Island	Weaned pup dead in trawl net on nearshore reef
2002 - Lisianski	Nursing pup dead in line: drowned in shallow water

Source: NMFS 2004

Vessels: Hawaiian monk seals may be injured by collisions with vessels or indirectly by vessel groundings that result in the release of hazardous or toxic chemicals or gear that creates an entanglement hazard. Collisions are much more likely with small high-powered vessels. For example, a pup born at the Pacific Missile Range Facility on Kauai was reported dead in 1999.

There was an anonymous and unconfirmed report that the pup may have been hit by a zodiac-type vessel employed in the tourist industry.

In August 1998, Tesoro Hawaii Corporation tanker offloading operations resulted in a spill of about 5,000 gallons of bunker fuel off Barber's Point, leeward Oahu. The waters and shoreline of Kauai were affected, and oiled Hawaiian monk seals were reported in the area. During September 1998, up to five oiled Hawaiian monk seals were observed. One Hawaiian monk seal had its entire oral mucosa coated with red, blood-like fluid. This Hawaiian monk seal was later resighted and exhibited signs of a respiratory infection. Another Hawaiian monk seal exhibited "gagging behavior." As there were no physical exams conducted on the animals observed, the wildlife resource agencies could not reach a conclusion about the effects of the oil on the Hawaiian monk seals (Natural Resources Trustees 2000).

In October 1998, the lobster fishing vessel *Paradise Queen II* ran aground near Kure Atoll. Nearly 4,000 gallons of diesel fuel was estimated to be released into the nearshore environment as well as hundreds of lobster traps. No monk seals were reported to be impacted from the vessel grounding.

In April 1999, a longline vessel (*F/V Van Loi*) grounded on a reef off of Kapa'a, Kaua'i. The vessel had 6,000 gallons of diesel fuel on board and was carrying three tons of bait and gear. All fuel, bait and gear (including monofilament line and hooks) went overboard into the marine environment. Monk seals and sea turtles were observed in the area, but no adverse interaction with fuel or gear was reported by wildlife resource managers on scene.

Other Pinniped: The Northern Elephant Seal

Although uncommon in the action area of the bottomfish fishery, the northern elephant seal (*Mirounga angustirostris*) has been observed in the MHI and the NWHI. In 2002 a yearling appeared on the island of Hawaii, was captured, and transported to the Marine Mammal Center in California for rehabilitation and reintroduction to the wild.

2.2.7.2 Sea Turtles

All sea turtles are designated as either threatened or endangered under the Endangered Species Act. The five species of sea turtles known to be present in the Hawaii EEZ are: the leatherback (*Dermochelys coriacea*), the olive ridley (*Lepidochelys olivacea*), the hawksbill (*Eretmochelys imbricata*), the loggerhead (*Caretta caretta*), and the green turtle (*Chelonia mydas*). However, only the hawksbill and green sea turtles have been observed in Hawaii's nearshore areas.

Leatherbacks have the most extensive range of any living reptile and have been reported circumglobally from latitudes 71°N to 42°S in the Pacific and in all other major oceans. The diet of the leatherback turtle generally consists of cnidarians (i.e., medusae and siphonophores) in the pelagic environment. They lead a completely pelagic existence, foraging widely in temperate waters except during the nesting season, when gravid females return to beaches to lay eggs. Typically, leatherbacks are found in convergence zones and upwelling areas in the open ocean, along continental margins, and in archipelagic waters.

The loggerhead turtle is a cosmopolitan species found in temperate and subtropical waters and inhabiting continental shelves, bays, estuaries and lagoons. Major nesting grounds are generally located in warm temperate and subtropical regions, generally north of 25°N or south of 25°S latitude in the Pacific Ocean. For their first several years of life, loggerheads forage in open ocean pelagic habitats. Both juvenile and subadult loggerheads feed on pelagic crustaceans, mollusks, fish and algae. As they age, loggerheads begin to move into shallower waters, where, as adults, they forage over a variety of benthic hard and soft bottom habitats.

The olive ridley 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. Since the directed take of sea turtles was stopped in the early 1990s, the nesting populations in Mexico seem to be recovering, with females nesting in record numbers in recent years. The olive ridley turtle is omnivorous and identified prey include a variety of benthic and pelagic items such as shrimp, jellyfish, crabs, snails and fish, as well as algae and sea grass.

The hawksbill turtle is listed as endangered under the ESA. Anecdotal reports throughout the Pacific indicate that the current population is well below historical levels. 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 (NMFS 2001).

Like other sea turtles, hawksbills will make long migrations between foraging and nesting areas (Meylan 1999), but otherwise remain within coastal reef habitats. Hawksbill turtles occur in the water around the Hawaiian Islands (on Oahu, Molokai, Maui and Hawaii) and nest on Maui and the southeast coast of the Island of Hawaii.

Green turtles were listed as threatened under the ESA on July 28, 1978, except for breeding populations found in Florida and the Pacific coast of Mexico, which were listed as endangered. Using a precautionary approach, Seminoff (2004) estimates that the number of nesting female green turtles has declined by 48 to 67 percent over the last three generations (~ 150 yrs). Causes for this decline include harvest of eggs, subadults and adults; incidental capture by fisheries; loss of habitat; and disease. The degree of population change is not consistent among all index nesting beaches or among all regions. Despite an overall declining trend globally, green turtle population growth rates are variable among nesting populations and regions and some populations are stable or increasing in abundance (Chaloupka et al. in press).

Green turtles in Hawaii are considered genetically distinct and geographically isolated although a nesting population at Islas Revillagigedos in Mexico appears to share the mtDNA haplotype that commonly occurs in Hawaii. In Hawaii, green turtles nest on six small sand islands at French Frigate Shoals, a crescent-shaped atoll situated in the middle of the Hawaiian Archipelago (Northwestern Hawaiian Islands) (Balazs 1995). Ninety to 95 percent of the nesting and breeding activity occurs at the French Frigate Shoals, and at least 50 percent of that nesting takes place on East Island, a 12-acre island. Long-term monitoring of the population shows that there is strong island fidelity within the regional rookery. Researchers monitoring East Island since 1973 have collected information on numbers of females nesting annually and have conducted tagging studies (Balazs 2002).

Since the enactment of the ESA in 1973, and following years of exploitation, the nesting population of Hawaiian green turtles has shown a steady increase (Balazs 1996; Balazs and Chaloupka 2004). The number of nesting females at East Island increased from 67 nesting females in 1973 to 467 nesting females in 2002. Nesting abundance increased rapidly at this rookery during the early 1980s, leveled off during the early 1990s before again increasing rapidly during the late 1990s and up to the present. This trend is very similar to the underlying trend in the recovery of the much larger green turtle population that nests at Tortuguero, Costa Rica (Bjorndal et al. 1999).

The stepwise increase of the long-term nester trend since the mid-1980s is suggestive, but not conclusive, of a density-dependent adjustment process affecting sea turtle abundance at the foraging grounds (Bjorndal et al. 2000; Balazs and Chaloupka 2004). Balazs and Chaloupka (2004) conclude that the Hawaiian green sea turtle stock is well on the way to recovery following 25 years of protection. This increase can be attributed to increased female survivorship since harvesting of turtles in the foraging grounds was prohibited in the mid-1970s and cessation of habitat damage at the nesting beaches since the early 1950s (Balazs and Chaloupka 2004). Low level nesting also occurs at Laysan Island, Lisianski Island and on Pearl and Hermes Reef (NMFS and USFWS 1998a).

Important resident areas of green turtles have been identified and are being monitored along the coastlines of Oahu, Molokai, Maui, Lanai, Hawaii, and at nesting areas in the reefs surrounding the French Frigate Shoals, Lisianski Island, and Pearl and Hermes Reef (Balazs 1982; Balazs et al. 1987).

The green turtle population in the Hawaiian Islands area is afflicted with a tumor disease, fibropapillomatosis, which is of an unknown etiology and often fatal, as well as spirochidiasis, both of which are the major causes of stranding of this species. Green turtles captured off Molokai from 1982-96 showed a massive increase in fibropapillomatosis over this period. Prevalence of fibropapillomatosis peaked at 61% occurrence in 1995 (Balazs et al. 1998). Preliminary evidence suggests that there is an association between the distribution of fibropapillomatosis in the Hawaiian Islands and the distribution of toxic benthic dinoflagellates (*Prorocentrum* spp.) known to produce a tumor promoter, okadaic acid (Landsberg et al. 1999). Stranding reports from the Hawaiian Islands from 1982-1999 indicate that the green turtle is the most commonly stranded sea turtle (96.5 percent, compared to other species), averaging around 150 per year (2,689 total/18 years). While the disease is often fatal, a recent study found no apparent effect of fibropapillomatosis on Hawaiian green turtle population-specific somatic growth rates (Balazs and Chaloupka 2004b). Moreover, despite the occurrence of fibropapillomatosis in the Hawaiian Archipelago green turtle stock, nester abundance continues to increase (Aguirre et al. 1998 in Balazs and Chaloupka 2004) and the stock is well on the way to recovery (Balazs and Chaloupka 2004b).

2.2.7.3 Seabirds

The NWHI are home for around 14 million seabirds and provide important nesting habitat for around 5.5 million breeding pairs (USFW 2004). The only ESA-listed seabird found in NWHI is the Short-tailed albatross (*Phoebastria albatrus*), with 1-3 individuals observed to visit Midway

each year. Other seabirds found in the NWHI include, but are not limited to the black-footed albatross (*Phoebastria nigripes*), the Laysan albatross (*Phoebastria immutabilis*), the Masked booby (*Sula dactylatra*), brown booby (*Sula leucogaster*), red-footed booby (*Sula sula*), wedge-tailed shearwater (*Puffinus pacificus*), and the Christmas shearwater (*Puffinus nativitatis*). More than 95 % of the world's Laysan and black-footed albatross nest in the NWHI. Population trends for most seabird species in the NWHI appear stable or increasing, but nonetheless there is continuing concern for albatross species. Threats to NWHI seabirds include introduced and invasive species, contaminants, marine debris, oil pollution, climate change, and fishery interactions.

Short-tailed Albatross (*Phoebastria albatrus*)

General Description: The short-tailed albatross is the largest seabird in the North Pacific with a wingspan of more than three meters (nine feet). The short-tailed albatross bill is larger than the bills of Laysan and black-footed albatrosses and is characterized by a bright pink color with a light blue tip and defining black line extending around the base. The juvenile plumage is brown, and at this stage, except for the bird's pink bill and feet, the seabird can be easily 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 adult 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.

Distribution: The short-tailed albatross is currently 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 ("Torishima") (30° 29' N., 140° 19' E.) and Minami-Kojima Island (25° 56' N., 123° 42' E.). A few short-tailed albatross have been observed attempting to breed, although unsuccessfully, at Midway Atoll. Midway lies roughly 1,750 miles east and slightly to the north of Torishima.

Today, the breeding population of the short-tailed albatross is estimated at approximately 326 breeding pairs: 276 pairs on Torishima and 50 pairs on Minami-Kojima. The short-tailed albatross have an annual survival rate of 96% and a population growth rate of 7.8% (65 FR 46643, July 31, 2000; Hasegawa, 1997). 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. At least 25% of the reproducing adults also remain at sea during each breeding season (Cochrane and Starfield, 1999). As a consequence, the exact number of individuals in the population is difficult to assess and at this time is unknown. The population size has been estimated at about 1,900 individuals (P. Sievert, personal communication: in NMFS 2005), and the Torishima population is estimated to have increased by 9% between the 2003-04 and 2004-05 nesting seasons (Harrison, 2005).

It is unknown if short-tailed albatrosses historically bred in the NWHI. Visits to the NWHI by short-tailed albatrosses were first recorded on Midway in 1938, when a female was seen incubating an infertile egg (Haden, 1941; Munro, 1944). Sighting and banding records show that

between 1938 and 2003, at the most, 22 short-tailed albatrosses visited the NWHI, with only one or two sighted on the same island at any one time. The first time two short-tailed albatrosses were known to be present on Midway at the same time, although located at different locations, occurred in February 1981. No more than four short-tailed albatross have been observed at Midway in one breeding season. Since 1998, however, a female has returned each year has laid four infertile eggs (USFWS 2004).

Black-footed Albatross (*Phoebastria nigripes*)

General Description: The black-footed albatross is characterized by dark plumage, bills, legs, and feet at all stages of their development. Comparatively, the black-footed albatross is slightly larger and heavier than the Laysan albatross, but for same-sex birds there is no significant difference between the two species (Harrison et al., 1983; Whittow, pers. comm.). The plumage coloration for both the immature and adult black-footed albatross is extremely similar; brown with a white band at the base of their bill and a white sweep defining their eyes. One of the distinguishing features between adult and juvenile (i.e., young-of-the-year) black-footed albatross are that the juveniles lack the white plumage at the base of their tail. The plumage of the immature birds can be, but is not always, slightly darker in coloration than the adult birds. Generally, as the juvenile black-footed albatross mature, they tend to become more gray or dusty in appearance (Whittow, 1993a; Miller, 1940).

Distribution: The current world population of breeding black-footed albatross is estimated at approximately 327,753 individuals, with 58,898 breeding pairs in 12 colonies (Flint and Hasegawa, unpub. data). Nine colonies are located in the NWHI comprising the majority of the breeding population (55,775 breeding pairs). Seventy-nine percent of the NWHI breeding pairs nest in three colonies that are routinely surveyed by the FWS: Laysan Island, Midway Atoll, and French Frigate Shoals. The largest black-footed albatross colony, accounting for approximately 36 percent of the world population, is on Laysan Island. Midway Atoll has the second largest black-footed albatross colony with 32 percent of the world population. French Frigate Shoals only accounts for less than 7 percent of the world population. Three black-footed albatross colonies are also located in the western Pacific (estimated 2,244 breeding pairs) accounting for approximately 4 percent of the world population. On Torishima, six black-footed albatross chicks were successfully reared in 1957, and since then the number of chicks reared has increased to 914 in 1998 (H. Hasegawa, unpub. data). The black-footed albatross populations on Bonin and Senkaku Islands have also modestly increased.

Under the IUCN criteria for identification of threatened species, the conservation status of the black-footed albatross is currently listed as Vulnerable (BirdLife International, 2000; Croxall and Gales, 1998). The Vulnerable status was given because the taxon “is not critically endangered or endangered but is facing a very high risk of extinction in the wild in the near future” (Croxall and Gales, 1988). To obtain the Vulnerable conservation status, the black-footed albatross population must show declines of greater than 20 percent over three generations - 45 years in the case of the black-footed albatross. Since there are not good census data from 45 years ago, the IUCN evaluates the average annual rate of decline over the period of time that data do exist and extrapolates to 45 years.

The USFWS was recently petitioned to list the black footed albatross under the ESA (Earthjustice 2004). However, the USFWS rejected the petition in a letter to Earthjustice, dated December 3, 2004, stating that emergency listing was not warranted at this time. The petition painted a dismal picture of the prospects for black-footed albatrosses, arguing that the Pacific population is in decline and that this decline is exacerbated by human threats, particularly pelagic longline fishing. However, Harrison (1990) reports that in the early 1980s, black-footed albatross populations in the NWHI ranged from 36,240 to 49,410 nesting pairs, or taking the average, about 43,000 pairs. The most recent nesting population estimate for the NWHI is about 55,775 nesting pairs (NMFS 2004). The difference represents an increase of 12,775 nesting pairs or an increase of 30% over this time period. Midway's black-footed albatross population has increased to over 20,000 nesting pairs, from a population in the early 1980s of 6,500-7,500 nesters - an increase of 300% in less than two decades. Using an even more conservative estimate from the early 1960s of 7,000 pairs (Robbins 1961) indicates a tripling of the black-footed albatross population size over the past 40 years. The 2005 Midway nesting population of black-footed albatrosses was found by the USFWS to include 24,085 nesting pairs, a 10% increase from the 2004 count and a 26% increase since 2001 (TenBruggencate, 2006). Both the black-footed albatross nesting populations at French Frigate Shoals and Laysan Island in 2003 appeared to be at the high end of the population sizes observed in the early 1980s (Harrison 1990). In addition, the overall increase of black-footed albatross nesting pairs in the NWHI increased by 7.2% between 2001 and 2003 (USFWS 2004b). Taken together, these observations strongly suggest either an increasing population, or at worst, a stable population.

Laysan Albatross (*Phoebastria immutabilis*)

General Description: Laysan albatross are characterized by white plumage on their head, neck, and chest, and sooty brown plumage on their upper wings, back, and tail. The Laysan albatross underwings have variable patches of dark and white plumage and are distinguished by dark leading edges and wing tips. Laysan albatross have fleshy-pink colored legs and webbed feet, and in flight the feet project beyond the tail. The Laysan albatross eye is gray, and black plumage extends in a thin line behind the eye. There are no distinguishing characteristics between sexes or between adult and immature phases (Whittow, 1993b).

Distribution: It is estimated that before feather hunters reached Marcus Island, the island had a population of one million Laysan albatross (Rice and Kenyon, 1962). Feather hunters also raided Laysan albatross colonies in the NWHI taking at least 300,000 birds from Laysan Island in 1909 (Dill and Bryan, 1912). The latest available information indicates that it is estimated that the Laysan albatross population is 3.4 million individuals, with 623,622 breeding pairs in 15 colonies. Twelve of the colonies are located in the NWHI comprising of the majority of the breeding population (623,495 breeding pairs). The largest Laysan albatross colony (approximately 71% of the world population) is on Midway Atoll. A complete direct nest count by the USFWS on Midway Atoll in late 2005 and early 2006 found that the number of nesting pairs of Laysan Albatrosses had increased by 70% since 2001 (TenBruggencate, 2006). Laysan Island has the second largest colony representing nearly 22% of the world population.

A serious problem for the Laysan albatross population is lead poisoning of chicks from weathering lead-based paint on old buildings on Midway Atoll. Chicks raised in nests close (< 5

meters) to buildings ingest deteriorating paint directly from the buildings or paint chips that have fallen in and around their nests. Blood lead concentrations in chicks near buildings average 440 µg/dL, compared to an average blood lead of 6 µg/dL in chicks nesting more than 100m from buildings. For comparison, the Centers for Disease Control's blood level of concern for children is 10 µg/dL. The chicks near buildings frequently exhibit a condition of peripheral neuropathy called "droopwing." These chicks cannot raise their wings, leading to broken bones and open sores. They die either as a direct result of lead poisoning or from starvation when their parents stop feeding them. It is estimated that chicks suffering significant detrimental effects from lead exposure on Midway's Sand Island could number in the thousands per year (Finkelstein, 2004).

Boobies (Order Pelecaniformes, Family Sulidae)

Three species of boobies breed in the NWHI and forage in the North Pacific: the masked booby (*Sula dactylactra*), the brown booby (*S. leucogaster*), and the red-footed booby (*S. sula*). Currently, the IUCN classifies boobies as “not globally threatened.” Like the albatrosses, the boobies are also long-lived and have a delayed maturity. Unlike the albatrosses, which are primarily surface feeders, the boobies are plunge divers and also tend to take flying fish (*Cypselurus* spp.) just above or at the surface of the water. To date, there have been no reports of lethal interactions between boobies and the Hawai‘i-based longline fishery, but boobies are reported to sit on vessel decks and watch the baited hooks as they are being set or hauled back. NMFS observers report boobies hovering over baited hooks and some birds may actually attempt a dive, however, no boobies have been reported hooked. Although the foraging behavior of boobies may differ from that of the albatrosses, such that they do not interact with longline fishing vessels or gear in the same manner, boobies are present during fishing operations and the potential for fatal interactions does exist.

Masked, brown, and red-footed boobies range throughout the tropical and subtropical waters of the world's oceans. All three booby species breed throughout the NWHI and on rocky remnants offshore of the main Hawaiian Islands. Generally, the boobies that breed in the Hawaiian Archipelago are year-round residents (Harrison, 1990) and forage close to the breeding colonies. Relatively large red-footed booby colonies (>500 breeding pairs; Harrison, 1990) are located on O‘ahu, Kaua‘i, and Lehua Islands while only a few masked and brown boobies are known to breed on Lehua and Moku Manu Islands (Harrison, 1990).

Adult masked and red-footed boobies tend to remain close to their breeding colonies while the younger and immature birds roam up to 150 km offshore (Nelson, 1978). Masked boobies, in particular, tend to return to land to roost at night. Some red-footed boobies, as well as brown boobies, are known to range as far as Wake Atoll and the Marshall Islands, but the resident masked boobies tend to remain in the Hawaiian Archipelago (Harrison, 1990). Although boobies breed throughout the Hawaiian Archipelago, apparently only three localities have been routinely monitored by FWS. Harrison (1990) reported breeding pair numbers from surveys of booby colonies completed between 1981 and 1988. From the surveys completed in the 1980s, it was estimated that there were about 14,000 masked boobies, 1,500 brown boobies, and 11,000 red-footed boobies (Harrison, 1990). The population sizes and composition of the three booby species are currently unknown, but are thought to be healthy.

Masked Booby (*Sula dactylatra*)

General Description: Adult masked boobies, also called white boobies, blue-faced boobies, or whistling boobies, are mostly white with dark plumage on their tail and tips of their wings. This booby is distinguished by a dark ‘mask’ around the eyes and bill. The ‘mask’ is actually the featherless bluish skin of the bird. There is some variation in the color of the bill and feet, such that the bill varies in color from a deep orange to a pink and the feet are a dark grey to olive green (Nelson, 1978). During the breeding season, the male’s bill becomes a brighter yellow than the female’s bill (Nelson, 1978). Juvenile masked boobies differ from the adults in that they are predominantly brown with a white underbelly, throat, and neck (Anderson, 1993).

Brown Booby (*Sula leucogaster*)

General Description: The adult brown booby is recognizable by chocolate brown to dark plumage on the head, neck, upper surface of the wings, and tail, with a sharp line across the upper breast defining the white plumage of the lower breast and abdomen. The undersurface of the wing has a distinctive white bar extending out from the white of the body toward the wing tip. In the Pacific, the head and neck plumage can vary with some birds being slightly darker and others, such as those in the eastern Pacific being pale grey to white (Nelson, 1978). The color of the bill, face, and feet also vary with region, sex, and breeding condition (Nelson, 1978). In general, the female bill is a light greenish-yellow with a white or greyish-green tip, whereas, the male bill is greenish-grey with a white tip. The feet vary in color from a pale green to a bluish-green. Juvenile brown boobies are similar to the adults except that the plumage is paler and the undersurface is a pale, dirty grey color.

Red-footed Booby (*Sula sula*)

General Description: In flight, the adult red-footed booby, also known as the white-tailed or Webster’s booby, resembles the masked booby, in that the plumage is mostly a brilliant white with black wing tips and a light yellow crown and nape. The diagnostic features for the species are a blue bill, reddish facial skin, and bright red legs and feet (Schreiber *et al.*, 1996). In some regions, there are adult red-footed boobies with ashy-brown plumage, but these birds are rare in the NWHI (Harrison, 1990). The juvenile characteristics differ greatly from the adult, such that the plumage is a pale brown, the bill is a dark brown, the facial skin is purple, and the legs and feet are yellow. About eight months after hatching, the legs and feet will become redder (Nelson, 1978). Overall, it takes about two or three years for the juveniles to mature to the adult form (Woodward, 1972).

Wedge-tailed Shearwater (*Puffinus pacificus*)

The wedge-tailed shearwater is one of the largest of the tropical shearwaters with an overall length of 43 cm, and body mass of 390 g (Whittow, 1997). The bird has grayish brown plumage on its back and white on its belly and underparts except for dark edge to the wings and dark undertail coverts. The sexes are indistinguishable and there are a light and a dark morph to this species.

The wedge-tailed shearwater has migratory behaviors. From September to November, large flocks of the species gather offshore before migrating near the Hawaiian Islands (King, 1974). Often during this period there may be rafts of birds with up to 700 individuals. The wedge-tailed shearwater breeds between February and November in the Northern Hemisphere and August and October to May and June in the Southern Hemisphere.

The wedge-tailed shearwater breeds from Kure Island in the NWHI to Maui Island in the main Hawaiian Islands (Ainley et al., 1997). The wedge-tailed shearwater also breeds on other islands spread throughout the Northeast and South Pacific, including Johnston Atoll and Christmas, Bonin, Volcano, Marshall, and Caroline Islands, and the Indian Ocean where it is known to breed as far west as Madagascar (Whittow, 1997).

A female wedge-tailed shearwater lays a single white egg in a burrow at sea level. The bird may use ledges and rock piles on rocky islands such as Necker in the NWHI (Harrison, 1990), or use shell debris or crevices under coral ledges (Gallagher, 1960). Both adults share in the excavation of the burrow, incubation of the egg, and feeding of the young (Shallenberger, 1973; Shallenberger, 1984). First breeding is at four years of age (Floyd and Swanson, 1983), and a wedge-tailed shearwater may live as long as 29 years (E. Flint in Whittow, 1997).

Christmas Shearwater (*Puffinus nativitatis*)

Christmas shearwaters are slender-bodied with a length of 35-38 cm and body mass of 354 g. (Harrison, 1983). Their plumage is dark brown with their underparts being lighter than their upperparts. The sexes are indistinguishable.

The Christmas shearwater breeds primarily in the tropical Pacific ranging as far north as the Hawaiian Islands to as far south as Easter Island (Harrison, 1996). The species usually breeds on remote, small, flat and sandy islands under dense vegetation such as naupaka (*Scaevola sericea*). Christmas shearwaters also breed on a steep grass covered slope on Motu Nui (Johnson et al., 1970).

Breeding adults return to the NWHI from early to late February (Naughton, 1982). A breeding pair will occupy a nest site in early to late March (Seto, 2001). The nest is a shallow scrape or depression in the ground, and usually located under vegetation. The female lays a single white egg each breeding season, and both parents share incubation of the egg and feeding of the chick (Seto, 2001). Chicks fledge between September and October on Midway Atoll. The oldest record of a banded Christmas shearwater was 17 years on Laysan Island (K. Swift in Seto, 2001).

Oceanographic Factors Influencing Seabird Food Availability

The region of greatest interactions between seabirds and the Hawai'i-based longline fleet is a latitudinal band from 25° N. to 40° N., from the dateline to about 150° W. longitude (NMFS, unpub. data). This region is often termed the North Pacific Transition Zone and contains a broad, weak, eastward flowing surface current composed of a series of fronts situated between the Subtropical Gyre to the south and the Subarctic Gyre to the north (Roden, 1980; Polovina, in press; Seki *et al.*, in prep.). During the winter and spring, westerlies in the northern portion of the

Transition Zone and trade winds to the south result in wind-driven transport of surface waters creating fronts as colder, more dense northern water converges with warmer and lighter water from the south (Roden, 1980). North of Hawai‘i, convergent fronts have been observed during winter to persist at about 28° N., 31° N., and 34° N. latitude (Niiler and Reynolds, 1984; Roden, 1980; Seki *et al.*, in prep.). These fronts represent sharp boundaries in a variety of physical parameters including temperature, salinity, chlorophyll, and sea surface height (geostrophic flow) (Niiler and Reynolds, 1984; Roden, 1980; Seki *et al.*, in prep.).

Biologically, these convergent fronts appear to represent zones of enhanced trophic transfer (Bakun, 1996; Olson *et al.*, 1994). The dense, cooler phytoplankton-rich water sinks below the warmer water creating a convergence of phytoplankton (Roden, 1980). Buoyant organisms such as jellyfish, as well as vertically swimming zooplankton, can maintain their vertical position in the weak down-welling, and aggregate in the front to graze on the down-welled phytoplankton (Bakun, 1996; Olson *et al.*, 1994). The concentration of these organisms in turn attracts the higher trophic level predators, and ultimately a complete pelagic food web is assembled (Olson *et al.*, 1994) and available to foraging fish and seabirds.

Although the oceanographic conditions described above are typical for the region, periodic anomalies dramatically alter these regimes. Events such as the *El Niño*-Southern Oscillation (ENSO) can have widespread and long-lasting impacts, disrupting trophic transfer with far-reaching consequences within the food chain. In addition, poorly understood phenomena such as the Pacific Decadal Oscillation (PDO) are now increasingly believed to play a significant role in oceanographic conditions and resultant variability in the distribution and abundance of pelagic food web assemblages.

Ecological Interactions Affecting Seabirds

A variety of human activities other than fisheries are known to affect seabirds. Marine pollution has long been identified as a source of negative impacts to seabirds and their populations (e.g., Bourne, 1976; Tanabe *et al.*, 1984). Of greatest concern for albatrosses in the North Pacific Ocean is ingestion of marine debris, especially plastics (Day, 1980; Furness, 1983; Morris, 1980; Petit *et al.*, 1981). Plastic ingestion seems to be significant, especially for albatross chicks. Up to 50 percent of the weight of material regurgitated by albatross chicks consists of plastics, and plastics have been found in 97.6 percent of Laysan albatross chicks at Midway Atoll. For reasons not clearly understood, Laysan albatross seem to consume more plastics than black-footed albatross. Although there is not consensus within the scientific community about the population-level impacts of plastics ingestion by albatrosses, the problem seems to be increasing and could escalate to serious levels despite international conventions (e.g., International Convention for the Prevention of Pollution from Ships (MARPOL)).

Seabird Foraging Behavior

Given their capability of flying long distances, seabirds have some ability to adapt to temporal and geographic changes in forage availability. During the non-breeding season, most pelagic seabirds have sufficient energetic reserves to travel whatever distances are required to reach areas with adequate forage.

During the breeding season, however, seabirds are tied to terrestrial colonies for pre-breeding behavior, egg-laying, incubation, and protection and care of hatchlings and juveniles. This is often an extended period, and the need for nearby forage food is considerable during much of this stage of the breeding season. It is especially high when hatchlings are young and require frequent provisioning. As chicks grow older and require less frequent feeding, adults tend to forage longer distances and remain away from the colony for longer periods of time. This pattern of feeding close to colonies at times of peak food demand, then gradually extending foraging forays is well-known for albatrosses.

2.2.8 Description of Hawaii's Fisheries

2.2.8.1 Bottomfish and Seamount Groundfish Fisheries

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 (Figure 5): the inhabited main Hawaiian Islands (MHI) with their surrounding reefs and offshore banks; and the Northwestern Hawaiian Islands (NWHI), a chain of largely uninhabited islets, reefs and shoals extending 1,200 nm across the North Pacific. In the MHI approximately 80% of the bottomfish habitat lies in state waters. Bottomfish fishing grounds within federal waters around the MHI include Middle Bank, most of Penguin Bank and approximately 45 nm of 100-fathom bottomfish habitat in the Maui-Lanai-Molokai. For management purposes the NWHI fishery has been separated into the Mau Zone, closer to the MHI, and the Ho'omalulu Zone.

In addition to the deep-slope fisheries in the MHI and NWHI, there is a potential seamount groundfish fishery in the Hawaiian Islands. A trawl and bottom longline fishery targeting alfonsin and armorhead at the southeast Hancock Seamount in the NWHI was started by Russian and Japanese fishing vessels in the late 1960s (Okamoto 1982). Large catches were made by foreign fishing vessels for about 10 years until overfishing caused the fishery to collapse. A moratorium on the harvest of alfonsin and armorhead on the Hancock Seamounts has been in effect since 1986 in an effort to rebuild the stocks. The moratorium was reissued by the Council and NMFS in September 2004 and therefore in effect until 2010 (69 FR 51400). Because periodic reviews of the stocks indicate that no recovery has occurred and it is unlikely that the moratorium will be lifted in the near future, the seamount groundfish fishery will not be discussed further.

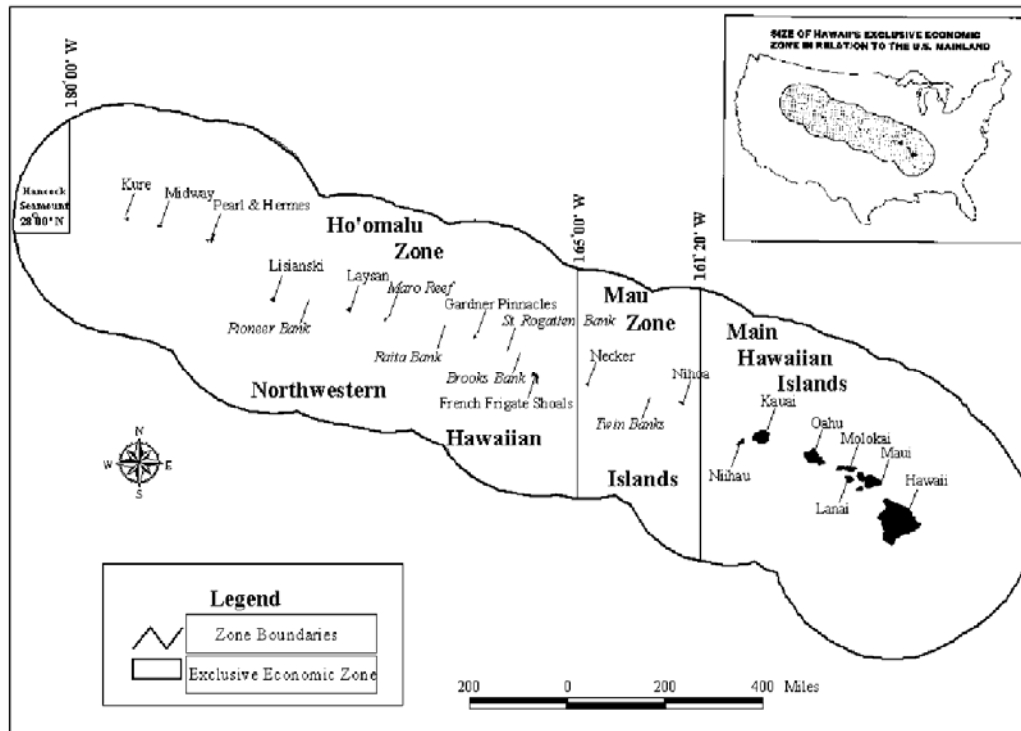


Figure 5: Bottomfish Fishery Management Subareas in the Hawaiian Archipelago

History

Bottomfish fishing was a part of the economy and culture of the indigenous people of Hawai'i long before European explorers first visited the islands. Descriptions of traditional fishing practices indicate that Native Hawaiians harvested the same deep-sea bottomfish species as the modern fishery and used some of the same specialized gear and techniques employed today (Iversen et al. 1990). The *poo lawaia* (expert fishermen) within the community knew of dozens of specific *koa* (fishing areas) where bottomfish could be caught (Kahaulelio 1902). As Beckley (1883:10) noted, each *koa* could be precisely located:

Every rocky protuberance from the bottom of the sea for miles out, in the waters surrounding the islands, was well known to the ancient fishermen, and so were the different kinds of rock fish likely to be met with on each separate rock....[They] took their bearing for the purpose of ascertaining the rock which was the habitat of the particular fish they were after, from the positions of the different mountain peaks.

European colonization of the Hawaiian Islands during the early nineteenth century and the introduction of a cash economy led to the development of a local commercial fishery. As early as 1832, fish and other commodities were sold near the waterfront in Honolulu (Reynolds 1835). Other fish markets were established on the islands of Maui and Hawaii. John Cobb (1902), who investigated Hawaii's commercial fisheries in 1900 for the U.S. Fish Commission, reported that the bottomfish *ulaula*, *uku* and *ulua* were three of the five fish taken commercially on all the Hawaiian Islands.

Initially, the commercial fishing industry in Hawaii was monopolized by Native Hawaiians, who supplied the local market with fish using canoes, nets, traps, spears and other traditional fishing devices (Jordan and Evermann 1902; Cobb 1902). However, the role that Native Hawaiians played in Hawaii's fishing industry gradually diminished during the latter half of the nineteenth century as successive waves of immigrants of various races and nationalities arrived in Hawaii. Between 1872 and 1900, the non-indigenous population increased from 5,366 to 114,345 (OHA 1998). Kametaro Nishimura, credited by some to be the first Japanese immigrant to engage in commercial fishing in Hawaii, began his fishing career in the islands in 1885 harvesting bottomfish such as *ōpakapaka*, *ulua* and *uku* (Miyaski 1973). By the turn of the century, Japanese immigrants to Hawaii dominated the bottomfish fishery using wooden-hulled "sampans" propelled by sails or oars (Cobb 1902). The sampan was brought to Hawaii by Japanese immigrants during the late nineteenth century, and over time Japanese boat-builders in Hawaii adapted the original design to specific fishing conditions found in Hawaii (Goto et al. 1983). The bottomfish fishing gear and techniques employed by the Japanese immigrants were imitations of those traditionally used by Native Hawaiians, with slight modifications (Konishi 1930).

During the early years of the commercial bottomfish fishery, vessels restricted their effort to areas around the MHI. Cobb (1902) records that some of the best fishing grounds were off the coasts of Molokai and notes that large sampans with crews of four to six men were employed in the fishery. Typically, the fleet would leave Honolulu for the fishing grounds on Monday and return on Friday or Saturday. The fishing range of the sampan fleet increased substantially after the introduction of motor powered vessels in 1905 (Carter 1962). Fishing activity was occurring around the NWHI at least as early as 1913, when one commentator recorded: "Fishing for *ulua* and *kāhala* is most popular, using *bonito* for bait, fishermen seek this [sic] species in a 500 mile range toward Tori-Jima [NWHI]" (Japanese Consulate 1913, as cited in Yamamoto 1970:107). Within a few years more than a dozen sampans were fishing for bottomfish around the NWHI (Anon. 1924; 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 1930s, 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). In addition to catching bottomfish, the sampans harvested lobster, reef fish, turtles and other marine animals (Iversen et al. 1990).

During World War II the bottomfish fishery in Hawaii virtually ceased operations, but it recommenced shortly after the war ended (Haight et al. 1993b). 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. During the 1960s, only one or two vessels were operating around the NWHI.

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. 1993b). The entry of several modern boats into the NWHI fishery and the resultant expanding supply of high-valued bottomfish such as *ōpakapaka* and *onaga* made

possible the expansion of the tourism-linked restaurant market by allowing a regular and consistent supply of relatively fresh fish (Pooley 1993a). 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 non-full time vessels also engaged in the pelagic or lobster fisheries (Iversen et al. 1990). In 1989, the Council developed regulations that divided the fishing grounds of the NWHI bottomfish fishery into the Ho'omalau Zone and Mau Zone. Limited access programs were established for the Ho'omalau Zone and Mau Zone in 1988 and 1999, respectively, to avoid economic overfishing (Pooley 1993b; WPRFMC 1998b).

The 1970s 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 the result of 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 as 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 fish bottomfish successfully was reduced and the labor associated with hauling up the long lines was considerably lightened.

During the early 1980s, with the development of a much larger market for bottomfish, bottomfish fishermen fishing around the main Hawaiian Islands were able to obtain premium prices for their catches, and thus were motivated to increase their landings (Pooley 1993a). However, the number of vessels participating in the MHI fishery declined after reaching a peak of 583 in 1985. The 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 areas of Penguin Bank within the EEZ¹². In addition, new state rules established a recreational bag limit of five *onaga* or *ehu*, or a mix of both, per person.

Hawaii's sportfishing charter boat fleet began to develop during the early 1950s as Hawaii became an increasingly popular tourist destination (Markrich 1994). What started as a few charter boats operating out of harbors such as Kewalo Basin and Kona has evolved into a highly competitive industry involving nearly 200 vessels state-wide (Hamilton 1998; Walker 1996). The charter boat fleet mainly targets pelagic game fish such as billfish and tuna. However, a few

¹²The State of Hawaii claims the authority to manage and control the marine, seabed and other resources within "archipelagic waters." These archipelagic waters encompass a number of bottomfish fishing grounds, such as parts of Penguin Bank, that lie inside the EEZ. An October 24, 1997 memorandum from NOAA/General Counsel Southwest Region to the Council Chairman declared that, despite any contentions by the State of Hawaii to the contrary, for purposes of federal fishery management, state waters do not extend beyond three miles from the coast.

charter boats take bottomfish fishing trips if patrons are interested (Hamilton 1998). Most of the charter boats engaged in bottomfish fishing are based on the islands of Maui and Kauai.

Fishing Methods and Current Use Patterns

The basic design of the handline gear used in Hawaii's bottomfish fisheries has remained essentially unchanged from gear used by early Native Hawaiians (Haight et al. 1993b). The gear consists of a main line with a 2-4 kg weight attached to the terminus. Several 40-60 cm sidelines with circle hooks are attached above the weight at 0.5-1 m intervals. A chum bag containing chopped fish or squid may be suspended above the highest of these hooks. The gear is pulled after several fish are hooked.

Circle hooks used in the bottomfish fishery are flat by design. "Kirbed" hooks (bent or offset to the side) are also available but are not generally used. The flat circle hooks are designed to be self-setting and work well for fish that engulf the bait and move off with it in their mouth. As a fish moves off with the baited hook, the line will trail out of the corner of the fish's mouth. The hook will be drawn into the corner of the mouth where the motion of the fish in relation to the pull of the line will rotate the hook through the corner of the jaw. Circle hooks, unlike "J" type hooks, are generally not effective for fish that pick at the bait or mouth the bait and spit it out (Kawamoto pers. comm.).

Fishermen use the circle hook for its self-setting ability and for its curved design with its long inward pointing hook point that makes it difficult for the fish to rid itself of the hook once it is embedded. The circle hook shank is typically thicker and round in cross section (unlike the thinner straight J type hooks), which tends to minimize ripping or wearing a hole in the fish's jaw. An additional characteristic of the circle hook design that appeals to fishermen is that it's less prone to snagging on rocky or hard substrate bottoms and very difficult to snag flat or smooth surfaces. This characteristic minimizes the loss of gear (Kawamoto pers. comm.).

All bottomfish fishermen in Hawai target the same assemblage of bottomfish species. The ability to target particular species varies widely depending on the skill of each captain. Electronic navigation and fish-finding equipment greatly aid fishermen in returning to a particular fishing spot and catching desired species with little incidental catch (Haight et al. 1993). According to Hau (1984), *ōpakapaka* is one of the primary target species due to the relatively high price it commands as a result of its constant demand at the fish auction. *Hāpuupuū* and white *ulua* are sought because of their sturdiness and ability to retain good flesh quality. In addition, white *ulua* can be caught in rough sea conditions when other species are difficult to capture. *Kāhala* are one of the least valuable bottomfish because large specimens have a reputation for carrying ciguatera toxin.

MHI Bottomfish Fishery and Participation

In the small boat fishery around the MHI the distinction between "recreational" and "commercial" fishermen is extremely tenuous (Pooley 1993a). A state-wide survey of small boat fishermen conducted in 1995-96 indicated that of the 42 fishermen interviewed who predominately use bottomfish fishing gear, 80 percent sell a portion of their catch (WPRFMC

1998b). However, most of those selling fish are just trying to cover fishing trip expenses and do not expect a profit from their operation.

The number of fishermen engaged in bottomfish fishing in the MHI increased dramatically in the 1970s and 1980s but then declined in the early-1990s, rebounded somewhat in the late 1990s, but in 2002 reached its lowest level since 1977 (Figure 6). The decline in vessels and fishing effort may be due to the long-term decrease in catch rates in the bottomfish fishery and a shift of fishing effort towards tuna and other pelagic species

The individuals participating in the MHI fishery who make trips longer than 24 hrs are mostly full-time commercial fishermen. They typically operate larger boats than the part-time commercial/recreational fishermen and are able to fish during rough weather and venture further from port to fish less-exploited areas off Kauaī, Niīhau and east Maui that are less accessible to the small boat fishermen.

The majority of participants in the MHI fishery shift from species group to species group and from the bottomfish fishery to other fisheries, primarily the pelagics fishery, in response to seasonal fish abundance or fluctuations in price. Except for those individuals who fish commercially on a full-time basis, most fishermen usually fish for bottomfish no more than 60 days a year (WPRFMC 1998b).

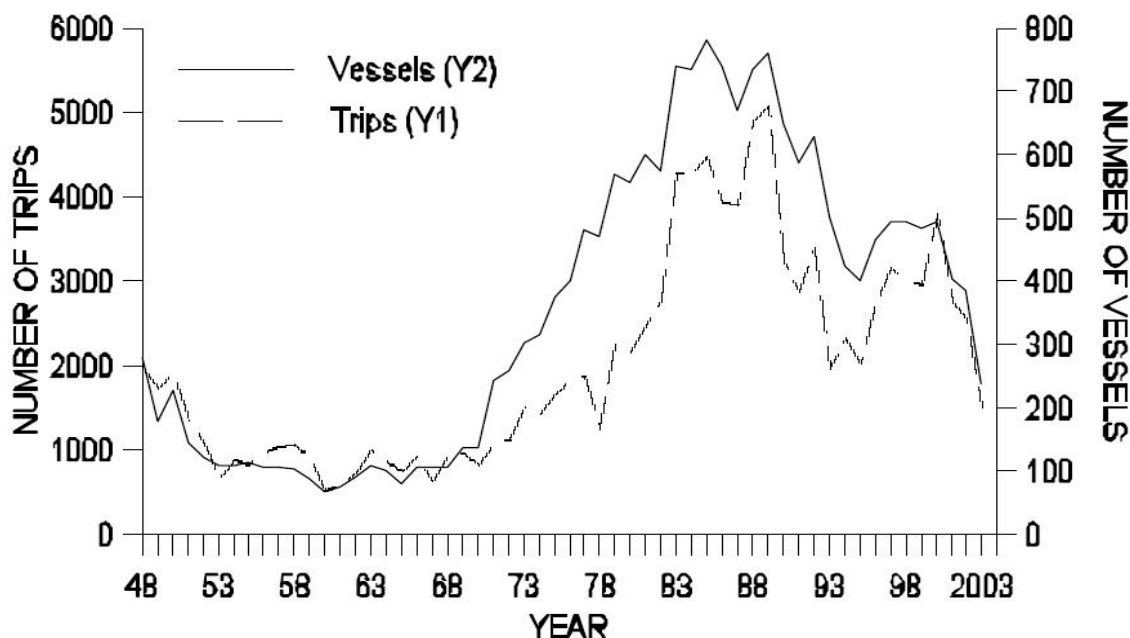


Figure 6: MHI Bottomfish Fishery Participation and Effort
(Source: WPRFMC 2004)

Seasonal price variability causes part-time commercial fishermen to concentrate their bottomfish fishing effort during December, when they can take advantage of the year-end holiday demand

for red snappers. Pelagic species are often an important secondary target during bottomfish fishing trips regardless of the season.

Data from various surveys indicate that the importance of the MHI fishery varies significantly among fishermen of different islands. According to a 1987 survey of boat fishing club members, bottomfish represented roughly 13% of the catch of Hawaii fishermen, 25% of the catch of Oahu and Kauai fishermen and 75% of the catch of Maui fishermen (Meyer Resources 1987). A survey of licensed commercial fishermen conducted about the same time indicated that the percentage of respondents who used bottomfish fishing methods was 25% on Hawaii, 28% on Kauai, 29% on Oahu, 33% on Lānai, 50% on Molokai and 51% on Maui (Harman and Katekaru 1988). Presumably, the differences among islands relate to the proximity of productive bottomfish fishing grounds.

Favored grounds in the MHI include banks off Molokai, Maui, Lānai and Kauai. These grounds account for more than about two-thirds of the bottomfish harvested in the MHI. Specific bottomfish fishing locales favored by fishermen vary seasonally according to sea conditions and the availability and price of target species. Historically, Penguin Bank is one of the most important bottomfish fishing grounds in the MHI, as it is the most extensive shallow shelf area in the MHI and within easy reach of major population centers. Penguin Bank is particularly important for the MHI catch of *uku*, one of the few bottomfish species available in substantial quantities to Hawaii consumers during summer months. Penguin Bank is frequented mostly by bottomfish fishermen residing on Oahu, while Middle Bank is especially popular among fishermen living on Oahu and Kauai. The Maui-Lānai-Molokai complex is frequented mostly by bottomfish fishermen residing on Maui, Molokai and Oahu.

NWHI Bottomfish Fishery and Participation

In contrast to the MHI fishery, bottomfish fishing in the NWHI is conducted solely by part-time and full-time commercial fishermen. The vessels venturing into the NWHI tend to be larger than those fishing around the MHI, as the distance to fishing grounds is greater (Haight et al. 1993b). As the number of vessels participating in the NWHI fishery increased during the 1980s, the fleet characteristics of the fishery became more diverse. Pooley and Kawamoto (1990) divided the fleet into three groups based on size and mode of propulsion: motor sailers, medium-sized powered vessels and large-sized powered vessels. The motor sailers are 46 to 66 ft long and are more streamlined in hull design than the standard powered vessels. The sail can be used to save on fuel costs, but it also limits the hold capacity compared with powered vessels of similar length. The powered vessels generally share one characteristic: a large working area on the back deck. The medium-sized powered vessels are 42 to 49 ft long. Because their smaller size limits fishing range and hold capacity, they usually operate in the lower (southeastern) end of the NWHI (Mau Zone) or in the MHI. The larger powered vessels are 47 to 64 ft long. With an average fuel capacity of 1,500 gallons, the vessels have a maximum range (round-trip) of 1,800 miles. The average maximum hold capacity is 4,000 pounds.

Many of the boats that fish in the Mau Zone switch to different fisheries and move to other fishing grounds during the year. The majority of vessels fish in the Mau Zone during a season

that generally extends from November to April. Figure 7 provides the trend in number of bottomfish vessels operating in the NWHI since 1984.

A 1993 survey of participants in the NWHI fishery found that vessels fishing in the Mau Zone made an average of 12.7 trips to the area to target bottomfish and 3.4 trips to target pelagic fish or a mixture of pelagic species and bottomfish (Hamilton 1994). In addition, during that year an average of 5.6 trips were made by these vessels to bottomfish fishing grounds around the MHI. Although bottomfish fishing in the Mau Zone is not the only activity of these boats, it may be vital to the year-round operations of some fishermen.

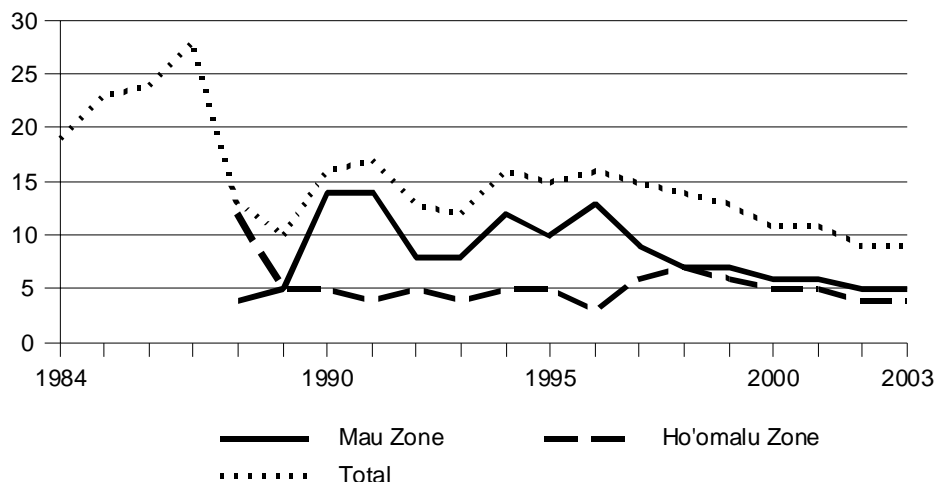


Figure 7: NWHI Bottomfish Fishery Participation (# of vessels)

The fishing strategies and catch levels of vessels fishing in the Ho'omalulu Zone tend to be fairly uniform (Pan 1994). The 1993 survey referred to above found that all boats fishing in the Ho'omalulu Zone were engaged exclusively in commercial bottomfish fishing (Hamilton 1994). They averaged 9 trips per year to the zone, and the average trip length was about three weeks.

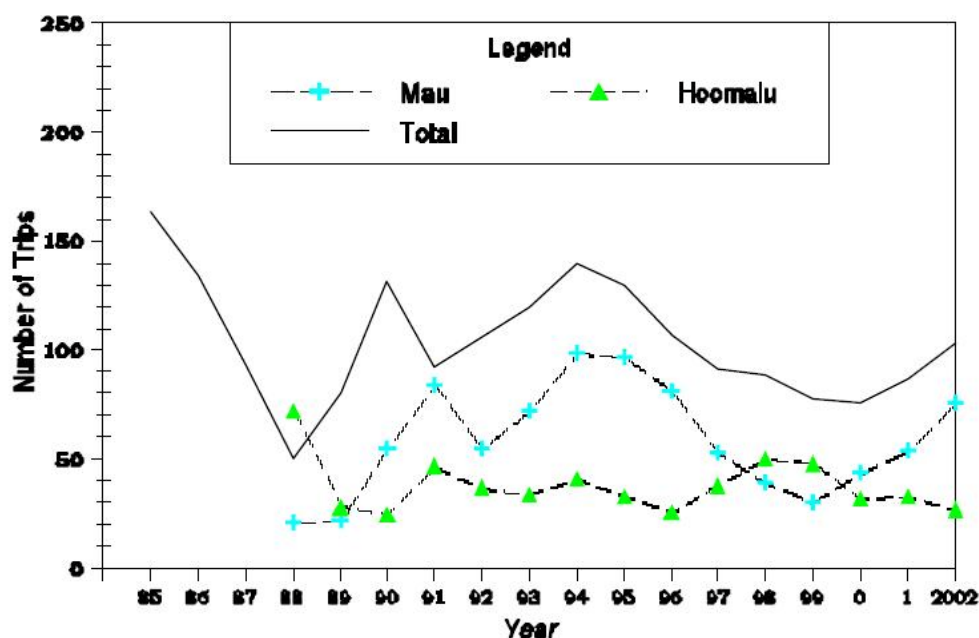


Figure 8: Trend in Number of Trips/year for NWHI Bottomfish Fishery Permit Holders
(source: WPFMC 2004)

Popular fishing grounds in the Mau Zone include the waters around Nihoa Island and Necker Island (Table 16). Especially productive fishing areas in the Hoomalū Zone are Brooks Bank, Laysan Island and Gardner Pinnacles.

Table 16: Approximate Percentage of Total Catch in NWHI Bottomfish Fishery from Selected Areas Based on Historical Fishing Data

AREA	PERCENT OF TOTAL CATCH
Nihoa Island and Twin Banks	16.6
Brooks Bank and St. Rogatien Bank	14.2
Laysan Island	13.6
Necker Island	13
Gardner Pinnacles	12.9
Lisianski Island	6.8
French Frigate Shoals	5.6
Kure Atoll	4.4
Maro Reef	4.2
Pioneer Bank	4
Raita Bank	2.6

AREA	PERCENT OF TOTAL CATCH
Pearl and Hermes Reef	2.1
Midway Atoll	0

Note: Percentages from NMFS landings data for 1997-1999.

Source: M. Mitsuyasu pers. comm. 2000. WPRFMC

Harvest of BMUS

Only commercial landings data are available for the MHI fishery because the State of Hawaii does not require a saltwater recreational fishing license and there are no state or federal reporting requirements for recreational fishing in the waters around Hawaii. It is estimated that the recreational/subsistence catch in the MHI bottomfish fishery is about equal to the commercial catch (WPRFMC 1999). Charter boat operators are considered to be commercial fishermen under Hawaii statute and therefore are required to submit monthly catch reports. Consequently, charter boat catches are included in estimates of commercial landings.

Based on recent (1998-2003) harvest data, commercial bottomfish catches in the MHI fishery represent approximately 60 percent of the total commercial bottomfish harvest in Hawaii (WPRFMC 2004). The annual bottomfish harvest in the MHI has been fairly stable for the past 10 years (Figure 9).

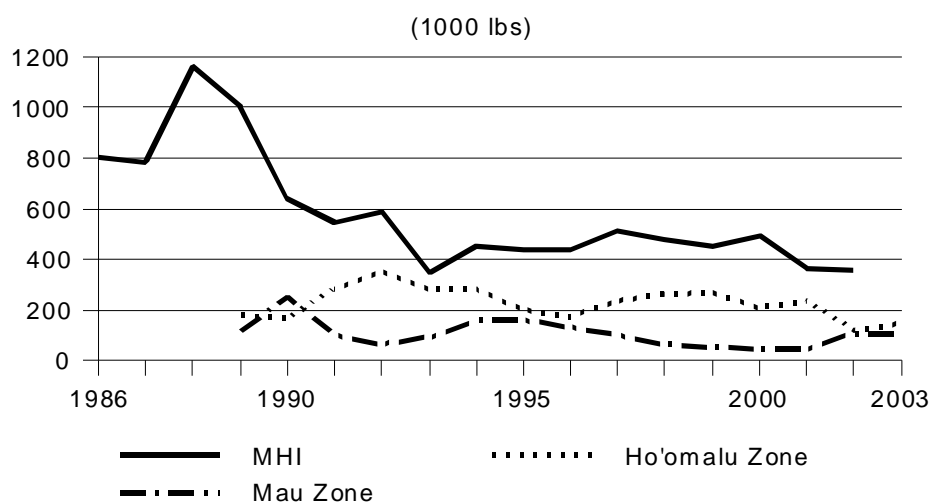


Figure 9: Trends in MHI and NWHI Bottomfish Landings
(Source: WPFMC 2004)

MHI bottomfish landings peaked in 1987 and then declined to relatively stable levels since. Much of this decline was caused by reductions in fishing participation (vessels and trips) due to limited entry and to a weak market for fresh bottomfish since the 1990s. In 2003, landings continued to decline, by 5% from the previous year.

However, the catch per unit effort (CPUE, in pounds landed per trip) in the MHI fishery shows a long-term decreasing trend, with current values approximately 25% that of the first recorded estimates (Table 17). MHI CPUE values decreased in 2002 by about 8% from the 2001 level, but remained above the 1996-1998 values, which were the lowest on record. The 1999 increase in MHI CPUE was due primarily to a large increase in *uku*, and to a lesser degree *onaga*, catches and catch rates. This relative peak in CPUE is similar to that of the late 1980s, which was due to increased *uku* catch rates alone, and may not indicate an increase in abundance of other species in either case. Rapid decreases in CPUE from the 1989-90 *uku*-derived peaks appear to be a return to the prevailing slow decline (WPRFMC 2004b).

Bottomfish landings from the Mau Zone has increased over recent years to over 100,000 lbs in 2002 while the number of trips increased by 38% (Figure 8; Table 17). The Mau Zone 2002 average landings per trip increased by about 500 lbs (Table 17) or 54% over 2001. Most of the major BMUS landings increased substantially, with only *ehu* and *butaguchi* landings categories decreasing (WPRFMC 2004b). Trip lengths varied by vessel and trip strategy/target. Most of the trips incorporated some trolling activity. The Ho'omalau Zone 2002 bottomfish landings per trip fell by 19%, as one highliner vessel dropped out of the fleet (Table 18). Up until 2002 the Ho'omalau Zone fleet had very stable participation and landings for the last 7-8 years (Figure 7: Table 18).

In the Mau Zone, trip CPUE dropped 14 percent from 1999 values to about 42 percent of early values. On a catch-per-day basis¹³, the 2000 Mau Zone CPUE dropped 23 percent to 61 percent of earliest values. Declines in CPUE for this zone may be largely due to the departure of highliners and greater concentration on other fishing methods, e.g., trolling, by participants. Ho'omalau Zone CPUE trends have remained stable in recent years (Table 18).

Table 17: Historical Annual Statistics for Mau Zone Bottomfish Fishery
(Source: WPRFMC 2004b)

Year	Total Landings (lbs)	CPUE (lbs/trip)	Inflation Adjusted Revenue	Price per Pound	Number of Vessels
1986	NA	2206	NA	NA	NA
1987	NA	2889	NA	NA	NA
1988	NA	2136	NA	NA	4
1989	118000	4463	\$443,680	\$3.76	5
1990	249000	3435	\$836,640	\$3.36	14
1991	103000	1199	\$372,860	\$3.62	14

¹³Data collected by HDAR and used for the MHI CPUE estimates do not include trip length. The NWHI bottomfish trip logs collected by NMFS include trip length, and this provides a more standardized measure of CPUE.

Year	Total Landings (lbs)	CPUE (lbs/trip)	Inflation Adjusted Revenue	Price per Pound	Number of Vessels
1992	71000	1273	\$248,500	\$3.50	8
1993	98000	1321	\$306,740	\$3.13	8
1994	160000	1573	\$537,600	\$3.36	12
1995	166000	1635	\$509,620	\$3.07	10
1996	135000	1543	\$449,550	\$3.33	13
1997	105000	1976	\$384,300	\$3.66	9
1998	66000	1689	\$196,680	\$2.98	7
1999	54000	1808	\$182,520	\$3.38	7
2000	49000	1053	\$173,460	\$3.54	6
2001	50000	916	\$144,500	\$2.89	6
2002	108000	1416	\$342,360	\$3.17	5
2003	77000	2070	\$222,530	\$2.89	5
Ave.	107267	1922	\$356,769	\$3.31	8
s.d.	53957	894	\$183,346	\$0.28	3

Table 18: Historical Annual Statistics for Ho’omalū Zone Bottomfish Fishery

Year	Total Landings (lbs)	CPUE (lbs/trip)	Inflation Adjusted Revenue	Price per Pound	Number of Vessels
1986	NA	5301	NA	NA	NA
1987	NA	8187	NA	NA	NA
1988	NA	4702	NA	NA	12
1989	184000	5481	\$631,120	\$3.43	5
1990	173000	5403	\$576,090	\$3.33	5
1991	283000	5871	\$914,090	\$3.23	4
1992	353000	9464	\$1,221,380	\$3.46	5
1993	287000	8412	\$984,410	\$3.43	4

Year	Total Landings (lbs)	CPUE (lbs/trip)	Inflation Adjusted Revenue	Price per Pound	Number of Vessels
1994	283000	6903	\$996,160	\$3.52	5
1995	202000	6130	\$650,440	\$3.22	5
1996	176000	6216	\$621,280	\$3.53	3
1997	241000	6351	\$802,530	\$3.33	6
1998	266000	5315	\$837,900	\$3.15	7
1999	269000	5611	\$989,920	\$3.68	6
2000	213000	5909	\$832,830	\$3.91	5
2001	236000	5757	\$769,360	\$3.26	5
2002	120000	4638	\$433,200	\$3.61	4
2003	145000	3713	\$494,450	\$3.41	4
Ave.	228733	6076	\$783,677	\$3.43	5
s.d.	63033	1416	\$217,036	\$0.20	2

Bycatch: The NWHI bottomfish fishery is strictly a commercial fishery in the NWHI, while the MHI bottomfish fishery is a mixed commercial, recreational and subsistence fishery. Although these fisheries use the same gear and operational methods, the motivation of the fishermen is different between the commercial operators and recreational or subsistence fishermen. This results in different bycatch characteristics. The NWHI commercial fishermen seek the highest economic return on their catch and therefore may discard lower valued species, especially early in a trip, thereby conserving both ice and hold space. Recreational or subsistence fishermen, on the other hand, are more inclined to retain a greater variety of species for home consumption or distribution to relatives and friends. For this reason, the bycatch of the NWHI commercial fleet is likely larger than that of the MHI fishery. In addition, because Hawaii has no permit, logbook, or catch reporting system for non-commercial marine fishermen, there are no data on bycatch by this sector. Data on bycatch in the NWHI commercial fishery is available from the logbook program, from limited observer data, and from NMFS research cruises in the NWHI.

Bottomfish gear types and fishing strategies are highly selective for desired species and sizes. Measures that serve to further reduce bycatch in the bottomfish fishery include prohibitions on the use of bottom trawls, bottom gillnets, explosives and poisons.

Logbook data (State of Hawaii), and observer programs conducted by NMFS indicate that total discards (including damaged target species) account for approximately 8 to 23% of the total catch in bottomfish fisheries in the Hawaiian archipelago (Nitta 1999, WPRFMC 1998a). Carangids, sharks, and miscellaneous reef fish (pufferfish, moray eels, etc.) are the most

numerous discard species. Two species in particular, kāhala (*Seriola dumerili*) and butaguchi (*Pseudocaranx dentex*), make up the majority of the bycatch. Most species are not kept by vessels because of their unpalatability, however some carangids (large jacks and amberjacks) are also discarded because of concerns of ciguatera poisoning¹⁴. Butaguchi, which commands a low price in the Hawaii market, may be discarded in the early days of a fishing trip to avoid reducing vessel hold space for more valuable bottomfish and because this species has a poor on-board “shelf-life.” The major discard species in the NWHI bottomfish fishery are given in Table 19. It should be noted that a large percentage of the snappers and the grouper listed there are included as bycatch because of damage from sharks.

In bottomfish fishing operations the largest proportion of lost fish and gear is attributable to interactions with sharks (Nitta 1999). Some fishing areas are so plagued with sharks that a majority of hooked fish are either stolen or damaged. The estimated economic losses experienced by fishermen as a result of shark interference with fishing operations are substantial (Kobayashi and Kawamoto 1995). In the NWHI the gray reef shark (*Carcharhinus amblyrhynchos*) is the worst offender. When shark interactions become a problem, some fishermen will attempt to kill sharks by catching and/or shooting them. During the late 1990s, an increase in the market demand for shark fins resulted in some bottomfish vessels “finning”¹⁵ the sharks that were killed. In 2000 however, both the State of Hawaiʻi and the federal government implemented legislation that required the entire shark carcass to be landed along with the fins (HRS § 188.40.5 and CFR 600.1023, respectively). This legislation has curtailed shark-finning in the bottomfish fishery. Limitations in hold space and limited marketability preclude most bottomfish vessels from retaining shark carcasses.

Table 19: Discards from Bottomfish Fishing Trips with NMFS Observers, 1990-1993

SPECIES	TOTAL NO. CAUGHT	TOTAL NO. DISCARDED	TOTAL % DISCARDED
Kāhala	2438	2266	92.9
Kalekale (yellowtail)	40	22	55
Sharks	176	92	52.3
Misc. fish	115	59	51.3
Ulua (white)	127	62	48.8

¹⁴Ciguatera fish poisoning results from eating a fish containing a neurological toxin produced by a microscopic dinoflagellate algae. The algae grow epiphytically on benthic macroalgae (seaweeds) and are ingested by herbivorous fish which in turn are eaten by larger carnivorous fish, with each step concentrating the toxin. In humans, ciguatera poisoning may cause severe illness or even death.

¹⁵“Finning” is the practice of removing the fins from a shark and discarding the remainder of the carcass at sea.

SPECIES	TOTAL NO. CAUGHT	TOTAL NO. DISCARDED	TOTAL % DISCARDED
Misc. snapper/jack	189	91	48.1
Butaguchi	3430	1624	47.3
Ulua (black)	23	10	43.5
Taape	110	40	36.4
Misc. fish unidentified	174	26	14.9
Kalekale	874	52	6
ōpakapaka	5092	107	2.1
Ehu	1185	20	1.7
Uku	2209	28	1.3
Hāpuupuu	1593	19	1.2
Gindai	459	3	0.7
Onaga	1141	8	0.7
Alfonsin	1	0	0
Armorhead	1	0	0
Lehi	3	0	0

Source: Nitta 1999

Data collected by NMFS during research bottomfish fishing cruises indicate the potential species composition of bycatch in the NWHI bottomfish fishery (Figure 10). Research bottomfish fishing is less likely to exclusively successfully target commercial species, however, Figure 10 indicates other species that may be caught in association with bottomfish fishing operations.

The most recent data available (WPRFMC 2004b) reinforce the trends described above, including the differences in strategy between Mau and Ho'omalū Zone operations. In both zones in 2002, 100% of the sharks and kāhala were discarded. In the Mau Zone, butaguchi was frequently discarded in 2002 (22%), unlike in 2001 when only 1% was discarded. The only other significant discard was ōmilu (*Caranx melampygus*) at 9%, down from 38% in 2001.

In the Ho'omalū Zone, several lesser valued species were commonly discarded, including kalekale (48% in 2002, 24% in 2001), butaguchi (20% in 2002, 32% in 2001) and white ulua (*C. ignobilis*) (63% in 2002, 70% in 2001).

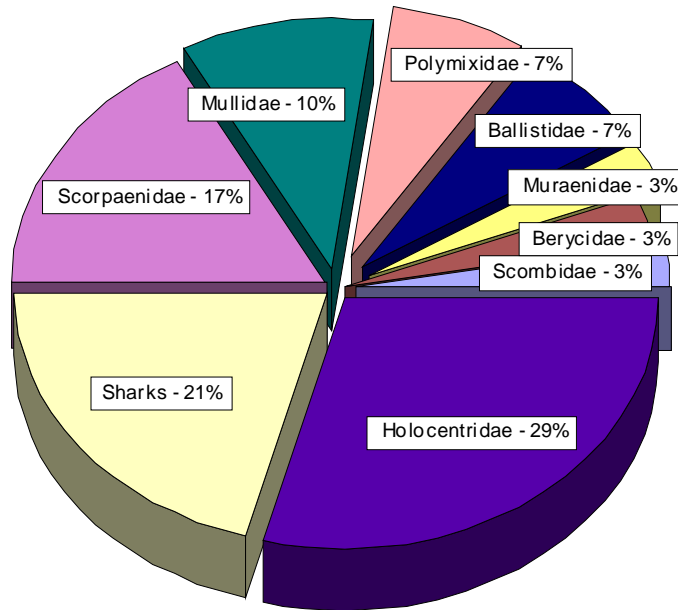


Figure 10: NMFS Research Cruise Estimates of Composition of Bottomfish Bycatch in Hawaii

(Percent of total number; Source: WPRFMC 1998a)

Economic Performance

MHI : Inflation-adjusted gross revenue in the MHI bottomfish fishery grew steadily in the 1980s as a result of increases in both real prices and landings (WPRFMC 2003). However, between 1988 and 1993, revenue in the MHI fishery decreased sharply as both MHI bottomfish prices and landings declined. In the late 1990s, the prices appeared to converge, perhaps due to the softness of the upscale part of the Hawaii market as the state's economic recession continued (WPRFMC 1999). In recent (1995-2000) years, the annual ex-vessel value of bottomfish landings in the MHI fishery has averaged about \$1.7M.

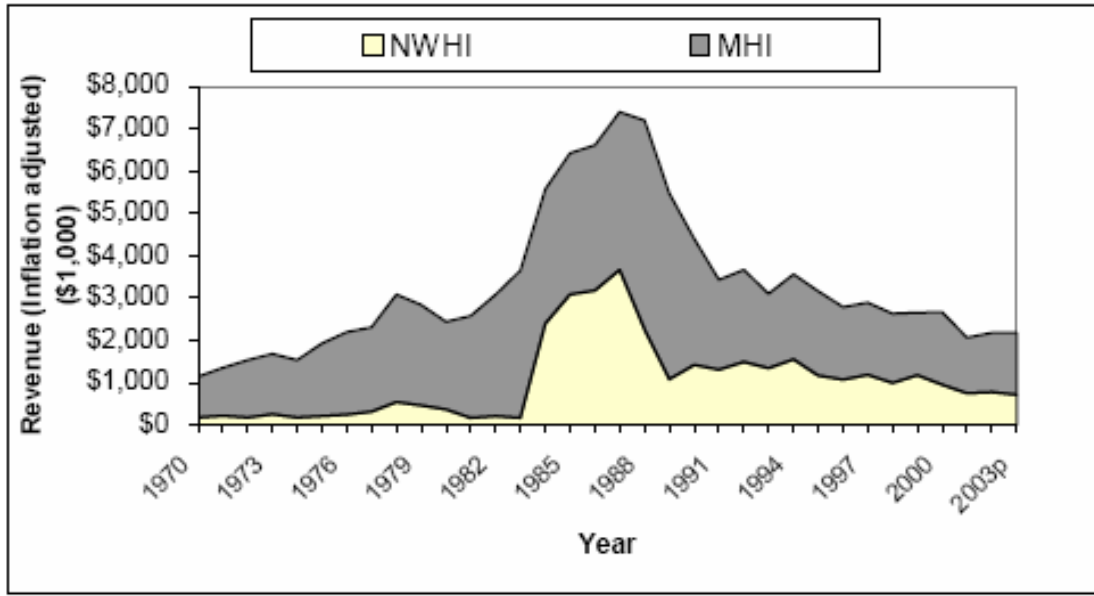


Figure 11: Hawaii Bottomfish Landings Revenue (inflation adjusted) by Area
(Source: WPFMC 2004)

As shown in Figure 7-22 the inflation-adjusted gross revenue in the NWHI fishery grew dramatically in the mid-1980s and then declined as landings fell. Inflation-adjusted revenue in 2002 was only 20% of the 1987 peak. In recent years, the annual ex-vessel value of bottomfish landings in the NWHI fishery has averaged about \$1,000,000.

Historically, bottomfish caught in the main Hawaiian Islands tended to have higher aggregate prices, reflecting both species composition and greater freshness. However, the MHI price declined in general in 1990s, while NWHI price was relatively steady during the same period. This relative lowering of the MHI bottomfish prices may have reflected the softness of the upscale part of the Hawaii market. As a result, it brought the prices of the two areas to a similar range in 1999, and slightly converge in 2000 as NWHI price was \$3.76 and MHI was \$3.75. In 2001, the prices from both areas drops, but to a greater degree for bottomfish caught in the Northwestern Hawaiian Islands. In 2002, the prices from both areas increased slightly, but in a greater degree for the MHI price. In 2003, the MHI price continued the increase trend from 2002, while the MWHI price fell slightly. As a result, the MHI price was higher substantially, \$1.22 per pound, than NWHI in 2003.

Onaga and opakapaka comprise the largest valued landings in each area for most years (ignoring the highly fluctuating landings of uku); NWHI ex-vessel prices were \$4.53 and \$4.79 per pound respectively in 2003 while MHI were \$5.89 and \$5.01, respectively (Figure 12). However, the NWHI landings are comprised of a higher percentage of these higher priced species compared to the MHI, so the difference in price for individual species by area is ironed out by the different species compositions between the two areas.

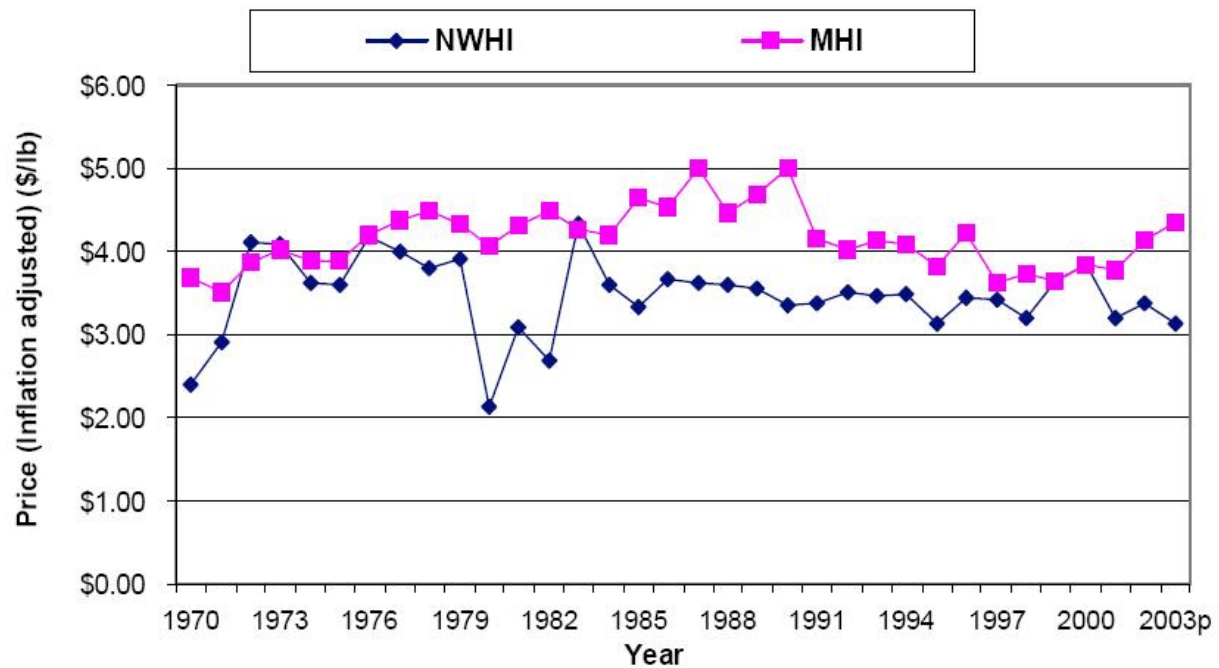


Figure 12: Average Price/lb for Hawaii Caught BMUS
(Source: WPFMC 2004)

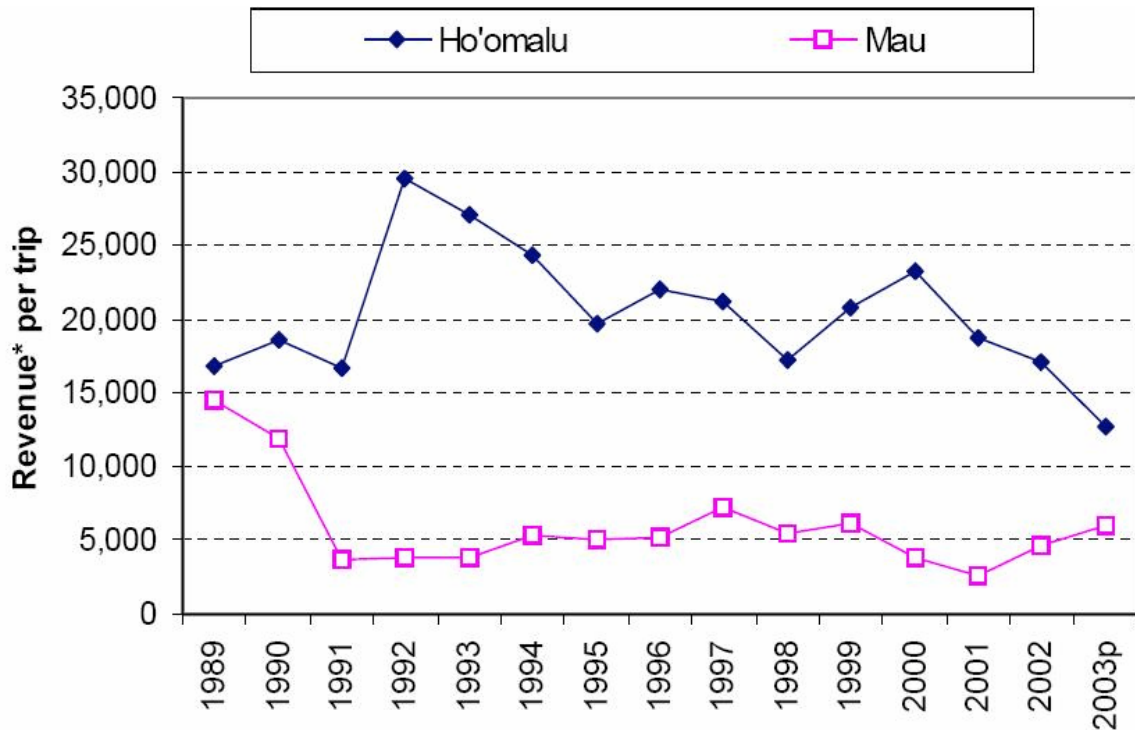


Figure 13: Mau Zone and Ho'omalau Zone Average Revenues Per Trip
(Source: WPFMC 2004)

Independent, owner-operator fishing operations prevail in both zones of the NWHI bottomfish fishery. In 1988, a limited access program was established for the Ho'omalū Zone, the primary motivation for which was avoidance of economic overfishing (Pooley 1993b). When the limited access program provisions began to take effect in 1989-91, the revenue per trip for Ho'omalū Zone vessels rose dramatically (Figure 12);. Since that time the revenue per trip in the Ho'omalū Zone has consistently been higher than that of the Mau Zone.

The two trends in inflation-adjusted revenue per trip show the distinct difference between Ho'omalū and Mau zone operations. When the limited entry provisions began to take effect in the Ho'omalū zone in 1989-91, revenue rose dramatically but has subsequently declined to slightly more than its average for the period. Revenue (inflation-adjusted) in the Mau Zone initially fell (as the limited entry vessels could no longer fish in the Mau zone, only smaller boats remained in the Mau zone). After that initial drop, however, revenue per trip in the Mau Zone rose for several years, but has subsequently declined from 1997 to 2001. Revenue per trip in Mau Zone rose again in 2002 and 2003, while it declined in Ho'omalū Zone. The limited entry program, which was implemented in the Mau Zone in 2001, may have improved the economic performance for the vessels that have a permit to fish in the Mau Zone.

Estimates of annual net revenue for vessels operating in the Mau Zone and Ho'omalū Zone were first presented in a 1993 cost-earnings profile of the NWHI bottomfish fishery (Hamilton 1994). The study revealed that on average Ho'omalū Zone vessels realized a positive economic return of \$2,238 per vessel in 1993 while Mau Zone vessels averaged an economic loss of \$21,947 per vessel. The principal factor explaining the disparity in the economic performance of vessels operating in the two zones was the difference in catch rates (Pan 1994). In comparison to boats fishing in the Mau Zone, boats operating in the Ho'omalū Zone caught more fish per fishing day and more of their catch consisted of high-valued bottomfish such as *onaga* and *ōpakapaka*.

Since 1993 however, the revenues of Ho'omalū Zone vessels have shown a downward trend due to decreasing catch rates for some species, particularly the high-priced *ōpakapaka* (Figure 13). As a result of this decrease in revenues, in recent years the average vessel fishing in the Ho'omalū Zone has failed to cover its total annual economic costs through bottomfish fishing (WPRFMC 2003). In 2000, Ho'omalū vessels averaged an economic loss of \$38,047 per vessel (Table 20). The average vessel earned a positive return on operations, and presumably vessel owners derive sufficient income from other economic activities to cover fixed costs.

Table 20: Average Income Statement for Vessels Fishing in the Mau Zone and Hoomalu Zone, 2000

(Source: WPRFMC 2003)

CATEGORY	MAU ZONE VESSELS	HO'OMALU ZONE VESSELS
Revenue	\$38,639	\$148,522
Fixed Costs:		
Capital	\$4,093	\$18,056
Annual Repair	\$4,840	\$12,694
Vessel Insurance	\$2,833	\$31,516
Administrative	\$1,535	\$7,441
Other	\$0	\$1,970
Total	\$13,301	\$71,678
Operating Costs:		
Fuel and Oil	\$4,158	\$9,958
Ice	\$1,094	\$2,298
Bait	\$1,641	\$5,253
Handling	\$3,900	\$14,900
Provisions	\$1,751	\$7,113
Gear and Supplies	\$2,407	\$8,426
Other (trip basis)	\$3,283	\$10,943
Crew's Income	\$6,100	\$35,000
Captain's Income	\$8,800	\$21,000
Total	\$33,134	\$114,892
Net on Operations	\$5,505	\$33,631
Total Cost	\$46,435	\$186,569
Net Revenue	- \$7,796	- \$38,047

Updated cost-earnings data for vessels operating in the Mau Zone indicate that the net economic returns to the average boat is still negative (Table 20). The poor economic performance of a substantial number of Mau Zone vessels has resulted in a considerable turnover pattern of entry and exit (Hamilton 1994). Between 1989 and 1997, over 15 vessels entered and left the fishery. Because access to the Mau Zone was unrestricted, economic failure of vessels in the fishery did

not reduce fishing effort to more appropriate levels (WPRFMC 1998b). Bankrupt vessels were sometimes bought for a fraction of their initial capital cost and returned to the Mau Zone with new owners who believed that reduced capital servicing obligations would give them a competitive edge over other fishermen. In addition, vessels displaced from overfished U.S. mainland fisheries arrived in Hawaii at a steady rate on a “look-see” basis. These owners and captains were largely unaware of the economic performance of those vessels already fishing in the Mau Zone.

In 1999, a limited access program was established for the Mau Zone to support long-term productivity of bottomfish resources in the zone and to improve the economic stability of the fishery (WPRFMC 1998b). The limited access program is intended to decrease the large reserve of potential effort that could threaten the resources and allow attrition due to market forces and freedom of choice to reduce the Mau Zone fleet to more economically rational levels.

Markets

A market for locally caught bottomfish was well-established in Hawaii by the late nineteenth century. Today, fresh bottomfish continues to be an important seafood for Hawaii residents and visitors. Nearly all bottomfish caught in the NWHI fishery are sold through the Honolulu fish auction (United Fishing Agency, Ltd.). Prices received at the auction change daily, and the value of a particular catch may even depend on the order in which it is placed on the floor for bidding (Hau 1984). Bottomfish caught in the MHI fishery are sold in a wide variety of market outlets (Haight et al. 1993b). Some are marketed through the fish auction in Honolulu and intermediary buyers on all islands. Sales of MHI bottomfish also occur through less formal market channels. For example, local restaurants, hotels, grocery stores and individual consumers are important buyers for some fishermen. In addition to being sold, MHI bottomfish are consumed by fishermen and their families, given to friends and relatives as gifts, and bartered in exchange for various goods and services.

Historically, the demand for bottomfish in Hawaii has been largely limited to fresh fish. Seventy years ago Hamamoto (1928) remarked on the fact that fish dealers in Honolulu refused to buy fish that had been harvested in the NWHI and frozen on-board because the demand for this product was so low. In the last few years the price differential between frozen and fresh product has narrowed for some species of bottomfish, but it remains substantial for *onaga* and *ehu*, the two highest priced fish. Until the market for frozen bottomfish develops, participants in the NWHI fishery will be caught in the same on-going dilemma – they must stay out long enough to cover trip expenses, but keep the trips short enough to deliver a readily saleable, high-quality product (Pan 1994). In the past, bottomfish catches from the MHI have tended to command higher aggregate prices than those caught in the NWHI, reflecting a larger proportion of preferred species and greater freshness. Bottomfish caught around the MHI are iced for only one to two days before being landed, whereas NWHI fresh catches may be packed in ice for ten days or more. By the late 1990s, however, the prices appeared to converge, perhaps due to the softness of the upscale part of the Hawaii market as the state’s economic recession continued (WPRFMC 1999).

Catches of bottomfish around the MHI typically consist of plate-sized fish preferred by household consumers in Hawaii and by restaurants where fish are often served with the head on. Bottomfish caught around the NWHI tend to be the medium to large fish (over 5 pounds) preferred for the restaurant fillet market. Because the percent yield of edible material is high, handling costs per unit weight are lower and more uniform portions can be cut from the larger fish.

According to U.S. Customs data for the Port of Honolulu, 801,000 pounds of snapper were imported in 2003 worth \$2.26 million (\$2.82 per pound). This amounts exceeded domestic supply and thus was a significant factor in ex-vessel prices. Tonga and Australia were the largest sources of fresh snapper, with Fiji and New Zealand also being major sources. Not only has the quantity of foreign-caught fresh fish increased during the last few years, but the number of countries exporting fresh fish to Hawaii has also increased. A decade ago, for example, fresh snapper was exported to Hawaii mainly from within the South Pacific region. In recent years, Tonga and Australia were the largest sources of imported fresh snapper, with Fiji and New Zealand also being major sources, and Viet Nam, Chad (fresh-water fish) and Madagascar as minor sources.

Although other locations would fill the market demand in Hawaii, many Hawaii restaurant owners and chefs would prefer to have fresh locally caught bottomfish on their menus due to their marketable qualities, i.e. "fresh island fish" (Coffman 2004).

2.2.8.2 Crustacean Fisheries

Most of the information in this section pertains only to the lobster fishery occurring in the NWHI. Because there are few shallow banks in the EEZ around the MHI, the MHI lobster fishery occurs almost entirely within State of Hawaii waters. One federally permitted vessel began to operate in the EEZ surrounding the MHI in 1997, but has since discontinued operations.

History

Ula (lobster) was a traditional source of food for Native Hawaiians and was sometimes used in early religious ceremonies (Titcomb 1978). After the arrival of Europeans in Hawaii, the lobster fishery became by far the most productive of Hawaii's commercial shellfish fisheries. Early in the twentieth century, Bryan (1915:469) wrote of the local market for spiny lobster: "The lively demand for them, owing to their excellent food qualities, brings large numbers of them fresh and sprawling into the markets every day." Bryan (1915:469) also noted that the slipper lobster was "quite common in the markets" and "is a favorite food of the native people." Cobb (1902) reported that the commercial lobster catch in 1901 was 131,200 lbs. The majority of the catch at that time was probably composed of the near-shore species *P. penicillatus* because fishing was confined to coastal waters around the MHI (Shomura 1987). According to Cobb (1902), lobster were taken with nets set around rocks, snared with a pole to which a noose was attached or captured by hand.

A rapid and substantial increase in Hawaii's population during the first decades of the twentieth century was accompanied by increased local demand for seafood and an expansion of the

fisheries. The many immigrants to Hawaii from Asia possessed a strong fishing tradition and brought with them a culture in which fish was an integral part of the diet. Early commentary suggests that heavy fishing pressure soon depleted the lobster resources adjacent to the more populated areas of the MHI. In 1925, for example, Lorrin Thurston (1925), President and General Manager of The Honolulu Advertiser, wrote:

In some of the out-districts of the other islands lobsters are still found; but on O‘ahu they are so scarce that they are hardly ever found in the market. The few which are caught are monopolized by the higher class restaurants and hotels, and bring extravagant prices ... So far as the general community is concerned, lobsters are practically locally extinct as an article of food.

By the early 1950s, the commercial catch of *P. penicillatus* around the MHI had dropped by 75 to 85% (Shomura 1987). The depletion of the fishery resources in the coastal areas of the MHI encouraged Hawaii’s fishermen to search for alternative fishing grounds. In particular, the Honolulu-based “sampan” fleet began to venture north to fishing grounds around the NWHI. The boats traveling to these remote islands primarily targeted bottomfish, but they also harvested lobster and other marine animals (Iversen et al. 1990). The commercial potential of a NWHI lobster fishery was recognized by Bell and Higgins (1939), who wrote: “Doubtless there are unexploited aquatic resources of unsuspected size throughout the great expanse of islands and atolls in the Hawaiian Archipelago extending westward from Kauai. For example, abundant supplies of two species of spiny lobster (Palinuridae) are reported from the French Frigate Shoals and to the westward.” However, full exploitation of the marine resources of the NWHI was hindered by the dangers of traveling to the more distant islands and the difficulty of maintaining the quality of the catch during extended trips (Konishi 1930; Shinsato 1973).

It was not until the late-1970s that the development of the NWHI lobster fishery was fully realized. NMFS, U.S. Fish and Wildlife Service and Hawaii Division of Aquatic Resources joined in a cooperative agreement to conduct a five-year assessment of the biotic resources of the NWHI (Grigg and Pfund 1980). The University of Hawaii Sea Grant College Program joined the study in 1977. Among the resource surveys conducted during the “tripartite-Sea Grant” investigation was a survey of the *P. marginatus* resource conducted at 26 sites. Of these study sites, only Necker Island and Maro Reef were reported to have sufficiently large stocks for commercial exploitation (Uchida and Tagami 1984).

Shortly after the survey began several commercial vessels began lobster trapping operations. The fishery was primarily developed by new fishermen coming to Hawaii from areas such as the Pacific Northwest where crustacean fisheries were experiencing declining catches (Clarke and Pooley 1988; Pooley 1993a). These newcomers came with large vessels, some over 100 ft in length, with advanced technology freezing and processing equipment (Pooley 1993a). In addition, a number of smaller, multi-purpose boats began fishing for spiny lobsters in the NWHI, combining that operation with bottomfish fishing (HDAR 1979).

A period of low catches was followed by a rapid increase in landings as more vessels entered the

fishery and markets were developed (Polovina 1993). In the mid-1980s, the NWHI lobster fishery was Hawaii's single most lucrative fishery (Pooley 1993b). Changing gear from wire to plastic traps introduced from the U.S. mainland led to significant catches of slipper lobster, which had been essentially unexploited with wire traps, and an increase in fishing efficiency (Boehlert 1993; Pooley 1993a).

Trapping activity fell in 1987 principally due to the exit of several large vessels from the fishery (Samples and Sproul 1988), but landings reached a record high in 1988 when wind and sea conditions allowed for an extended period of fishing in the upper bank areas where spiny lobsters tend to congregate (Clarke 1989).

In 1990, however, lobster catch rates fell dramatically. Overfishing is not thought to be responsible for the decline (Polovina and Mitchum 1992). Rather, the decrease was likely due to a climate-induced change in oceanic productivity (Polovina et al. 1994). Nevertheless, the 1990 season showed that there was excessive fishing capacity in the industry given the reduced population size and raised concern that an economic threshold might not prevent overfishing (Polovina and Haight 1999). Responding to this concern, the Council established a limited access program and a fleet-wide seasonal harvest quota in 1991 that significantly altered fishing operations (Kawamoto and Pooley 2000). During the 1980s, fishery participants had averaged three trips per year to the NWHI, each trip lasting about two months (Polovina 1993). With the implementation of a fleet-wide harvest quota vessels no longer fished for lobster year round, but instead shifted from other Hawaii-based fisheries or moved from fisheries in Alaska or the West Coast to participate in a short-term (less than one month) lobster fishery concentrated on the banks around Necker Island, Gardner Pinnacles and Maro Reef that were the historic mainstays of the fishery. The lobster fishery was open from July to December but it typically closed earlier because the harvest quota was reached. Given the derby-style fishing conditions there was no incentive for fishermen to operate on secondary or marginal banks. From 1992 through 1997, Necker Island accounted for 48 to 64% of the total effort and Gardner Pinnacles and Maro Reef accounted for most of the remaining effort (WPRFMC 1999b). In 1998, the quota was allocated among four fishing areas (Necker Island Lobster Grounds, Gardner Pinnacles Lobster Grounds, Maro Reef Lobster Grounds and General NWHI Lobster Grounds) to prevent localized depletion of the lobster population at the most heavily fished banks and encourage fishermen to broaden the geographical distribution of their effort. In 2000, NMFS closed the NWHI lobster fishery due to concerns about the potential for overfishing the lobster stocks based on uncertainty in its population assessment models.

Fishing Methods and Use Patterns

Two distinct types of vessels have historically operated in the NWHI lobster fishery (Maine Aquaculture Innovation Center 2000). About one-third of the permit holders operate North Pacific catcher-type crab vessels that travel to Hawaii for the lobster season. The other two-thirds operate Honolulu-based vessels that were also used in the pelagic longline fishery. The North Pacific crabbers are larger than the longline boats, but every vessel had the capability to carry and deploy the maximum number of traps allowed (1200).

All participants in the 1999 NWHI fishery use a plastic dome-shaped, single-chambered traps with two entrance funnels located on opposite sides (Polovina 1993). Although the minimum size limit established in 1985 was revoked in 1996, traps are still required to have escape vents. The traps are typically fished in strings of several hundred traps per string. The traps are set before sunset in depths from 20 to 70 m, and retrieved the next day. Both spiny and slipper lobsters may be caught in the same trap, but fishermen can alter the proportion of each species by selecting the trapping area and depth (Polovina 1993). Almost all lobsters harvested were sold as a frozen tail product. Catch was processed, packed and frozen at sea by the individual vessels, in contrast to most other lobster fisheries in which each vessel's catch is held live on-board and transported to shore-side plants for processing and packing (Sample and Gates 1987). From 1996 to 1998, the fleet also landed a significant quantity of live lobsters.

This is a seasonal fishery with vessel operators participating in other Hawaii or U.S. mainland fisheries during the remainder of the year. In 1999, the average vessel fished for lobster for 42 days (WPRFMC 2000). Although all participants in the lobster fishery engage in other fisheries, the lobster fishery occurs during a comparatively slow season for alternate fishing activities (NMFS 2000). Therefore, the lobster fishery may represent an important component of the participants' annual fishing operations and income.

Fishing beyond September involves the risk of encountering severe weather. Poor sea conditions increase operational problems, increase trap losses and reduce the fishing effectiveness of traps (Maine Aquaculture Innovation Center 2000).

Necker Island, Gardner Pinnacles and Maro Reef are the most productive banks in the NWHI lobster fishery (Table 21). Since 1998, the first year that area-specific quotas were established, fishermen have spread out their effort over a larger area (Kawamoto and Pooley 2000). During both the 1998 and 1999 seasons all four subareas received fishing pressure. In 1999, the Necker Island, Gardner Pinnacles and Maro Reef Lobster Grounds were closed within two months while the "all other banks" area (General NWHI Lobster Grounds) remained open until the fishery was closed at the end of the year. Five of the six vessels that participated in the fishery that year fished in the General NWHI Lobster Grounds. Three vessels fished on Necker Bank and Gardner Pinnacles and four vessels fished on Maro Reef. The harvest from Necker Island, Gardner Pinnacles and Maro Reef accounted for about 75% of the total landings.

Table 21: Approximate Percentage of Total Catch at Selected Areas in the NWHI Lobster Fishery Based on Landings Data

AREA	PERCENT OF TOTAL CATCH
Necker Island	38.5
Maro Reef	34.0
Gardner Pinnacles	14.3
Pearl and Hermes Reef	6.7
Kure Atoll	2.8

AREA	PERCENT OF TOTAL CATCH
Lisianski Island	1.5
French Frigate Shoals	1.2
Nihoa Island	0.6
St. Rogatien Bank	0.3
Pioneer Bank	0.1
Brooks Bank	0.0
Raita Bank	0.0
Twin Banks	0.0
Laysan Island	0.0
Midway Atoll	0.0

Source: M. Mitsuyasu, pers. comm. 2000. WPRFMC

Harvest

Between 1985 and 1991, total landings showed an overall downward trend (Figure 14). Since 1992, landings have been largely determined by a harvest quota. The catch per unit effort (CPUE) expressed as number of lobsters caught per trap haul showed an overall decrease between 1983 and 1991 (Figure 15). There was an increase in CPUE in 1996 and 1997, followed by another decline. It is uncertain, because of the lack of catch size data, if the increased CPUE in 1996 and 1997 resulted from the 1995 implementation of Amendment 9, which instituted the “retain-all” policy. The retain all policy was put into place to offset the high lobster mortality associated with the handling and discarding (e.g. predation) associated with the NWHI lobster fishery. Using an equilibrium yeild-per-recruit model, Kobayashi (2001) found that that the reporductive potential of the NWHI lobster population more than doubled and mean weight per individual increased by 22 percent if the mortality rate of lobsters was above 75 percent. In 1996, the fishery had a discard rate of 62 percent with the discard mortality presumed to be above 75 percent (Dinardo et al. 2002). The Council amended the Crustaceans FMP in 1996 to allow the retention of all lobsters caught in the NWHI lobster fishery subject to the quota on total catch.

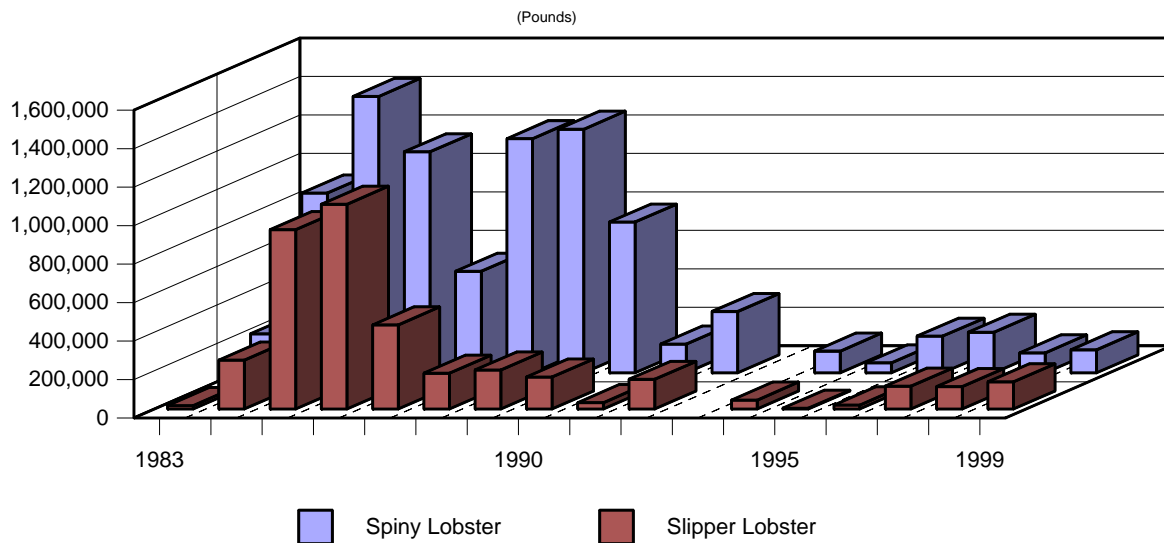


Figure 14: Landings of Spiny and Slipper Lobsters in the NWHI Lobster Fishery, 1983-1999
(Source: PIFSC 2002)

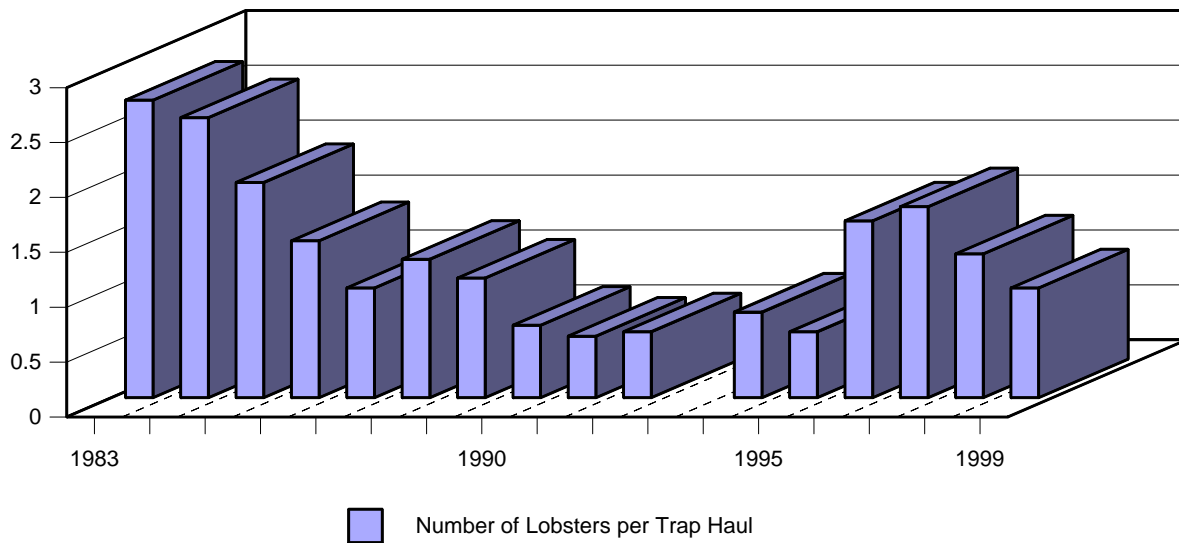


Figure 15: Catch per Unit Effort in the NWHI Lobster Fishery, 1983-1999
(Source: PIFSC 2002)

Bycatch and non-target species

Non-targeted species account for a small percentage of the total catch in the NWHI lobster fishery, as the traps are designed for high selectivity. Also, all NWHI lobster traps are required to be equipped with escape vents. Using data from 1976-1991 (wire traps) and 1986-2003 (plastic traps) from research cruises in the NWHI, Moffit et. al (2005) examined the diversity of catch composition from the study over time. The traps used for the research do not have escape vents but otherwise conform to fishery regulations. Both wire and plastic traps were found to be highly selective, that is, they primarily catch lobsters. Wire traps caught a total of 82 species, of which the two target species of lobsters accounted for 90.5% by number. Plastic traps contained 258 species of which 73.1% were the two target species. Because lobsters are one of the larger organisms captured, they would be an even larger percentage if measured by weight. Of the organisms which were caught incidentally, hermit crabs made up the largest component followed by moray eels and small reef fish.

Octopus abundance was also evaluated due to its potential as a prey species for the Hawaiian monk seal. Only 83 individuals were captured during the entire 1986-2003 study period and examination of the data shows no significant decline or increase in abundance over time. Based on the data, the study found that it is unlikely that lobster trapping activities have lowered octopus abundance to such a degree that monk seal populations would be negatively impacted.

Overall, Moffit et. al (2005, in review) concluded that lobster trapping activities are responsible for changes in abundance of a few species (target species have declined and some crab species have increased due to competitive replacement) of the benthic community in the NWHI, but do not appear to have resulted in major changes to the ecosystem. Moffit et. al. also state that gear lost in this fishery has not been found to be ghost fishing (still catching organisms), and that although direct damage to the benthic habitat by the traps has not been studied, it is not likely to be substantial due to the low relief, hard substrate that characterizes the fishing grounds.

Participation

At present, the 15 federal limited access permits for the NWHI lobster fishery are owned by 12 permit holders.¹⁶

16 The federal regulations that established the limited access program for the NWHI lobster fishery in 1992 prohibit an individual, partnership or corporation from holding a whole or partial interest in more than one permit. However, two qualified individuals who held multiple permits at the time the limited access program was implemented were allowed to retain all of their permits.

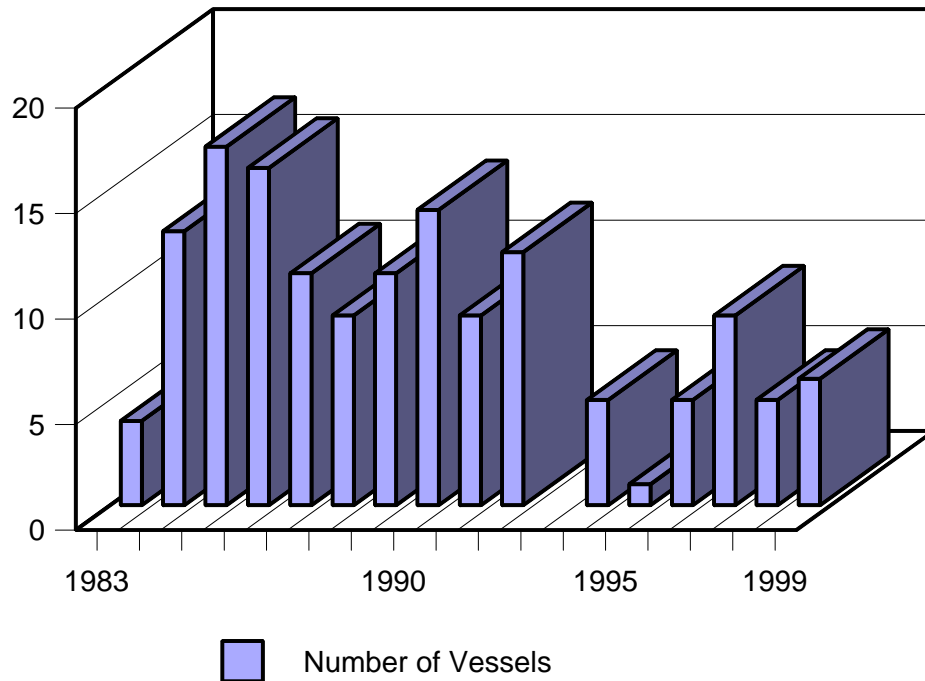


Figure 16: Trend in Number of NWHI Lobster Vessels

During the first years of the fishery the turnover of participants was relatively high due to the profit seeking entry-exit behavior by vessel owners who were flexible in the choice of fishing activities (Samples and Sproul 1988). The high turnover continued after 1992, the first year of the limited access program and harvest quota. The quota announced prior to the start of the fishing season weighed heavily in the participation decision as did the annual start-up costs of participating in the lobster fishery and the potential earnings in alternative fisheries (Kawamoto and Pooley 2000). In addition, during the first five years of the limited access program there were a total of 20 permit transfers. By 1997, less than half of the permits that were issued in 1991 were still held by the original recipients.

To date, approximately 37 limited access permits to participate in the NWHI lobster fishery have been issued, but only 19 of the permits have been actually used. The turn-over rate has been fairly high, with only 4 of the 19 active permit holders participating in the fishery for more than two years (Katekaru, 2001, pers. comm.).

Economic Performance

The total gross revenue of the NWHI lobster fishery has followed the trend in landings (Figure 17). The average gross revenue per trap has declined sharply since 1997 due to the overall decrease in CPUE and the higher catches of slipper lobsters which have a smaller average size and lower ex-vessel value in comparison to spiny lobsters (Kawamoto and Pooley 2000).

A cost-earnings study of the NWHI lobster fleet was conducted by Clarke and Pooley (1988) based on economic data collected in 1985 and 1986. The study found that despite record

revenues in the fishery in 1986, fishermen as a group earned little or no economic profit. Low fleet net returns appeared to be tied to high fishing costs and diminished average catch rates. That study does not reflect current operational characteristics of the fleet, as the fishery in the mid-1980s was essentially a year-round fishery.

Since the mid-1980s, adjustments in the regulatory regime for the fishery have changed the economic conditions of the fishery (Pooley and Kawamoto 1998). Because the fishery is now seasonal rather than year-round, start-up costs have become significant determinants in yearly participation by permit holders. The brief fishing season means that fixed costs have to be amortized over a shorter time period. Similarly, travel costs have become a higher percentage of total costs due to a decrease in the number of fishing days per trip. The establishment of area-specific quotas in 1998 and the resultant successive closure of banks during the 1998 and 1999 seasons as quotas were reached caused an increase in travel times and associated vessel operating costs as vessels were forced to move from bank to bank (WPRFMC 1999).

At least some of the permit holders have been able to adapt to these changing economic conditions. Fishery participants during the 1998 season realized a positive return on operations (gross revenues less operating costs) and were able to cover a portion of their fixed costs (WPRFMC 1999). In addition, the market value of the freely transferable limited access permits indicates that both economic and financial profits can still be earned in the fishery. Although the price of transferred permits is not recorded by NMFS, dockside reports in 1998 indicated that a permit was worth \$40,000 to \$100,000 (Pooley and Kawamoto 1998). However, the fact that generally only about half of the permits holders participated in the fishery in recent years suggests that profits from lobster fishing are low as compared to other available activities (Maine Aquaculture Innovation Center 2000). The MHI represent the young portion of the Hawaiian Archipelago. Consequently, they have less well-developed fringing reefs that have not subsided as far below sea level as those in the NWHI (Green 1997). The best reef development and highest live coral cover in the MHI are found in areas sheltered or partially sheltered from open ocean swell (Grigg 1997).

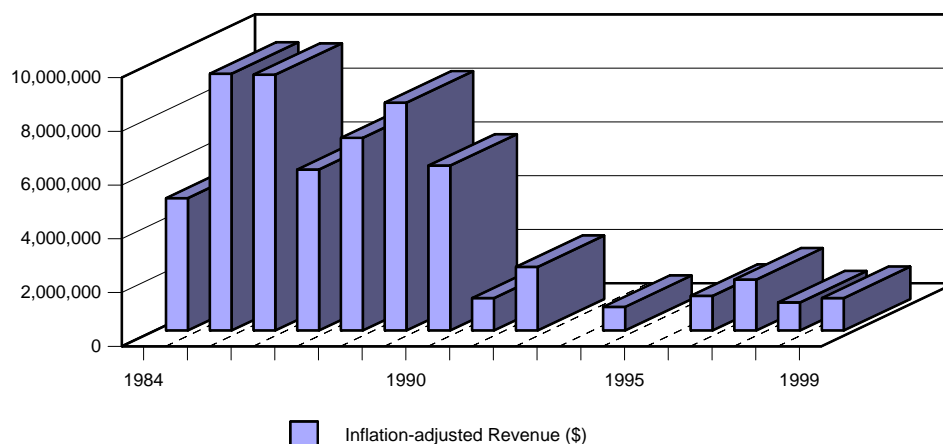


Figure 17: Inflation adjusted Revenue from the NWHI Lobster Fishery, 1983-1999
(Source: PIFSC 2002)

Markets

As an internationally traded commodity, supply and demand circumstances for lobsters tend to be volatile, resulting in frequent price adjustments (Samples and Gates 1987). In addition, the Hawaii fishery has changed over the years in terms of target species and product form. In the early years of the fishery (1977-1984) landings consisted mainly of spiny lobsters. However, for a three-year period from 1985 to 1987 the fishery targeted a previously lightly exploited population of slipper lobsters (Polovina 1993). Between 1988 and 1997 the target was again spiny lobsters, but the catch in 1998 and 1999 consisted mainly of slipper lobsters.

The traditional way of marketing lobsters in Hawaii was selling them live in local markets (HDAR 1979). In 1978, however, a Hawaii-based fishing company leased a modern fishing boat from the U.S. mainland equipped with on-board refrigeration for storing frozen lobster tails. Soon almost all lobsters harvested in Hawaii were sold as a frozen tail product to Hawaii and U.S. mainland buyers (Pooley 1993). This product form dominated until 1996, when the fleet landed a significant amount of live lobsters, which were exported to Japan, Taiwan and Hong Kong or sold in up-scale restaurants in Hawaii (Pooley and Kawamoto 1998). In 1999, however, nearly all fishery participants reverted to producing frozen tails because of a drop in the price of live spiny lobsters caused by the economic downturn in Asia (Kawamoto and Pooley 2000).

Because the NWHI lobster fishery is relatively small and harvest levels have fluctuated widely, product marketing has been challenging (NMFS 2000). Typically, seafood wholesalers and retailers prefer predictable and reliable supply sources. However, NWHI lobster have established a reputation as a locally-produced quality product, and fishery participants have found buyers willing to participate on a seasonal basis.

Imports of frozen lobster tails into Hawaii from various Pacific Basin countries have shown an overall decline over the past decade, from 41,023 lbs in 1990 to 3,866 lbs in 1999 (NMFS Fisheries Statistics and Economics Division n.d.). A small number of live spiny lobsters are imported into Hawaii from Australia and Kiribati. The average annual amount during the past decade has been about 1,450 lbs (NMFS Fisheries Statistics and Economics Division.)

2.2.8.3 Precious Corals Fishery

Most of the information in this section pertains only to the black coral fishery occurring in Au'au Channel off Maui, as currently, it is the only fishery harvesting precious corals management unit species in the EEZ (with majority of harvest occurring in State of Hawaii waters). In 2001, American Marines Services Group received federal permits to harvest deep-water precious corals at the Makapuu Bed and in the Hawaii Exploratory Area. The company did not renew its permit, and the harvest levels from its operation can not be reported here because of NOAA's data confidentiality policy. No precious corals harvester has received a federal permit to fish in the EEZ surrounding American Samoa or Guam since the implementation of the FMP in 1980.

Harvest

Between 1990 and 1997, the annual harvest of black coral in Hawaii varied from a low of 864 lb to a high of 6,017 lb, with a yearly average of 3,084 lb. As noted above, the harvest of black coral has occurred mainly in State of Hawaii waters. Table 22 provides historical landings and value of the black corals harvest between 1990-1997. Landings and value of the black corals recently harvested in Hawaii cannot be presented due to State of Hawaii confidentiality policy.

Table 22: Volume and Value of Black Coral Landings in Hawaii (1990-97)

YEAR	HARVESTED (LB)	SOLD (LB)	VALUE (\$)
1990	2349	2169	31575
1991	2305	2250	35080
1992	2398	2328	46560
1993	864	769	15380
1994	4354	4209	84180
1995	6017	5912	122765
1996	4865	1703	41325
1997	1520	415	10394

Source: Hawaii Division of Aquatic Resources

Bycatch and non-target species

The Precious Corals FMP only allows the harvest of MUS using selective gear, i.e with submersible or by hand. The use of tangle-nets and dredging is prohibited. For this reason, the precious corals fisheries in Hawaii have little to no bycatch.

Economic Performance

The ex-vessel value of precious corals varies widely according to color and size. It is uncertain whether the corals harvested by the 2001 participant in the deep-water sector of the precious corals fishery were be of sufficient quality to receive the high prices required to offset the high fishing costs. The State of Hawaii's proprietary confidentiality policy restricts the public dissemination of economic reports for businesses with less than three competitors.

Markets

The naming of black coral as the Hawaii state "gem" in 1987 increased consumer interest in this precious coral (Grigg 1993). However, the quantity of black coral required by jewelry manufactures in Hawaii has dropped considerably because the jewelry items produced are smaller and of higher quality and because modern cutting procedures have become much more

efficient (Carleton 1987). In addition, inexpensive black coral imported from the Philippines and elsewhere fills the demand for low quality, high volume jewelry products. Maui Divers of Hawaii, Inc., the leading manufacturer and retailer of precious corals jewelry in Hawaii, buys exclusively black coral harvested in the state.

In the past, the market for colonies of black coral small enough to fit inside the typical curio display case or household aquarium was small in comparison to the market for larger trees that are processed for jewelry (Oishi 1990). According to the Hawaii Division of Aquatic Resources, however, the demand for small, immature black coral colonies has increased with the growing popularity of household marine aquaria.

The worldwide glut of *Corallium* produced during the boom years of the early 1980s caused the market value of pink coral to fall even below breakeven prices for Taiwanese and Japanese coral fishermen (Grigg 1993). Consequently, many fishermen dropped out of the fishery and the worldwide supply of deep-water precious corals has dwindled. For the past 20 years Hawaii businesses engaged in the manufacture of deep-water precious corals jewelry have relied on local stockpiles of gold coral and imports of pink coral from foreign suppliers. Prices for precious corals have gradually increased, and specimens of the highest quality pink coral currently sell for \$5,000/lb in international auctions. However, changes in the jewelry industry during the past decade may have diminished the demand for precious corals. Products such as black pearls have captured a substantial share of the market formerly held by precious corals (C. Marsh pers. comm. 2000 Maui Divers of Hawaii, Inc., Honolulu). The precious corals jewelry industry in Hawaii has been estimated to be worth about \$25 million at the retail level (Grigg 1993).

2.2.8.4 Coral Reef Ecosystems Fishery

Main Hawaiian Islands

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.

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.

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/km² for resident species to 90-2,460 mt/km² 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.

Northwestern Hawaiian Islands

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.

Currently, there are no coral reef fisheries operating in the NWHI. Occasional visitors, including federal government personnel and contract workers at Midway Atoll, fish recreationally in the NWHI.

Bycatch and Non-target Species

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.

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 coprophagous 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).

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: 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).

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.

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.

2.2.8.5 Pelagic Fishery

Hawaii's pelagic fisheries are small in comparison with other Pacific pelagic fisheries, but comprise the largest fishery sector in the State of Hawaii (Pooley 1993) (Table 23). Tuna, billfish and other tropical pelagic species supply most of the fresh pelagic fish consumed by Hawaii residents and support popular recreational fisheries (Boggs and Kikawa 1993).

The longline fleet has historically operated in two distinct modes based on gear deployment: deep-set longline by vessels that target primarily tuna and shallow-set longlines by those that target swordfish or have mixed target trips including albacore and yellowfin tuna. Swordfish and mixed target sets are buoyed to the surface, have few hooks between floats, and are relatively shallow. These sets use a large number of lightsticks since swordfish are primarily targeted at night. Tuna sets use a different type of float placed much further apart, have more hooks per foot between the floats and the hooks are set much deeper in the water column. These sets must be placed by use of a line shooter to provide slack in the line which allows it to sink.

The longline fishery accounted for the majority of Hawaii's commercial pelagic landings (17.3 million lb) in 2003 (Table 7-28). The fleet includes a few wood and fiberglass vessels, and many newer steel longliners that were previously engaged in fisheries off the U.S. mainland. None of the vessels are over 101 ft in length and the total number is limited to 164 vessels by a permit moratorium.

Table 23: Hawaii-based longline fishery landings 1999-2003
(Source: NMFS, PIFSC, published and unpublished data)

Item	1999	2000	2001	2002	2003
Total Landings (million lb)	28.3	23.8	15.6	17.5	17.3
Catch Composition*					
Tuna	41%	41%	52%	52%	65%
Swordfish	9%	9%	1%	1%	2%
Miscellaneous	32%	32%	36%	37%	31%
Sharks	18%	18%	11%	10%	2%
Season	All year	All year	All year	All year	All year
Active Vessels	119	125	101	100	110
Total Permits	164	164	164	164	164
Total Trips	1137	1103	1034	1164	1216
Total Ex-vessel Value (nominal) (\$millions)	\$47.4	\$50.2	\$33.0	\$37.5	\$37.5

* Number of fish

The Hawaii-based skipjack tuna, or *aku* (skipjack tuna) fishery, is also known as the pole-and-line fishery or the bait boat fishery because of its use of live bait. The *aku* fishery is a labor-intensive and highly selective operation. Live bait is broadcast to entice the primary targets of skipjack and juvenile yellowfin tuna to bite on lures made from barbless hooks with feather skirts. Tuna are hooked on lines and in one motion swung onto the boat deck by crew members. The *aku* fishing fleet has declined from a maximum of 32 vessels in the 1950s to only 2-3 vessels. In 2003 this fleet landed about 700,000 lbs of fish (Table 24).

Pelagic handline fishing is used to catch yellowfin and bigeye tunas with simple gear and small boats. Handline gear is set below the surface to catch relatively small quantities of large, deep-swimming tuna that are suitable for *sashimi* markets. This fishery continues in isolated areas of the Pacific and is the basis of an important commercial fishery in Hawaii (Table 24). Three methods of pelagic handline fishing are practiced in Hawaii, the *ika-shibi* (nighttime) method, the *palu-ahi* (daytime) method and seamount fishing (which combines both handline and troll methods).

Troll fishing is conducted by towing lures or baited hooks from a moving vessel, using big-game-type rods and reels as well as hydraulic haulers, outriggers and other gear. Up to six lines rigged with artificial lures or live bait may be trolled when outrigger poles are used to keep gear from tangling. When using live bait, trollers move at slower speeds to permit the bait to swim “naturally.” The majority of Hawaii-based commercial troll production is generated by part time fishermen, however, some full-time commercial trollers do exist.

The total volume of pelagic fish caught annually from the NWHI by the commercial pelagic handline and troll fishery amounts about 450,000 lbs (Reginald Kokubun, Hawaii Division of Aquatic Resources, pers comm.), comprising principally yellowfin tuna and wahoo. Total pelagic fish catches in Hawaii, from commercial and recreational fishing amount to about 33 million lbs, of which the NWHI amount to about 1.4%. Yellowfin biomass in the Central and Western Pacific is currently estimated to lie between 1.5 and 3.1 million mt (Hampton et al, 2004). The total volume of yellowfin caught annually from the NWHI by the commercial mixed handline and troll fishery amounts about 170,000 lbs (77 mt) (Reginald Kokubun, Hawaii Division of Aquatic Resources, pers comm.), or 0.003-0.005% of the biomass

Hawaii’s charter fisheries primarily troll for billfish. Big game sportfishing rods and reels are used, with four to six lines trolled at any time with outriggers. Both artificial and natural baits are used. In addition to lures, trollers occasionally use freshly caught skipjack tuna and small yellowfin tuna as live bait to attract marlin, the favored landings for charter vessels, as well as yellowfin tuna.

The recreational fleet primarily employs troll gear to target pelagic species. Although their motivation for fishing is recreational, some of these vessel operators sell a portion of their landings to cover fishing expenses and have been termed “expense” fishermen (Hamilton 1999). While some of the fishing methods and other characteristics of this fleet are similar to those described for the commercial troll fleet, a survey of recreational and expense fishermen showed

substantial differences in equipment, avidity and catch rates compared to commercial operations. Vessel operators engaged in subsistence fishing are included in this recreational category.

Little is known about the scale of recreational fishing activities in the NWHI. A charter vessel operation was maintained at Midway Atoll by an eco-tourism operator, but this activity terminated in 2002. Some long range charter operators may be interested in fishing in the NWHI (David Itano, University of Hawaii pers comm.) where competition for pelagic fish is several orders of magnitude lower than in the Main Hawaiian Islands.

Table 24: Fishery information for Hawaii's non-longline pelagic fisheries for 2002

(Source: WPRFMC, 2004b)

Gear/Vessel Type	Troll/Handline	Pole-and-line Fishery (<i>Aku</i> Fishery)
Area Fished	Inshore and EEZ	Inshore and EEZ
Total Landings	3.4 million pounds	696,000 pounds
Catch Composition	48% yellowfin 18% mahimahi 10% wahoo 8% albacore 7% blue marlin	99.6% skipjack tuna <1% <1% <1% <1%
Season	All year	All year
Active Vessels	1455	6
Total Permits	NA	NA
Total Trips	18700	198
Total Ex-vessel Value	\$8 million	\$1.1 million

Bycatch and non-target species

There is little bycatch in Hawaii's non-longline pelagic fisheries. In the NWHI, fishers primarily are trolling for uku, mahi mahi, ono, or handlining for ahi. The gear and bait methods practiced are highly selective. For the most part, non-target species caught in these fisheries on such gears are often marketable and thus, would not be discarded.

2.2.9 Regional Economy and Society

The State of Hawai‘i lies 2,500 miles southwest of North America, the nearest continental land mass. The eight main islands are part of a 137-island archipelago stretching 1,523 miles from Kure Atoll in the northwest to the island of Hawai‘i in the southwest. The total land area of the archipelago is 6,423 square miles. The main islands include O‘ahu, Maui, Kaua‘i, Ni‘ihau, Hawai‘i, Moloka‘i, Kaho‘olawe and Lāna‘i. Hawai‘i was established as a territory of the United States in 1900 and became the 50th state in 1959.

2.2.9.1 Overview of the Economy

Income generation in Hawai‘i is characterized by tourism, federal defense spending and, to a lesser extent, agriculture (Table 25). Tourism is by far the leading industry in Hawai‘i in terms of generating jobs and contributing to gross state product. The World Travel and Tourism Council (1999) estimates that tourism in Hawai‘i directly generated 134,300 jobs in 1999. This figure represents 22.6 percent of the total workforce.

For 2002, DBEDT estimates that direct and indirect visitor contribution to the state economy was 22.3%. A bit less than half of that (10.2%) was generated in Waikiki. Total visitor expenditures in Hawaii were \$9,993,775,000. Tourism’s direct and indirect contribution to Hawaii’s Gross State Product in 2002 was estimated at \$7,974,000,000, or 17.3% of the total. Directly and indirectly, tourism accounted for 22.3% of all civilian jobs, and 26.4% of all local and state taxes.

Department of Defense expenditures in Hawaii in 2002 were \$4,293,459,000. Defense expenditures in Hawaii are expected to increase significantly in the near future. These expenditures fall into two broad categories: monies for the pending arrival of the Stryker force, which requires changes in facilities and additional facilities; and the renovation of old military housing as well as the construction of new military housing. As of late July 2004, Hawaii is expected to receive \$496.7 million in defense-related spending. When combined with funds earmarked for construction that are contained in a measure before the Senate, Hawaii stands to receive more than \$865 million in defense dollars, which do not include funds for day to day operations or payroll (Inouye 2004).

Agricultural products include sugarcane, pineapples (which together brought in \$269.2 million in 1997), nursery stock, livestock, and macadamia nuts. In 2002, agriculture generated a total of \$510,672,000 in sales. Agricultural employment decreased from 7,850 workers in 2000 to 6,850 in 2003. This change may be due to the increasing use of lots zoned for agriculture for construction of high-end homes, a trend which is evident throughout the state.

Median household income in Hawaii was calculated to be \$40,827 in 1990, rising to \$49,820 in 1999. Statewide per capita income in 1989 was calculated to be \$15,770, rising to \$25,684 in 1995 and \$27,544 in 1999. The figure for 2002 is \$30,040, or 97% of the national average. Hawaii per capital income as a percentage of the national average figure has fallen steadily since

1970 (DBEDT 2003). The poverty rate in Hawaii grew more over the 1990s than in the nation as a whole. Despite this growth, Hawaii's poverty rate, which increased from 11.2 percent in 1988-89 to 12.4 percent in 1997-98, remained lower than the national rate (13.0 percent in 1997-98). In 1999, 8% of Hawaii's families were below poverty level, compared to 9% nationally according to the 2000 Census. Hawaii employment growth was virtually nil for most of the 1990s, continuing through to the end of 1998. Civilian employment has decreased from 411,250 in 1991 to 396,050 in 2002, which is a decrease from 98% of all civilian labor force having employment, to 96%.

Table 25: Statistical Summary of Hawai'i's Economy, 1995-1999, 2002

Source: DBEDT 1999, 2002; BOH 1999a

CATEGORY	UNITS	1995	1996	1997	1998	1999	2002
Civilian Labor Force	Number	576400	590200	592000	595000	594800	582200
Unemployment	Percent	5.9	6.4	6.4	6.2	5.6	4.2
Gross state product in 1996 dollars	\$ Millions	37963	37517	37996	38015	38047	38,839 (2001)
Manufacturing Sales	\$ Millions	2045	1724.1	1468.8	NA	NA	NA
Agriculture (all crops and livestock)	\$ Millions	492.7	494.6	486.5	492.6	512992	510672
Construction completed	\$ Millions	3153.3	3196.4	2864.9	NA	NA	NA
Retail sales	\$ Millions	15693	16565	16426	NA	NA	NA
Defense expenditures	\$ Millions	3782.5	3883.5	4074.9	4103.7	4174.2	4293459

For several decades Hawaii benefited from the strength of regional economies around the Pacific that supported the state's dominant economic sector and principal source of external receipts – tourism (BOH 1999a). In addition, industries of long-standing importance in Hawaii, such as the federal military sector and plantation agriculture, also experienced significant growth. However, Hawaii's economic situation changed dramatically in the 1990s. The state's main tourist market, Japan, entered a long period of economic malaise that caused the tourism industry in Hawaii to stagnate. The post-Cold War era brought military downsizing. Tens of thousands of acres of plantation lands, along with downstream processing facilities, were idled by the end of the decade due to high production costs. Employment in Hawaii sugar production fell by 20% between 1990 and 1993 and by an additional 50% from 1994 to 1995 (Yuen et al. 1997). Net out-migration became the norm in Hawaii, notwithstanding the state's appeal as a place to live. In 1998, the state-wide unemployment rate was 6.2%, and unemployment on the island of Molokai reached 15% (DBEDT 1999).

By 2002, an improving economy showed a statewide unemployment rate of 4.4%, with Molokai down to 8.6% (DBEDT 2003). Despite downswings in tourism in the last few years due to the events of 9/11, the SARS scare, Japanese economic issues, and world political conditions, tourism in Hawaii is improving to the point that there are fears that there will not be enough hotel rooms to accommodate all the Japanese tourists who want to come for O Bon season in August 2004 (Schafers 2004).

As a consequence of the economic upheaval of the 1990s and the extensive bankruptcies, foreclosures and unemployment, Hawaii never entered the period of economic prosperity that many U.S. mainland states experienced. Between 1998 and 2000, Hawaii's tourism industry recovered substantially, mainly because the strength of the national economy promoted growth in visitor arrivals from the continental U.S. (Brewbaker 2000). However, efforts to diversify the economy and thereby make it less vulnerable to future economic downturns have met with little success. The events of September 11, 2001 and their negative effects on travel and tourism have halted Hawaii's short-lived economic recovery. To date, economic development initiatives such as promoting Hawaii as a center for high-tech industry have attracted few investors. It is unlikely that any new major industry will develop in Hawaii in the near future to significantly increase employment opportunities and broaden the state's economy beyond tourism, the military, and construction.

2.2.9.2 Fishing Related Economic Activities

The harvest and processing of fishery resources play a minor role in Hawaii's economy. The most recent estimate of the contribution of the commercial, charter and recreational fishing sectors to the state economy indicated that in 1992, these sectors contributed \$118.79 million of output (production) and \$34.29 million of household income and employed 1,469 people (Sharma et al. 1999). These contributions accounted for only 0.25% of total state output (\$47.4 billion), 0.17% of household income (\$20.2 billion) and 0.19% of employment (757,132 jobs). However, in contrast to the sharp decline in some traditional mainstays of Hawaii's economy such as large-scale agriculture the fishing industry has been fairly stable during the past decade. Total revenues in Hawaii's pelagic, bottomfish and lobster fisheries in 1998 were about 10% higher than 1988 revenues (adjusted for inflation) in those fisheries.

Hawaii's commercial fishing sector includes a wide array of fisheries. The Hawa'i longline fishery is by far the most important economically in commercial landings, accounting for 73 percent of the estimated ex-vessel value of the total commercial fish landings in the state in 1999 (Table 26). As shown in that table, the NWHI and MHI bottomfish fisheries account for a relatively small share of the landings and value of the state's commercial fisheries.

Another perspective on the role of bottomfish in Hawaii is to compare landings with pelagic, reef fish, and other fish. Table 27 shows the changing patterns from 2000 to 2003 (NMFS, 2004).

Estimates of the economic activity in the various sectors (commercial, charter and recreational) of Hawaii's bottomfish fishery can be obtained from various published data. According to the WPRFMC (1999), for the period 1994-1998, the ex-vessel value of annual commercial landings

in the NWHI and MHI bottomfish fisheries averaged about \$1,096,200 and \$1,625,800, respectively. Based on data collected in a recent cost-earnings study of Hawaii's charter fishing industry (Hamilton 1998), it is estimated that the charter boat fleet earns about \$342,675 per year from taking patrons on bottomfish fishing trips. Finally, based on information gathered in a recent cost-earnings study of Hawaii's small boat fishery (Hamilton and Huffman 1997), it is estimated that annual personal consumption expenditures for recreational vessels engaged in bottomfish fishing total about \$2,827,096. Recreational vessels are fishing boats that do not sell any portion of their catch.

Table 26: Volume and Value of Commercial Fish Landings in Hawaii by Fishery, 1999

Source: Data compiled by PIFSC.

FISHERY	POUNDS LANDED (1,000s)	PERCENT OF TOTAL POUNDS LANDED	EX-VESSEL VALUE (\$1,000s)	PERCENT OF TOTAL EX-VESSEL VALUE
Pelagic longline	28300	75%	47400	73%
Troll	2960	8%	4550	7%
Pelagic handline	2340	6%	3950	6%
Aku pole and line	1450	4%	1850	3%
MHI bottomfish handline	420	1%	1300	2%
NWHI bottomfish handline	370	1%	1210	2%
NWHI lobster trap	260	1%	1040	2%
All other fisheries	1650	4%	3330	5%
Total	37750	100%	64630	100%

Table 27: Annual Estimated Commercial Landings in Hawaii (1000lbs), 2000-2003

YEAR	PELAGIC FISH	BOTTOMFISH	REEF FISH	OTHER FISH
2000	26763	718	199	957
2001	22011	660	250	591
2002	22330	621	345	662
2003	21993	602	315	661

However, the above values reflect only the direct revenues and expenditures in the various sectors of the bottomfish fishery. They do not take into account that employment and income are also generated indirectly within the state by commercial, recreational and charter fishing for bottomfish. The fishery has an economic impact on businesses whose goods and services are used as inputs in the fishery such as fuel suppliers, chandlers, gear manufacturers, boatyards, tackle shops, ice plants, bait shops and insurance brokers. In addition, the fishery has an impact on businesses that use fishery products as inputs for their own production of goods and services. Firms that buy, process or distribute fishery products include seafood wholesale and retail dealers, restaurants, hotels and retail markets. Both the restaurant and hotel trade and the charter fishing industry are closely linked to the tourism base that is so important to Hawaii's economy. Finally, people earning incomes directly or indirectly from the fishery make expenditures within the economy as well, generating additional jobs and income.

A more accurate assessment of current contributions of the bottomfish fishery to the economy can be obtained using the Type II output, income and employment multipliers calculated by Sharma et al. (1999) for Hawaii's (non-longline) commercial, charter and recreational fishing sectors. Applying these multipliers to an approximation of the final demand in each of the sectors involved in bottomfish fishing, it is estimated that this fishing activity contributes \$10.78 million of output (production) and \$2.51 million of household income to the state economy and creates the equivalent of 113 full-time jobs (Table 28).¹⁷

Table 28: Estimated Output, Household Income and Employment Generated by Bottomfish Fishing Activity in Hawaii

FISHERY	SALES (\$)	FINAL DEMAND (\$)	OUTPUT (\$)	HOUSEHOLD INCOME (\$)	EMPLOYMENT (JOBS)¹
NWHI bottomfish fishery					
Commercial vessels ²	1,096,200	580,986	1,382,747	482,218	25
MHI bottomfish fishery					
Commercial vessels ²	1,625,800	861,674	2,050,784	715,189	36
Charter vessels ³	305,664	293,437	760,002	269,962	14
Recreational vessels ⁴		2,827,096	6,587,134	1,046,026	38

¹⁷ Several input-output models other than the one used here are available to study economic impacts. The model developed by Sharma et al. (1999) is based on data collected in Hawaii over a number of years, and is believed to be the best available for analyzing Hawaii's fisheries. It should be noted, however, that different practitioners may apply a model in different ways.

FISHERY	SALES (\$)	FINAL DEMAND (\$)	OUTPUT (\$)	HOUSEHOLD INCOME (\$)	EMPLOYMENT (JOBS)¹
Total			10,780,667	2,513,431	113

¹ Calculated as full-time jobs. The input-output model assumes that fishing accounts for 20% of the employment time of part-time commercial fishermen (Sharma et al. 1999).

² Average annual sales estimate for 1994-1998 from WPRFMC (1999).

³ Sales estimate based on the following assumptions: 199 active vessels; average annual sales of \$76,800 per vessel from charter fees and mount commissions; and 2% of total sales attributed to bottomfish fishing trips (Hamilton 1998).

⁴ Expenditure estimates based on the following assumptions (Hamilton and Huffman 1997; Pan et al. 1999):

Number of recreational boats	2490
Annual number of bottomfish fishing trips	3.81
Average trip costs	84.75
Average fixed costs: apportioned according to ratio of bottomfish fishing trips to total number of trips	213

2.2.9.3 Hawaii's Population Size and Ethnicity

The 1990 census listed the population of Hawai'i as 1,108,229. This figure rose to 1,179,198 in 1995 and to 1,211,537 in 2000. The population increased by a rate of 6.9 percent between 1990 and 1999.

The state of Hawaii is divided into five counties. The county of Maui includes the islands of Kahoolawe, Lānai, Maui and Molokai. The county of Honolulu encompasses the island of O'ahu and the Northwestern Hawaiian Islands excluding Midway Atoll. Kauai County consists of the islands of Kauai and Niihau. The population of each county is provided in Table 29.

Table 29: Hawaii Population by County

Source: U.S. Census Bureau

AREA	1990 CENSUS	2000 CENSUS
Hawaii State	1,108,229	1,211,537
Honolulu County, HI	836,231	874,154
Hawaii County, HI	120,317	148,677
Kaua'i County, HI	51,177	58,463
Maui County, HI	100,374	128,094

The 2000 Census redefined the way race is measured in a number of ways, allowing individuals to identify themselves as one race or a combination of races, as well as having a separate

classification system for Hispanic or Latino and race. As a result, describing the makeup of Hawaii's population is more complex. Perhaps the most accurate way to describe Hawaii's population is to report the proportions of race alone or in combination with one or more other races. In 2000, 39.3 percent of Hawaii residents described themselves as white, 2.8 percent as black or African American, 2.1 percent as American Indian or Alaska native, 58 percent as Asian, 23.3 percent as Native Hawaiian and other Pacific Islander, and 3.9 percent as some other race. These proportions add up to more than 100 percent because many individuals reported more than one race. Of the 78.6 percent of residents who reported just one race, 24.5 percent listed white, 1.8 percent black or African American, 41.6 percent Asian (including 4.7 percent Chinese, 14.1 percent Filipino, 16.7 percent Japanese, 1.9 percent Korean, and .6 percent Vietnamese), and 9.4 percent Native Hawaiian and or other Pacific islander.

In 1995-1996, Hamilton and Huffman (1997) conducted a survey of small-boat owners who engage in Hawaii's commercial and recreational fisheries, including the troll, pelagic handline and bottomfish handline fisheries. The survey found that the three largest ethnic groups represented in the sample were Japanese (33 percent), mixed with part-Hawaiian (16 percent) and Caucasian (12 percent). Hamilton and Huffman speculated that the high proportion of Japanese and part-Hawaiians in the sample reflects the traditional connections that these two ethnic groups have with the sea. These sociocultural connections are discussed further in the following section.

With specific regard to the NWHI bottomfish fishery, a 1993 survey of 15 owner-operators and hired captains who participate in the fishery found that 87 percent were Caucasian and 13 percent were part-Hawaiian (Hamilton 1994). However, it is likely that the ethnic composition of the deckhands aboard these vessels is much more mixed and reflects the highly diverse ethnic character of the state's total population

2.2.9.4 Sociocultural Setting

Blue sampans ride in the harbor at Kewalo
under the copper brilliance of the sun;
blue sampans reel and tilt into the trade wind
on sea-paths traced by the Hawaiian moon;
blue sampans stagger and rise gallantly out of chasms of sea
in storms blowing out of the sultry south,
in hurricanes howling over the barren isles
far to the north, in a world of wind and foam.

Clifford Gessler/ *Tropic Landfall: The Port of Honolulu*, 1942, p.267

Over the past 125 years the sociocultural 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 within certain fisheries, the fishing tradition in Hawaii is generally characterized by a partial amalgamation of multi-cultural attributes. An examination of the way in which the people of Hawaii harvest, distribute and

consume seafood reveals remnants of the varied technology, customs and values of Native Hawaiians and immigrant groups from Japan, China, Europe, America, the Philippines and elsewhere.

2.2.9.5 Social Aspects of Fish Harvest

Commercial fishing first became important in the Hawaiian Islands with the arrival of the British and American whaling fleets during the early nineteenth century. The whalers made the islands their provisioning and trading headquarters because of their central location in the Pacific (Nakayama 1987). This trade reached its zenith in the 1850s when more than 400 whaling vessels arrived in Honolulu annually (Shoemaker 1948). European- and American-owned trading concerns, called “factors,” were established to service the whalers and gradually became the dominant enterprises in Honolulu. The significance of whaling to Hawaii’s economy waned considerably during the late-nineteenth century by which time plantation agriculture centered on sugar and pineapple production had grown in importance. A number of the trading companies that supported the whaling industry, however, adjusted to these economic changes and remained at the heart of Hawaii’s industrial and financial structure (Shoemaker 1948).

The introduction of a cash economy into Hawaii and the establishment of communities of foreigners in the islands also led to the development of a local commercial fishery. As early as 1832, it was the custom for fish and other commodities to be sold in a large square near the waterfront in Honolulu (Reynolds 1835). In 1851, the first regular market house for the sale of fishery products was erected (Cobb 1902). The territorial government replaced this market in 1890 with an elaborate structure that Cobb (1902:435) referred to as “one of the best [market houses] in the United States.” Other fish markets were established on the islands of Maui and Hawaii. Locally caught bottomfish were in high demand at these markets. In Bryan’s (1915) list of seafood preferences by the various “nationalities” in Hawaii, all of the bottomfish species listed (i.e., *hāpuupuū*, *kāhala*, *ōpakapaka* and *uku*) were among the types of fish purchased by all social groups. Bryan (p.371) noted that some of the “snappers” “...may be procured almost every day, there being more than a hundred thousand pounds sold annually in the Hawaiian markets.” Jordan and Evermann (1903:240) wrote of *uku*: “This fish is common about Honolulu, being brought into the market almost every day. It is one of the best of food-fishes.” *Gindai* is also referred to as “one of our best food fishes” by Brigham (1908:17). Cobb (1902) reported that *ulaula*, *uku* and *ulua* were among the five species of fish taken commercially on all the islands. Titcomb (1972) writes that *ōpakapaka* was one of the most common fish on restaurant menus prior to World War II.

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 (Jordan and Evermann 1902; Cobb 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, but particularly significant in terms of having a long-term impact on the fishing

industry was the arrival of a large number of Japanese. The Japanese, like the majority of the early immigrants, were contracted to work on Hawaii's sugar cane plantations. When contract terms expired on the plantations many of the Japanese immigrants who had been skilled commercial fishermen from the coastal areas of Wakayama, Shizuoka and Yamaguchi Prefectures in Japan turned to the sea for a living (Okahata 1971). Later, experienced fishermen came from Japan to Hawaii for the specific purpose of engaging in commercial fishing. The bottomfish fishing gear and techniques employed by the Japanese immigrants were slight modifications of those traditionally used by Native Hawaiians.

During much of the twentieth century Japanese immigrants to Hawaii and their descendants were preeminent in Hawaii's commercial fishing industry. The tightly knit communities that the first Japanese immigrants formed both helped ease the transition to American society and retarded the process of acculturation (Tamura, 1994). The Japanese were able to maintain their separate communities in Hawaii more effectively than any other immigrant group. Among those Japanese communities of particular significance were the settlements of commercial fishermen and their families in the Palama, River Street and Kākāāko areas of Honolulu adjacent to the harbor (Lind 1980).

The adherence of Japanese immigrants to traditional cultural practices included Japanese religious observances, and many of the religious activities of communities such as Kākāāko were centered on fishing (Miyasaki 1973). Various traditional Japanese taboos and rituals directed how a new fishing boat was to be launched, when a vessel could leave or return to port, what items could be brought on board a boat and many other aspects of fishing behavior (Hamamoto 1928; Katamoto 1984). Over the years, succeeding generations of fishermen of Japanese ancestry in Hawaii became more "Americanized," but many Japanese fishing traditions persisted. For example, Japanese immigrant fishermen brought from Japan the Shinto practice of building a *jinsha* (shrine) dedicated to a deity such as *Konpira-sama* or *Ebisu-sama* (Kubota 1984; Miyasaki 1973). Today, an *Ebisu jinsha* constructed at Maalaea on the island of Maui during the early 1900s still stands, and fishermen of Japanese ancestry as well as others who share a common bond in fishing continue each year to ceremonially bless individual fishing vessels (Kubota 1984; T. Arine, pers. comm. 2000. *Maui Jinsha*).¹⁸

In addition to ethnic and community ties, the physical danger of fishing as an occupation also engendered a sense of commonality among fishermen. Describing the captains and crews of the early sampan fleet in Hawaii, Okahata (1971:208) wrote: "It is said that the fishermen were in a clan by themselves and were imbued with a typical seaman's reckless daring spirit of 'death lies only a floor board away.'" The extreme isolation of the NWHI and the limited shelter they offered during rough weather made fishing trips to these islands particularly hazardous. The perils of fishing in the NWHI for bottomfish and other species captured the attention of the

18 In some communities in Japan *Ebisu* is regarded specifically as the god of fishing, farming and commerce (Tokihiko 1983). He is depicted holding a fishing rod in his right hand and a sea bream under his left arm.

public media (e.g., Inouye 1931; Lau 1936), and inspired one individual to compose the poem included in the preface to this section.

As late as the 1970s, the full-time professional fishermen in Hawaii were predominately of Japanese descent (Garrod and Chong 1978). However, by that period hundreds of local residents of various ethnicities were also participating in Hawaii's offshore fisheries as part-time commercial and recreational fishermen. In addition, a growing number of fishermen from the continental U.S. began relocating to Hawaii. Many of the new arrivals came to the islands because declining catch rates in some mainland fisheries had led to increasingly restrictive management regimes.

Today, the people who participate in Hawaii's bottomfish fishery and other fisheries comprise an ethnically mixed and spatially dispersed group numbering several hundred individuals, although actual numbers are difficult to ascertain. Most are year-round residents of Hawaii, but some choose to maintain principal residences elsewhere. Participants in the bottomfish fishery do not reside together in a specific location and do not constitute a recognizable "fishing community" in the geographical sense of the term. There are a few rural villages in the state where most residents are at least partially economically dependent on fishing for pelagic species (Glazier 1999). In general, however, those who are dependent on or engaged in the harvest of fishery resources to meet social and economic needs do not include entire cities and towns, but subpopulations of metropolitan areas and towns. These subpopulations comprise fishing communities in the sense of social groups whose members share similar lifestyles associated with fishing.

The dispersal of bottomfish fishery participants can be examined by mapping residence information from relevant fishery license or permit holders. The Hawaii Division of Aquatic Resources (HDAR) administers a register of State of Hawaii commercial marine license holders. State regulations require any person who "takes marine life for commercial purposes," whether within or outside of the state, to first obtain a commercial marine license from HDAR. For a particular vessel this regulation applies to each person aboard (captain or deckhand) who catches or attempts to catch a fish for commercial purposes. Figure 7-28 shows the distribution of the business or home mailing address zip codes of commercial marine license holders who indicate that their primary fishing gear is bottomfish handline gear. Each of the five larger main islands has significant concentrations of participants.

Another potential source of information on the distribution of participants in the MHI bottomfish fishery is the HDAR list of registered bottomfish fishing vessels. Hawaii Administrative Rule Chap. 13-94 requires any vessel owner who fishes for certain bottomfish species to register their vessels for bottomfish fishing. As of 2002, approximately 2,960 vessels were registered (W. Ikehara, pers. comm. 2002. HDAR). The residences of the owners of these boats were not mapped, however, as the list contains many individuals who do not actually harvest bottomfish but who registered their vessels in anticipation of a future limited entry program for the MHI bottomfish fishery. There are currently no fees to register a vessel for bottomfish fishing, and many individuals may have registered, not because they intended to enter the bottomfish fishery at this time, but because they wanted to be ensured access to the fishery in the future.

Information on the residences of Mau Zone and Ho'omalu Zone limited entry program permit holders is available from the register of permit holders administered by NMFS. The register

indicates that eight permit holders reside in various communities on Oahu, three reside in two different communities on Kauai, one resides on Maui, one resides on the island of Hawaii and three have mailing addresses at separate locations on the U.S. mainland.

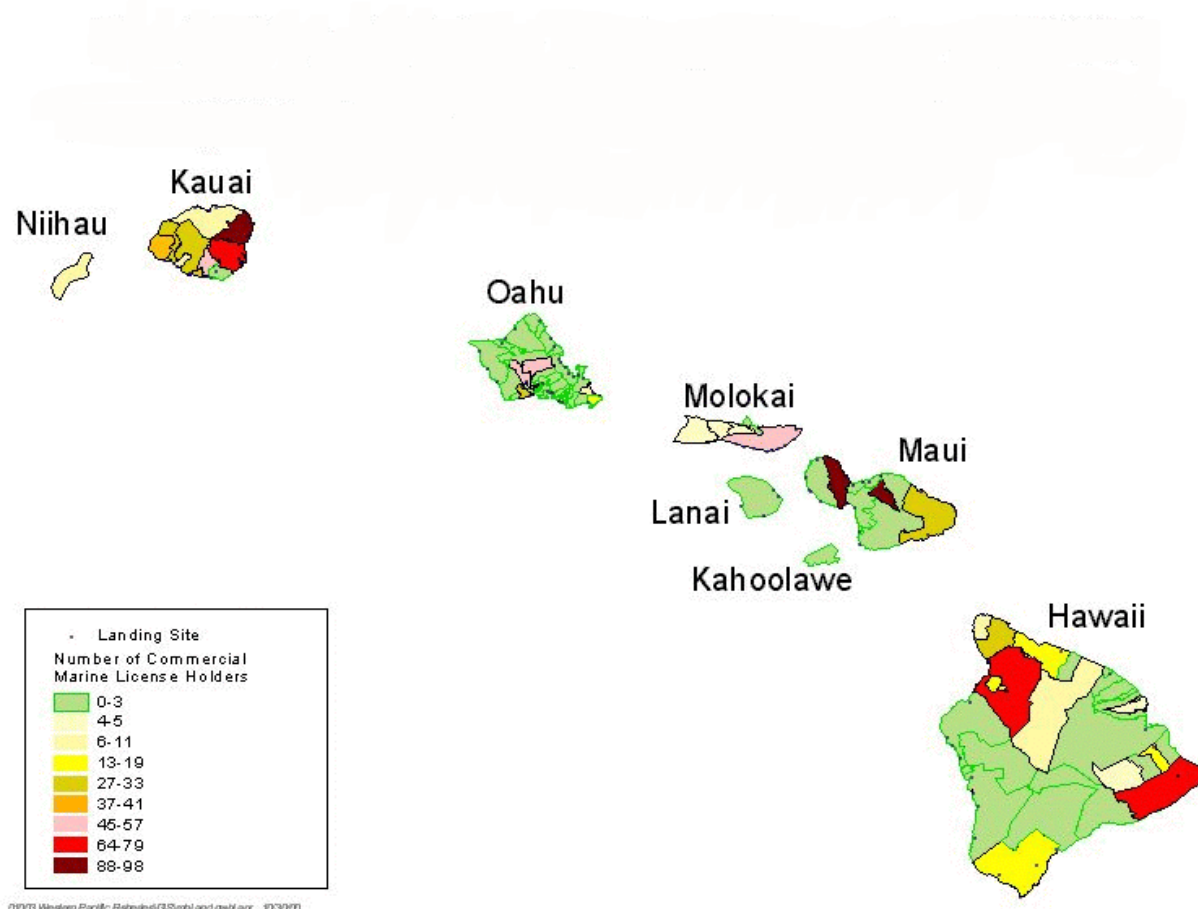


Figure 18: Distribution of Mailing Address Zip Codes of HDAR Commercial Marine License Permit Holders Who Participated in the Hawaii Bottomfish Fishery, 1998

Most of the vessels that comprise the NWHI bottomfish fishing fleet utilize harbor facilities at Kewalo Basin, a harbor located in the metropolitan Honolulu area. Three vessels operate from Port Allen Harbor on Kauai. Nearly all of the participants in the NWHI bottomfish fishery reprovision in Honolulu and offload their catch at Kewalo Basin because it is close to the fish auction. In addition, most of the large-volume, restaurant-oriented wholesalers that buy, process and distribute fishery products are located in the greater Honolulu area. Businesses whose goods and services are used as inputs in Hawaii's offshore commercial fisheries, such as ice plants, marine rail ways, marine suppliers, welders and repair operations, are similarly concentrated in Honolulu. However, the contribution of the harvesting and processing of fishery resources to the total economic fabric of Honolulu is negligible in comparison to other economic activities in the metropolitan area, such as tourism. In other words, Honolulu is the center of a major portion of commercial fishing-related activities in the state but is not a community substantially dependent

upon or substantially engaged in fisheries in comparison to its dependence upon and engagement in other economic sectors.

The bottomfish fishing fleet that concentrates its effort in the waters around the MHI consists mainly of trailered vessels operating from numerous launching facilities scattered throughout the state (Hamilton 1997). Glazier (1999) identified 55 ramps and harbors used by commercial and recreational fishing boats. This number does not include several private boat mooring and launching facilities. Many of these harbors and ramps offer minimal shore-side support services, and even some of the large, well-developed harbors are remote from any central business district or residential area. However, the extensive network of launching sites provides fishermen living anywhere on a given island ready access to multiple fishing grounds (Glazier, 1999).

The motivations for fishing among contemporary Hawaii fishermen tend to be mixed even for a given individual (Glazier 1999). In the small boat fishery around the MHI the distinction between “recreational” and “commercial” fishermen is extremely tenuous (Pooley 1993a). Hawaii’s seafood market is not as centralized and industrialized as U.S. mainland fisheries, so that it 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.

It is also important to note that many people in Hawaii who might be considered “commercial” fishermen hold non-fishing jobs that contribute more to their household income than does fishing (Pooley 1993a). For some fishermen non-fishing jobs are not a choice, but a necessity due to the inability to earn an adequate return from fishing. Many participants in Hawaii’s offshore fisheries often catch insufficient fish to cover even fuel, bait and ice expenses, but they continue fishing simply for the pleasure of it. Some go so far as to pursue non-fishing occupations that allow them to maximize the time they can spend fishing regardless if it is profitable or not (Glazier 1999).

Fulfillment of social obligations may also at times be an important reason for fishing. Fish are an important food item among many of the ethnic groups represented in Hawaii, especially during various social events. Fishermen are expected to provide fish during these occasions and may make a fishing trip especially for that purpose (Glazier 1999).

Finally, some Hawaii fishermen feel a sense of continuity with previous generations of fishermen and want to perpetuate the fishing life style. The aforementioned 1993 survey of participants in the NWHI bottomfish fishery found that half of the respondents who fish in the Ho’omalau Zone were motivated to fish by a long term family tradition. 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. A recent sociocultural survey of small trolling vessel captains in Hawaii found that many of those interviewed either descend from long time fishing families or have worked in fishing or fishing-related work since they were in their teens (Glazier 1999). The average captain had almost 18 years of offshore fishing experience. The survey found that 35% of boat captains were taught how to fish by their fathers, grandfathers or uncles, while 32% reported being taught by friends (Glazier 1999). Only 14% indicated that

they taught themselves. Most Hawaii fishermen consider knowledge and experience to be more important factors in determining fishing success than “high-tech” gear. An example of the value placed on information passed down from previous generations of fishermen is the monument that one town on Oahu has recently proposed to commemorate the *kūpuna* (elders) of that area who are recognized for their fishing skills and knowledge (Ramirez 2000).

Whatever the motivations for fishing, the contributions of friends and family members to these efforts are often substantial. Small boat fishing in Hawaii is almost always a cooperative venture involving friends or relatives as crew members (Glazier 1999). In addition, wives, in particular, often play an essential role in shore-side activities such as the transport of fish to markets, purchase of ice, vessel maintenance, bookkeeping and so forth (Glazier 1999).

In Hawaii during the past several years there have been a number of highly publicized clashes between the owners of large and small fishing boats and between fishermen who are newcomers and those who are established residents (Glazier 1999). The reasons for these conflicts are complex, but the perception that the state’s marine resources are being damaged and depleted by certain groups of fishermen is a central factor. Fish landing statistics support the notion that catch rates in some fisheries are on the decline. Many fishermen have found that fishing is no longer a profitable enterprise and have dropped out of the industry (Glazier 1999). The situation is aggravated by a depressed state economy that has made it more difficult for many fishermen to find the financial resources to support marginal fishing operations.

In some cases, government regulations have helped alleviate competition among fishermen. In 1991, for example, a longline vessel exclusion zone ranging from 50 to 75 nm was established around the MHI to prevent gear conflicts between large longline vessels and small troll and handline boats. However, government regulations have also added to the level of tension and feelings of frustration among fishermen. For instance, many fishermen in Hawaii have adjusted to natural variations in the availability of various types of fish by adopting a multi-species, multi-gear, highly flexible fishing strategy. However, this strategy is increasingly constrained by the implementation of limited access programs in Hawaii’s major commercial fisheries (Pooley 1993a).

Despite this highly competitive and divisive environment fishermen have been able to develop and maintain networks of social relations that foster collaboration and mutual support. For example, fishermen’s attempts at organizing to promote their shared interests, whether in the market or lobbying government for changes in policy, have generally been fragmented. Nevertheless, some fishermen in Hawaii are represented by a *hui* or organization, and these voluntary associations often facilitate coordination and cooperation for the mutual benefit of their members. A case in point is the Maui Cooperative Fishermen’s Association, which is comprised of bottomfish fishermen many of whom are part-timers. The Association negotiates product prices with one or more seafood distributors who, in turn, supply local hotels and restaurants with fresh fish.

Glazier (1999) observed that membership in a Hawaii fishing *hui* can instill a strong feeling of camaraderie and solidarity among fishermen. The cohesion within these organizations constitutes

available social capital for both their members and the broader community. For example, fishing clubs often organize or participate in community service projects (Glazier 1999). Examples of more ad hoc forms of cooperation among fishermen are also common. For instance, fishermen may take turns trucking each other's fish from distant landing sites to the central fish auction in Honolulu, thereby reducing transportation costs (Glazier 1999).

Close social relationships also continue to be maintained between some fishermen and fish buyers. For example, small boat fishermen on Kauai and the Kona side of the island of Hawaii tend to sell their catch directly to local buyers who, in turn, sell it to restaurants or retail markets (Glazier 1999). By sending their fish directly to dealers fishermen not only avoid the commission charged by the auction but also enjoy the price stability over the long-term that comes with an established reciprocal relationship. As Peterson (1973) noted, "A fisherman feels that if he is 'good to the dealer' in supplying him with fish that he needs to fill his order, 'the dealer will be good to him' and give him a consistently fair price for his fish."

2.2.9.6 Social Aspects of Fish Distribution and Consumption

Archaeological evidence indicates that seafood was part of the customary diet of the earliest human inhabitants of the Hawaiian Islands (Goto 1986). An early European visitor to Hawaii observed that, "There is no animal food which a Sandwich Islander esteems so much as fish" (Bennett 1840:214). Nineteenth century immigrants to Hawaii from Asia also possessed a culture in which fish was an integral part of the diet. Despite the "exorbitant" fish prices that Hawaii residents have often encountered in the markets, the level of consumption of seafood in the islands has historically been very high. One early commentator noted:

In the Honolulu market 2,000,000 pounds of fresh salt water fish valued at \$5,000,000 are sold annually. These figures represent a high price for a food that abounds in the waters all around the Islands, yet the people of this community, who are great lovers of the products of the sea, will gratify their tastes even at this expense (Anon. 1907:17).

Today, per capita seafood consumption in Hawaii is still at least twice as high as the national average (Shomura 1987).

Because seafood was such a significant item in the diets of local residents, the fish markets themselves became important institutions in Hawaii society. Dole (1920:20) noted that the fish market located in the busiest section of Honolulu was more than a commercial establishment, it was also "...Honolulu's political center where impromptu mass meetings were held ...; it was, in a way, a social center also, especially on Saturdays for then business was at its height." Much of the retailing of fish now occurs through self-service supermarkets, but Honolulu's fish markets have endured and continue to be centers of social interaction for some island residents.

The fish markets are comprised of retail units the majority of which are single proprietorship-family type operations. Close social connections have developed between retailers and consumers, as the success of the dealers is largely a function of their ability to maintain good

relations with their customers and maintain a stable clientele (Garrod and Chong 1978). One journalist wrote of the Oahu Market, where fresh fish and produce have been sold for nearly a century: “In the hustle and bustle of daily life in downtown Honolulu, many people are drawn to Oahu Market because of its informal charm and the feeling of family one gets while shopping there” (Chinen 1984).

Early in the last century Bryan (1915) developed a list of the various fish purchased in the Honolulu market by each of Hawaii’s principal “nationalities.” The ethnic identification of Hawaii’s *kamāina* (long-time residents) with particular species has continued to the present day. The large variety of fish typically offered in Hawaii’s seafood markets reflects the diversity of ethnic groups in Hawaii and their individual preferences, traditions, holidays and celebrations.

Many of the immigrant groups that came to Hawaii brought with them cultures in which fish are not only an integral part of the diet but given symbolic and even transformative connotations. Certain fish communicate messages of solidarity, favor, opulence and the like, or are believed to impart specific desirable traits to the diners (Anderson 1988; Baer-Stein 1999). For example, some types of bottomfish that are red in color have found acceptance within the Japanese community in Hawaii as a substitute for red *tai* (sea bream, *Pagrus major*) – a traditional Japanese symbol of good luck and, therefore, an auspicious fish to be served on festive occasions (HDAR 1979; Shoji 1983). The red color of these fish also symbolizes prosperity and happiness.¹⁹ The December peak in landings of *ōpakapaka*, *onaga*, *kalekale* and *ehu* reflect the demand for them as an important dish in feasts celebrating *Oshogatsu* (Japanese New Year’s), considered the most important cultural celebration for people of Japanese ancestry in Hawaii. Serving these fish is also important during non-seasonal events such as wedding and birthday banquets. For Hawaii residents of Chinese descent fish or “*yu*” is an important item during feasts celebrating *Tin nien* (Chinese lunar New Year) and other ritual observances, as it is a homophone for abundance (Choy 1989). Fish also symbolize regeneration and freedom because of their rapid ability to propagate as well as their speed and unconfined lifestyle (Baer-Stein 1999). Fish with white, delicately-flavored flesh are in particularly high demand by the Chinese community during New Year celebrations and other festive occasions (Peterson 1973).

An insistence on quality, as well as quantity and variety, has also long been a hallmark of Hawaii’s seafood markets. For example, the Japanese immigrants to Hawaii came from a society in which fishermen, fish dealers and even cooks typically handle prized fish with considerable care (Joya 1985). Hawaii seafood consumers continue to demand fresh fish. Both the discriminating tastes of local residents and the symbolic meaning with which some fish are imbued are linked to the importance of fish as gifts from one person or family to another. In Hawaii various types of high-priced fish such as red snapper are highly regarded as gifts (Peterson 1973). Such sharing and gift giving may play an important role in maintaining social relations, as exemplified by the traditional Japanese obligation to engage in reciprocal exchanges

19 The reason *tai* is regarded as a celebratory fish among Japanese is thought to be due not only to its beauty of form and color but also because “*tai*” suggests the word “*medetai*,” meaning auspicious (Shoji 1983)

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.

The sharing of fish among members of the extended family and community is also an early tradition of the indigenous people of Hawaii. The social responsibility to distribute fish and other resources among relatives and friends remains a salient feature of the lives of many Native Hawaiians that is enacted on both a regular basis and during special occasions (Glazier 1999). Among Native Hawaiians fish is considered a customary food item for social events such as a wedding, communion, school graduation, funeral or child's first birthday (baby *lūau*) (Glazier 1999).

2.2.9.7 Social Significance of Fishing to the Broader Community

Commercial fishing has been part of Hawaii's economy for nearly two centuries. Long-established fishing-related infrastructure in Honolulu such as the fish markets and Kewalo Basin mooring area has helped define the character of the city. Moreover, for some major ethnic groups in Hawaii such as the Japanese and Native Hawaiians the role that their forebears played in the development of commercial fisheries in the islands remains an important part of their collective memory. 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.

Given the historical significance of commercial fishing in Hawaii, it is likely that some local residents consider the fishing industry to be important in the cultural identity and heritage of the islands. Individuals who have never fished and do not intend to may nonetheless value the knowledge that others are fishing and that this activity is continuing to contribute to Hawaii's social, cultural and economic diversity. This existence value may be expressed in various ways. For example, some individuals 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, the image of Hawaii has become linked with some types of locally caught seafood. Among the fish species that have become closely identified with Hawaii are bottomfish such as *ōpaka* and *onaga*. The continued availability of these seafoods in Hawaii has important implications for the mainstay of the state economy - tourism.²⁰ Many Japanese tourists visiting Hawaii want to enjoy

20 Suryanata (2000) notes that many attributes of Hawaii have been constructed in the marketing of Hawaii by the tourist industry, and unusual or exotic food complements the marketed image. In describing the current initiative to revive Hawaii's agricultural sector by diversifying into high-value non-traditional export crops, such as tropical flowers, gourmet coffee and tropical speciality fruits, she writes "None of these products is unique to Hawaii in a true sense to merit a higher price, but marketing strategies seek to define a strong place-association of these products with Hawaii, to capitalize on Hawaii's exotic image and to develop niche markets for speciality

the traditional foods and symbols of prosperity 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 perceived as part of the unique experience of a Hawaii vacation. For both Japanese and U.S. mainland tourists, the experience of consuming fish in Hawaii may be enriched if the fish eaten is actually caught in the waters around Hawaii. Suryanata (2000) observes that markets within the state for “grown in Hawaii” products have expanded in the past decade through the proliferation of gourmet restaurants that feature “Pacific Rim” and “Hawaii Regional Cuisine.” This marketing strategy eschews traditional symbols constructed by the tourism industry in favor of inciting an appreciation of the social relationships and physical environment that make Hawaii a unique place.

Suryanata (2000) also notes that place-based speciality food can retain its appeal to buyers beyond a vacation period or even attract buyers who have never been to the place in question. Just as a consumption of organic food may signify a commitment to a certain environmental and social value, a consumption of products from Hawaii can symbolize a partial fulfillment of a desire to experience or relive a Hawaii vacation. According to a national seafood marketing publication, the power of this constructed value to influence prospective buyers has not been lost on Hawaii’s seafood dealers:

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, 1995).

Local production of food as opposed to a reliance on imports also creates opportunities to foster social connections between consumers and their food producers. As noted above, much of the retailing of fish in Hawaii now occurs through supermarkets, and a large quantity of the seafood sold is imported. However, there still exists in Hawaii personal connections between consumers and the individuals who harvest and retail fish. Such connections may have broad public value. For example, a recent article by agricultural researchers identified proximity as one of the key attributes of a sustainable food system:

A sustainable food system is one in which “food is grown, harvested, processed, marketed, sold, [and] consumed as close to home as possible.” An emphasis on locally grown food, regional trading associations, locally owned processing, local currency, and local control over politics and regulation is found within a proximate system. A proximate food system will have “grocery stores close to home which carry local items with little or no corporately owned products to

products from paradise.” This statement is equally true for locally-produced seafood sold in Hawaii.

compete,” and would provide “specialty items that characterize the bioregion”
(Kloppenburger et al. 2000:182).

2.2.9.8 Native Hawaiian Community

Mai Kīnohi Mai (From the Very Beginnings)

The foundation of a people’s culture is often revealed in the stories told about their origins. Native Hawaiians define their relationship to the *āina* (land) as the relationship between younger sibling (*poe Hawaii* - Native Hawaiians) and elder sibling (*āina*) both of whom were descended from *Papa* (Earth mother) and *Wākea* (Sky father) (Kameeleihiwa 1992). The relationship of *poe Hawaii* with the ocean was one defined in sacred terms as manifested by the embodiment of the ocean as the realm of *Kanaloa*, one of four primary *Akua* (Divine Beings) in the pantheon of Native Hawaiian *Akua*. The customary and traditional relationship of *poe Hawaii* to the fauna and flora of this oceanic realm was one of *ohana* (family) in which many of the naturally occurring plants and animals (including fish) were regarded as ancestors embodied in temporal form who acted as divine family guardians (Kamakau 1976; Malo 1951).

This spiritual connection was the foundation of the Hawaiian commitment to care for the land and sea and protect them for use by future generations. The understanding of Native Hawaiians in the interdependence of people and the natural resources that sustain them was preserved in the wisdom of *kūpuna* (ancestors) and articulated in *ōlelo noeau* (sayings of wisdom). The following sample of proverbs compiled by Pukui (1983) illustrate the conservation ethic of Native Hawaiians.

E ai i kekahi, e kāpi kekahi.

Eat some now and save some for another time. (#252)

He pono ka pākiko ma mua o ka hookelakela wale aku.

Better to be economical than too liberal. (#912)

Lilo akula ka nui a koe ka unahi.

Most [of the fish] are taken and only the scales are left.

Said after one has taken the “lion’s share” for himself. (#2004)

The Hawaiian sense of stewardship was essential given the dense human population in Hawaii and the islands’ limited natural resources. Estimates of the population of Hawaii prior to European contact vary. A recent analysis of the Hawaiian population by Stannard (1989) suggests that the population may have approached one million people prior to foreign penetration into the Pacific. Such a large population could also explain how it was that the Native Hawaiian people came to use the area now known as the Northwestern Hawaiian Islands. A population approaching the population that inhabits these islands today would have likely sought to expand its fishing territory as far as possible in order to survive and prosper.

It is part of the historic record that voyages between the MHI and the southern reaches of the NWHI were undertaken on a regular basis. There is also ample evidence that Native Hawaiians were skilled and prolific fishermen both in inshore waters, including the banks near the main islands and extending into the open ocean (e.g., Beckley 1883; Goto 1986; Kahaulelio 1902; Murakami and Freitas 1987; Scobie 1949). It is likely, therefore, that Native Hawaiians frequented the NWHI for ritual and food gathering. Physical evidence found on both Nihoa and Necker islands indicates that Native Hawaiians frequented these islands long enough to build a series of religious temples and agricultural terraces (Emory, 1928).

Evidence of Hawaiian habitation of the NWHI can also be found in the oral traditions of Native Hawaiians. Moses Keale, a recently deceased native of Niihau, related a tradition of Niihauans voyaging to Nihoa for extended periods of time in conjunction with changing weather patterns. These stays were long enough to plant sweet potatoes and harvest those that had been planted on the previous visits. Fish were also caught and preserved for transport back to the MHI (pers. comm. 1980). More recently, in answer to a question regarding extent of the aforementioned voyages, a *kūpuna* (elder) from Niihau stated that these voyages went beyond Nihoa (and possibly Necker) to “*mokupuni palahalaha*” (small flat islands) where one could see from one side of the island to the other (Malaki Kanahale, pers. comm. 2000).

Another example of Hawaiian familiarity with the Northwestern Hawaiian Islands found in the oral record is a section of the story of *Pele* and *Hiiaka* published in the Hawaiian language newspaper *Kūokoa Home Rula* (1911) in which *Pele* recites the wind names of Nihoa.

Na Makani o Nihoa
He Honouli ka makani o Nihoa
He Waialoha ka makani noho ana o Nihoa
He Lupekiikai ka makani kaapuni o Nihoa

Rauzon (2001) suggests that other *mele* (chants) and legends as well as accounts of the navigational assistance that Hawaiians provided to early European explorers indicate that Hawaiians were familiar with many of the NWHI.

Komo Ka Po e Haole (Penetration of Foreigners)

By the time Captain James Cook came upon the Hawaiian Islands in 1778, the sovereign line of Hawaii had persisted for more than 23 generations - or more than 500 years - of a sustained, stable system of governance. In 1810, Kamehameha succeeded in establishing political control over all of the major islands. In order to cope with increasing foreign contacts, the Hawaiian Kingdom began adopting western legal systems such as a parliament, a constitution and treaties with other nations, including several with the United States. However, during the remainder of the century the succession of Hawaiian monarchs that followed Kamehameha were unsuccessful in warding off the increasing encroachment by various colonial powers. In 1883, the Kingdom of Hawaii was overthrown by a group of mostly American businessmen backed by U.S. soldiers (Kuykendall, 1953). The provisional government sought annexation by the United States, and

after passage of the “Newlands Resolution” in 1898, Hawaii was considered a territory of the United States.

Today, a fundamental question for many Native Hawaiians and others is the legality of the methods used by the United States to acquire the Hawaiian Islands in the 19th century. In 1993, the U.S. 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.”

In the absence of any treaty or voluntary relinquishment, the lingering sovereign claim by Native Hawaiians may dictate that a higher right to the living marine resources within the U.S. EEZ surrounding the Hawaiian Islands might still be justified. Murakami and Freitas (1987) argue that legal claims of Native Hawaiians to the fishery have not been extinguished by the U.S. government. He notes that, “...Congressional enactments and the 1983 Presidential Proclamation to extend U.S. jurisdiction over mineral resources of the EEZ and the fisheries of the FCZ [200-mile Fishery Conservation Zone] would not affect the viability of this claim in the absence of any treaty or settlement act resolving the potential Hawaiian claim to the fishery, mineral and other natural resources of the FCZ and EEZ around the Hawaiian and Northwest Hawaiian Islands.”

Murakami and Freitas (1987:27) summarize the legal aspects of U.S. participation in the conservation of fisheries around the Hawaiian Archipelago in regard to Native Hawaiian claims:

The U.S. government has the power to affect the Hawaiian claim to portions of the Hawaiian and Northwestern Hawaiian Island FCZ and EEZ by either: 1) condemning the fisheries granted to Hawaiian commoners and their successors in the FCZ, which will require it to compensate the Hawaiian people for the taking of their fishing grounds; or 2) exercising its public trust duties to protect the aboriginal claims to the resources of the EEZ and FCZ, which will require it to determine what allocation of the revenues it will allow to Hawaiians and what form and extent of participation it will grant to protect the marine environment in which the communal right to fish and gather may take place. The resolution of these issues may have to involve a resolution of the Hawaiian claim for reparations or restitution linked to the 1893 overthrow.

The legal uncertainty is rooted in the failure of the U.S. to resolve the potential aboriginal or other claims of Hawaiians for restitution or reparations as a domestic, dependent nation of people, as those of native Americans and Alaska natives have been, or are being resolved. There is ample precedent to support such a claim in Congress. So long as that claim is outstanding, Hawaiians will continue to have a defensible claim to the fishery resources of the FCZ and mineral and other resources of the EEZ.

The aforementioned Apology Bill stated that

The Congress ... (4) expresses 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 United States and the Native Hawaiian people; and (5) urges the President of the United States to also acknowledge the ramifications of the overthrow of the Kingdom of Hawaii and to support reconciliation efforts between the United States and the Native Hawaiian people.

Some progress has been made in resolving the Hawaiian claim for reparations or restitution linked to the 1893 overthrow. In December 1999, a series of reconciliation hearings attended by federal representatives, Native Hawaiians and the general public was conducted in Hawaii. In addition, in July 2000, Hawaii's congressional delegation introduced a bill to express the policy of the United States regarding the United States' relationship with Native Hawaiians, to provide a process for the reorganization of a Native Hawaiian government and the recognition by the United States of the Native Hawaiian government.

As these reconciliation efforts proceed, it is also likely that clarification of rights will be an outgrowth of litigation in the courts. The Hawaii Supreme Court, for example, has addressed the nature of certain Hawaiian traditions and customs in a number of cases where it had been asked to address the protection of traditional and customary practices under state law. Most recently, in *Public Access Shoreline Hawaii v. Hawaii County Planning Commission*, 79 Hawaii 425, 903 P.2d 1246 (1995), the court emphasized the obligation of a state agency to preserve and protect Native Hawaiian rights. In its consideration of an action by the Hawaii Planning Commission arising under the Coastal Zone Management Act, the court concluded that the legitimate customary and traditional practices must be protected to the extent feasible in accordance with Article XII, Section 7 of the state constitution and that the state does not have the unfettered discretion to regulate the rights of ahupuaa tenants out of existence.²¹ The court reiterated that the Native Hawaiian rights protected by the state constitution may extend beyond the *ahupuaa* in which a Native Hawaiian resides. Moreover, the rights remain intact "...notwithstanding arguable abandonment of a particular site, although this right is potentially subject to regulation in the public interest." Finally, the court went one step further in supporting traditional practices. It said that ancient practices can revive themselves and still have legal authority. In the words of the court, "...continuous exercise is not absolutely required to maintain the validity of a custom."

Socio-economic Conditions of Native Hawaiians

At present, people of Native Hawaiian ancestry comprise about 21% of Hawaii's population (DBEDT 1999). By most statistical measures, they have the lowest incomes and poorest health of any ethnic group in the state. Native Hawaiians have long been among the most economically disadvantaged ethnic or racial group in Hawaii in terms of standard of living, degree of

21 Article XII, Section 7 of the Hawaii Constitution states: "The State reaffirms and shall protect all rights, customarily and traditionally exercised for subsistence, cultural and religious purposes and possessed by *ahupuaa* tenants who are descendants of native Hawaiians who inhabited the Hawaiian Islands prior to 1778, subject to the right of the State to regulate such rights."

unemployment, dependence on transfer payments and limited alternative employment opportunities. In recent years, Native Hawaiians have had the highest proportion of individuals living below the poverty line. In 1989, 6% of all the families in the state had incomes classified below the federal poverty level (OHA 1998). During the same period, 14% of Native Hawaiians were below the poverty line. Nearly 15% of Native Hawaiian households receive public assistance income, compared to 6.8% of households in the State (OHA 1998). In several residential areas over a third of Native Hawaiian households receive public assistance.

For centuries Native Hawaiians relied on seafood as their principle source of protein. However, the availability of many traditional seafoods has been significantly diminished. Overfishing and ecological degradation of inshore areas by pollution has had a pronounced negative impact on Native Hawaiian marine subsistence practices. Shomura (1987), for instance, notes that between 1900 and 1986, the harvest of coastal fish species in Hawaii declined by 80 percent, and catches of neritic-pelagic species declined by 40 percent. The changes in diet that resulted from loss of access to sea resources have contributed to the poor health of Native Hawaiians. Of all 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).

As noted earlier, there is abundant historical and archaeological evidence of the social importance of fishing in traditional Hawaiian culture. With specific regard to bottomfish, this significance was of both an economic and ritual nature (Iversen et al. 1990). Bottomfish such as *kāhala*, *ulua* and *ulaula* (*onaga*) are specifically mentioned in traditional prayers used by fishermen, and fishing for these species was associated with religious rites. The cultural significance of bottomfish species to Hawaiian society is also indicated by the growth stage names for *ōpakapaka*, white *ulua*, *kāhala* and the varietal names for *ulaula* and *uku*.

There may continue to be a strong cultural and religious connection between contemporary Native Hawaiians and certain species of bottomfish (Iversen et al. 1990). Some present day Native Hawaiian consumers of these bottomfish may still associate these fish with traditional beliefs and with their dependence upon the fish for food. Because of the high cost of some bottomfish, they may be frustrated in maintaining such a traditional connection. Industry sources report that Native Hawaiians purchase proportionally less bottomfish than other ethnic groups, possibly because other types of fish cost less, and if Native Hawaiians have less disposable income to spend on fish, they would likely opt to purchase less costly species (Iversen et al. 1990).

3.0 CHAPTER THREE: ALTERNATIVES

This section describes the alternatives currently being considered as amendments to the Council's Fishery Management Plans. These range from No Action (Alternative 1) to a ban on all fishing within the proposed NWHI sanctuary (see Figure 19) that would take effect five years after the (yet to be determined) sanctuary designation.

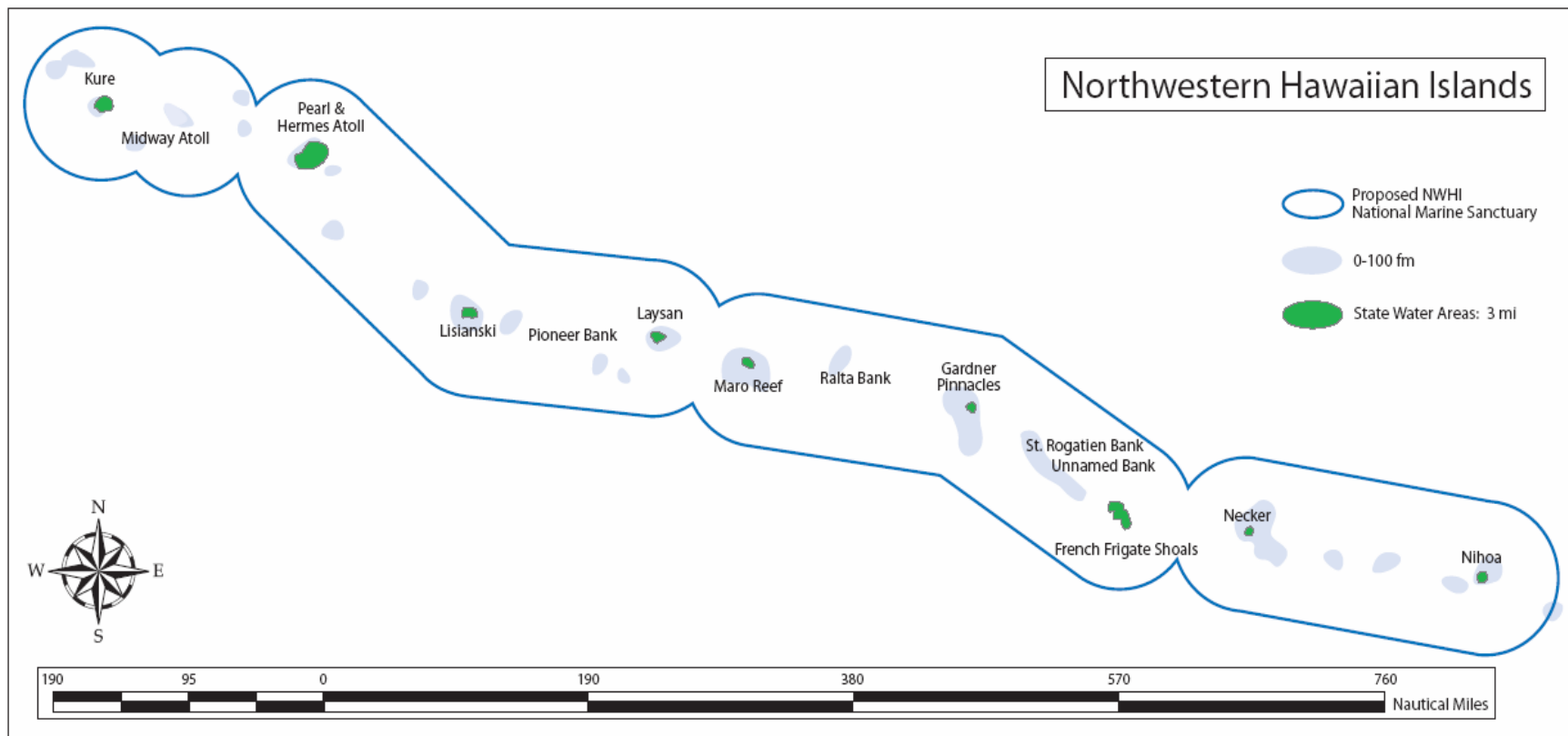


Figure 19: Proposed NWHI Sanctuary

3.1 Alternative 1A: FMP Status Quo (No Action A)

Under this alternative, all NWHI federal fisheries would be conducted according to the existing management measures of the following five FMPs that have been developed, approved, and implemented for the NWHI by the Council NMFS. Please see section 660 of Title 50 of the Code of Federal Regulations for the regulations implementing the following FMPs.

3.1.1 Bottomfish and Seamount Groundfish FMP

The NWHI bottomfish fishery is divided into two sections, the more northern Ho'omalua Zone and the southerly Mau Zone. Each zone is managed under a limited entry program with no more than seven vessels allowed in the Ho'omalua Zone and no more than ten allowed in the Mau Zone. Bottom trawling, nets, poison, explosives and other destructive gears are prohibited. Vessels can be no more than 60 ft in length and vessel captains must attend protected species workshops and carry federal observers if requested by NMFS. Fishing for armorhead is prohibited on the Hancock Seamount while stocks recover from the impacts of foreign fishing prior to the implementation of the Magnuson-Stevens Fishery Conservation and Management Act.

The Bottomfish and Seamount Groundfish FMP was implemented in 1986. It prohibits certain destructive fishing techniques, including explosives, poisons, trawl nets and bottom-set gillnets; establishes a moratorium on the commercial harvest of seamount groundfish stocks at the Hancock Seamounts; and implements a permit system for fishing for bottomfish in the EEZ around the NWHI. (The moratorium on the commercial harvest of seamount groundfish stocks at the Hancock Seamounts, the only exploitable seamount habitat in the management area, remains in effect. At its 123rd meeting (June 21-24, 2004), the Council approved an extension of the moratorium until August 31, 2010 (69 FR 51400). Consequently, there is no seamount groundfish fishery in the region. The plan also establishes a management framework that includes adjustments such as catch limits, size limits, area or seasonal closures, fishing effort limitation, fishing gear restrictions, access limitation, permit and/or catch reporting requirements and a rules-related notice system.

Implemented in 1987, Amendment 1 includes the establishment of potential limited access systems for bottomfish fisheries in the EEZ surrounding American Samoa and Guam within the framework measures of the FMP. Amendment 2 (1988) divides the EEZ around the NWHI into two zones: the Ho'omalua Zone to the northwest and the Mau Zone to the southeast. The amendment also establishes a limited access system for the Ho'omalua Zone. Amendment 3 (1991), which has been supplanted by Amendment 6, defined recruitment overfishing as a condition in which the ratio of the spawning stock biomass per recruit at the current level of fishing to the spawning stock biomass per recruit that would occur in the absence of fishing is equal to or less than 20 percent. Amendment 3 also delineated the process by which overfishing is monitored and evaluated. Amendment 4 (1990) requires vessel owners or operators to notify NMFS at least 72 hours before leaving port if they intend to fish in a 50 nm "protected species study zone" around the NWHI. This notification allows federal observers to be placed on board

bottomfish vessels to record interactions with protected species if this action is deemed necessary. Amendment 5 (1999) establishes a limited access system for the Mau Zone and a framework for a Western Pacific Community Development Program. Amendment 6 (1999) identifies and describes essential fish habitat for managed species of bottomfish, discusses measures to minimize bycatch and bycatch mortality in the bottomfish fishery, provides criteria for identifying when overfishing has occurred in the fishery and describes fishing communities in the Region. Amendment 6 initially was only partially approved, with the provisions for bycatch, overfishing and fishing communities in Hawaii disapproved. The disapproved provisions were rewritten and the revised provisions have been implemented. Amendment 7 was prepared and transmitted to NMFS for approval in parallel with the FMP for Coral Reef Ecosystems of the Western Pacific Region. This amendment prohibits the harvest of Bottomfish and Seamount Groundfish Management Unit Species (BMUS) in the no-take marine protected areas established under the Coral Reef Ecosystems FMP. The Coral Reef Ecosystems establishes such areas around Rose Atoll in American Samoa, Kingman Reef, Jarvis Island, Howland Island, and Baker Island. No-take areas were also recommended for the NWHI, but all measures recommended in the Coral Reef Ecosystems FMP that would have applied to the waters around the NWHI (including Midway) were disapproved because of possible conflict and duplication with Executive Orders 13178 and 13196.

3.1.2 Crustaceans FMP

A limited entry program is in place for the NWHI lobster fishery, with no more than 15 vessels allowed in the NWHI. The fishery is further limited by an annual harvest guideline. Because the majority of fishing occurs around Necker Island, Maro Reef, and Gardner Pinnacles, this harvest guideline is divided into four fishing areas (the fourth is “all other areas”). No harvest guideline has been issued by NMFS for this fishery since 1999, due to uncertainties in the population modeling results. This model calculates the exploitable biomass in each fishing area, managers then determine the annual harvest based on a given risk of overfishing ratio. Through 1999 this ratio indicated that an annual harvest of 13% of the exploitable population was associated with a 10% risk of overfishing, and these were the harvest and risk levels that were chosen. When an anticipated new model is released by NMFS it may contain a different risk ratio and managers may have to choose a new harvest level to maintain the 10% risk level. Fishery participants must use specified traps designed to allow small lobsters to escape, as well as to prevent monk seal entanglement. Federal observers are carried on every vessel and no lobster fishing is permitted within 20 miles of Laysan Island or within 10 fathoms of all other NWHI.

The FMP was implemented in 1983. Initial provisions in the FMP include: a prohibition on fishing for spiny lobster within 20 nm of Laysan Island and within the EEZ landward of the 10 fm curve as depicted on National Ocean Survey Charts Numbers 19022, 19019, and 19016; a minimum size limit; requirements for gear design; prohibitions on retention of ovigerous females; and a mandatory federal logbook and permit program. Since its implementation in 1983, the FMP has been amended ten times. Amendment 1, implemented in 1983, adopted State of Hawaii regulations in the EEZ around the main Hawaiian Islands (MHI). Amendment 2, implemented in 1983, specified trap opening dimensions. Amendment 3, implemented in 1985, clarified definitions for minimum size and tail length. Amendment 4, implemented in 1986,

prohibited all lobster fishing in the FMP closed areas in the NWHI. Amendment 5, implemented in 1987, established a minimum size for retained slipper lobsters and required escape panels in traps. Amendment 6, implemented in 1990, defined recruitment overfishing. Amendment 7, implemented in 1991, established a closed season, limited access system and adjustable annual harvest quota. Amendment 8, implemented in 1994, eliminated the “use-it-or-lose-it” landing requirement for permittees. Amendment 9, implemented in 1995, revised the annual harvest guideline and, based on high discard mortality rates, replaced minimum size and condition restrictions in the NWHI with a “retain-all” fishery in which every lobster brought aboard is counted against the annual harvest guideline. Amendment 10, implemented in 1998, identified and described essential fish habitat for crustacean management unit species, discussed measures to minimize bycatch and bycatch mortality, and provided criteria for identifying when overfishing has occurred. In 1998, bank-specific harvest guidelines were established through a framework regulatory measure. The annual harvest guideline represents 13 percent of the exploitable population, which results in a 10 percent chance of overfishing the lobster stock at a particular permit area. In 1999, a process was established by which NMFS is authorized, in consultation with the Council, to allocate the annual harvest guideline among permit subareas (i.e. Necker Island, Gardner Pinnacles and all other NWHI lobster fishing grounds). Amendment 11 was prepared and transmitted to NMFS for approval in parallel with the FMP for Coral Reef Ecosystems of the Western Pacific Region. This amendment prohibits the harvest of Crustacean Management Unit Species (BMUS) in the no-take marine protected areas established under the Coral Reef Ecosystems FMP. The Coral Reef Ecosystems establishes such areas around Rose Atoll in American Samoa, Kingman Reef, Jarvis Island, Howland Island, and Baker Island. No-take areas were also recommended for the NWHI, but all measures recommended in the Coral Reef Ecosystems FMP that would have applied to the waters around the NWHI (including Midway) were disapproved because of possible conflict and duplication with Executive Orders 13178 and 13196.

3.1.3 Precious Corals FMP

The Precious Corals FMP utilizes a combination of minimum sizes, quotas and other measures to manage potential NWHI harvests of these deep-water species (none have occurred since the Council began managing the fishery in 1983). There are several known beds of precious corals in the NWHI and the use of non-selective gear (such as dredges or tangle nets) is prohibited in all areas.

The FMP was implemented in 1983. The plan established harvest quotas for separate beds, a minimum size limit for pink coral, gear restrictions, area restrictions and fishing seasons. The FMP has been amended four times. Amendment 1, implemented in 1988, applied the management measures of the FMP to U.S. Pacific Insular Areas other than Guam, American Samoa and the Northern Mariana Islands by incorporating them into a single exploratory permit area; expanded the managed species to include any coral of the genus *Corallium*; and outlined provisions for experimental fishing permits. Amendment 2, implemented in 1991, defined a bed as overfished with respect to recruitment when the total spawning biomass (all species combined) has been reduced to 20 percent of its unfished condition. Amendment 3, implemented in 1998, established a framework procedure for adjustment of management measures.

Amendment 4, implemented in 1998, identified and described essential fish habitat for managed species of precious corals, discussed measures to minimize bycatch and bycatch mortality in the precious corals fishery and provided criteria for identifying when overfishing has occurred in the fishery.

In 2002 NMFS partially approved a regulatory amendment to the FMP which prohibited the use of non-selective gear to harvest precious corals, defined live and dead corals, established minimum size limits for live pink and black corals, and suspended the harvest of gold coral at Makapu'u Bed. Additional recommendations contained in the regulatory amendment would have revised the boundaries of the NWHI Brooks Bank Bed and reduced its harvest quota for pink coral as well as suspending its quota for gold coral, designate a newly discovered bed at French Frigate Shoals (Gold Pinnacle Bed) as a conditional bed and implement a zero harvest quota for all precious corals at this bed. These recommendations were disapproved by NMFS as inconsistent with Executive Orders 13178 and 13196.

Amendment 5 was prepared and transmitted to NMFS for approval in parallel with the FMP for Coral Reef Ecosystems of the Western Pacific Region. This amendment prohibits the harvest of Coral Reef Ecosystems Management Unit Species (BMUS) in the no-take marine protected areas established under the Coral Reef Ecosystems FMP. The Coral Reef Ecosystems establishes such areas around Rose Atoll in American Samoa, Kingman Reef, Jarvis Island, Howland Island, and Baker Island. No-take areas were also recommended for the NWHI, but all measures recommended in the Coral Reef Ecosystems FMP that would have applied to the waters around the NWHI (including Midway) were disapproved because of possible conflict and duplication with Executive Orders 13178 and 13196.

3.1.4 Coral Reef Ecosystems FMP

This FMP was developed to manage coral reef ecosystem associated species but was only partially implemented by NMFS. Those measures that would apply to the NWHI were disapproved as potentially in conflict with the NWHI Reserve established by President Clinton as a precursor to sanctuary designation.

The Council completed the Fishery Management Plan for Coral Reef Ecosystems of the Western Pacific Region in October of 2001. On June 14, 2002 NMFS issued a Record of Decision that partially approved the FMP. NMFS disapproved a portion of the plan that governs fishing in the NWHI because of possible conflict and duplication with Executive Orders 13178 and 13196. A final rule implementing the Coral Reef Ecosystem FMP was published on February 24, 2004 (69 FR 8336).

The FMP is the nation's first ecosystem-based plan for fisheries and includes specific measures to promote sustainable fisheries while providing for substantial protection of coral reef ecosystem resources and habitats throughout the Council's jurisdiction. The management measures of the Coral Reef Ecosystems FMP:

1. Establish a network of marine protected areas (MPA) in the Pacific Remote Island Areas (PRIA). Howland, Baker, Jarvis Islands, Rose Atoll and Kingman Reef have been

- designated as no-take MPAs. Palmyra, Johnston Atolls and Wake Islands are designated as low-use MPAs where fishing is allowed under special fishing permits. Both no-take and low-use MPAs were proposed for the NWHI in the FMP but disapproved by NMFS;
2. Establish a special permit and federal reporting system for controlling and monitoring the harvest of certain coral reef ecosystem MUS for which there is little or no information. Special permits are also required to fish in all areas designated as low-use MPAs. The FMP also uses data collected under existing local reporting systems to monitor the harvest of currently fished coral reef ecosystem management unit species (MUS);
 3. Prohibit the use of destructive and non-selective fishing gears;
 4. Prohibit harvesting of coral and live rock, but allow limited take under the special permit system for collection of seed stock by aquaculture operations, and religious/cultural use by indigenous peoples;
 5. Incorporate 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;
 6. Consider and take into account in management, the historical and cultural dependence of coral reef resources by indigenous people and;
 7. Identify and prioritize coral reef related research needs for each island area, including socio-economic and cultural research for future potential allocation of resources.

3.1.5 Pelagics FMP

Under the Pelagics FMP, longlining within 50 miles of the NWHI is prohibited but other types of pelagic fishing (trolling, handlining) are allowed. Drift gillnets and shark finning are prohibited.

The Fishery Management Plan for the Pelagic Fisheries of the Western Pacific Region became effective on March 23, 1987. The Pelagic Management Unit Species at that time were billfish, wahoo, mahimahi, and oceanic sharks. The FMP's first measures prohibited drift gillnet fishing within the region's waters of the Exclusive Economic Zone and prohibited foreign longline fishing within certain areas of the EEZ.

Amendment 1 became effective on March 1, 1991 (56 FR 9686, March 7, 1991) and defined recruitment overfishing for each PMUS. It also defined the optimum yield for PMUS 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 became effective on May 26, 1991 (56 FR 24731, May 31, 1991). It implemented requirements for domestic pelagic longline fishing and transshipment vessel operators to have Federal permits, to maintain Federal fishing logbooks, and, if wishing to fish within 50 nm of the Northwestern Hawaiian Islands (NWHI), to have observers placed on board if directed by the National Marine Fisheries Service (NMFS). Amendment 2 also required longline gear to be marked with the official number of the permitted vessel, and incorporated the waters of the EEZ around the Commonwealth of the Northern Mariana Islands into the area managed under the FMP.

Amendment 3, which became effective on October 14, 1991 (56 FR 52214, October 18, 1991), created a 50 nm longline exclusion zone around the NWHI to protect endangered Hawaiian monk seals. This is a contiguous area extending 50 nm from named features in the NWHI and connected by corridors between those areas where the 50-nm-radius circles do not intersect. Amendment 3 also implemented framework provisions for establishing a mandatory observer program to collect information on interactions between longline fishing and sea turtles.

Amendment 4 was effective October 10, 1991 through April 22, 1994 (56 FR 14866, October 16, 1991). It established a three-year moratorium on new entry into the Hawaii-based domestic longline fishery. The amendment also included provisions for establishing a mandatory vessel monitoring system for domestic longline vessels fishing in the Western Pacific Region. A final rule effective December 15, 1994 (59 FR 58789, November 15, 1994) under Amendment 4 required Hawaii-based longline vessels to carry and use a NMFS-owned vessel monitoring system (VMS) transmitter to ensure that they do not fish within prohibited areas.

Amendment 5 became effective on March 2, 1992 (57 FR 7661, March 4, 1992) and created a domestic longline vessel exclusion zone around the Main Hawaiian Islands (MHI) ranging from 50 to 75 nm, and a similar 50 nm exclusion zone around Guam and its offshore banks. The zones were designed primarily to prevent gear conflicts and vessel safety issues arising from interactions between longline vessels and smaller fishing boats. A seasonal reduction in the size of the closure was implemented in October 1992; between October and January longline fishing is prohibited within 25 nm of the windward shores of all Main Hawaiian Islands except Oahu, where it is prohibited within 50 nm from the shore.

Amendment 6, which became effective on November 27, 1992 (57 FR 48564, October 27, 1992), specified that all tuna species are designated as fish under U.S. management authority and included tunas and related species as Pelagic Management Unit Species under the FMP. It also applied the longline exclusion zones of 50 nm around the island of Guam and the 25-75 nm zone around the MHI to foreign vessels.

Amendment 7 became effective on June 24, 1994 (59 FR 26979, May 25, 1994). It instituted a limited entry program for the Hawaii-based domestic longline fishery with transferable permits, a limit of 164 vessels, and a maximum vessel size of 101' in length overall.

Amendment 8 addressed new requirements under the 1996 Sustainable Fisheries Act (SFA). Portions of the amendment that were immediately approved included designations of essential fish habitat and descriptions of some fishing communities. Those provisions became effective on February 3, 1999 (64 FR 19067, April 19, 1999). Remaining portions that were approved on August 5, 2003 (68 FR 46112) were provisions regarding Hawaii fishing communities, overfishing definitions, and bycatch.

In August 2000, the State of Hawaii enacted a law prohibiting the retention or landing of shark fins without their associated carcasses (a practice called “finning”). Effective March 13, 2002 the Magnuson-Stevens Fishery Conservation and Management Act was amended with a similar nation-wide prohibition (67 FR 6194, February 11, 2002).

Framework Measure 1 became effective March 1, 2002 (67 FR 4369, January 30, 2002) and established an area seaward of 3 nm out to approximately 50 nm around the islands of American Samoa in which fishing for PMUS is prohibited by vessels greater than 50' in length overall that did not land PMUS in American Samoa under a Federal longline general permit prior to November 13, 1997.

Framework Measure 2 became effective June 13, 2002 (67 FR 34408, May 14, 2002) and incorporated the terms and conditions of a November 28, 2000 Biological Opinion issued by the U.S. Fish and Wildlife Service under section 7 of the Endangered Species Act. These measures required Hawaii-based pelagic longline vessel operators to use blue-dyed bait, strategic offal discards, and line shooters with weighted branch lines to mitigate seabird interactions when fishing north of 23° N. Also included was a requirement that all Hawaii-based longline vessel owners and operators annually attend a protected species workshop conducted by NMFS.

Regulatory Amendment 1 to the FMP became effective June 9, 2002 (67 FR 40232, June 12, 2002) and incorporated the reasonable and prudent alternative of a March 2001 Biological Opinion issued by NMFS under section 7 of the Endangered Species Act (this followed and superseded a series of emergency and interim rules issued by NMFS between December 2000 and December 2002 which arose out of litigation activities and are not itemized here). To mitigate interactions with sea turtles, this amendment prohibited shallow set pelagic longlining north of the equator by vessels managed under the FMP and closed waters between 0° and 15° N from April through May of each year to longline fishing. It also instituted sea turtle handling requirements for all vessels using hooks to target pelagic species in the region's EEZ waters. It also extended the protected species workshop requirement to include the operators of vessels registered to longline general permits.

Regulatory Amendment 2 to the FMP became effective October 4, 2002 (67 FR 59813, September 24, 2002) and established Federal permit and reporting requirements for any vessel using troll or handline gear to catch PMUS in EEZ waters around the Pacific Remote Island Areas of Kingman Reef, Howland, Baker, Jarvis, Johnston and Wake Islands, and Palmyra and Midway Atolls.

Amendment 10 was prepared and transmitted to NMFS for approval in parallel with the FMP for Coral Reef Ecosystems of the Western Pacific Region. This amendment prohibits the harvest of Pelagic Management Unit Species (PMUS) in the no-take marine protected areas established under the Coral Reef Ecosystems FMP. The Coral Reef Ecosystems establishes such areas around Rose Atoll in American Samoa, Kingman Reef, Jarvis Island, Howland Island, and Baker Island. No-take areas were also proposed for the NWHI, but all measures proposed in the Coral Reef Ecosystems FMP that would have applied to the waters around the NWHI (including Midway) were disapproved because of possible conflict and duplication with the management regime of the NWHI Coral Reef Ecosystem Reserve. Accordingly, NMFS issued a Record of Decision on June 14, 2002 that partially approved the Coral Reef Ecosystems FMP and Amendment 10 to the Pelagics FMP. A final rule implementing the Coral Reef Ecosystem FMP (including Amendment 10 to the Pelagics FMP) was published on February 24, 2004 (69 FR 8336).

Regulatory Amendment 3 implements management measures for the longline fisheries managed under the Pelagic FMP, with the objective of achieving optimum yield from these fisheries, without being likely jeopardize the long term existence of sea turtles and other listed species. The amendment established a limited model shallow-set swordfish fishery using circle hooks with mackerel bait. This hook and bait combination has been found to reduce interactions with leatherback and loggerhead turtles by 67% and 92% respectively in the U.S. Atlantic longline fishery. Fishing effort in the model shallow-set swordfish fishery is limited, in the first instance, to 50% of the 1994-1999 annual average number of sets, or just over 2,100 sets, allocated between those fishermen applying to participate in the fishery. As an additional safeguard a 'hard' limit on the number of leatherback (16) and loggerhead (17) turtles that could be taken by the swordfish fishery. In addition the amendment includes a number of conservation projects to protect sea turtles in their nesting and coastal habitats.

Amendment 11 established a limited access system for pelagic longlining in EEZ waters around American Samoa with initial entry criteria based on historical participation in the fishery. The final rule to implement Amendment 11 was published on May 24, 2005 (70 FR 29646).

Regulatory Amendment 4 includes a range of measures to minimize interactions with turtles by non-Hawaii based domestic longline vessels operating in the Western Pacific under general longline permits. Under this amendment, vessels with longline general permits making shallow sets north of the equator are required to use 18/0 circle hooks with mackerel-type bait and dehookers to release any accidentally caught turtles. The amendment also requires both operators and owners of vessels with general longline permits to annually attend protected species training workshops. Further, operators of vessels with general longline permits are required to carry and use specific mitigation gear to aid in the release of sea turtles accidentally hooked or entangled by longlines. These include dipnets, long-handled line clippers and bolt cutters (with allowances for boats with < 3' freeboard). This regulatory amendment also requires operators of non-longline pelagic vessels (e.g., trollers and handliners) to follow handling guidelines and remove trailing gear wherever they fish. The final rule implementing this amendment was published on November 15, 2005 (70 FR 69282).

3.2 Alternative 1B: Reserve Status Quo (No Action B)

Under this alternative, NWHI fisheries would be conducted according to the existing management measures of the above Fishery Management Plans as well as the following non-regulatory measures in place for waters between 3 and 50 miles from emergent NWHI lands which were established by Executive Order 13178 and subsequently amended by Executive Order 13196 as follow:

3.2.1 Executive Order 13178

Sec. 7. *Protection and Conservation Measures.* The conservation measures in this section apply throughout the Reserve.

(a) (1) *Commercial Fishing*. All currently existing commercial Federal fishing permits and current levels of fishing effort and take, as determined by the Secretary and pursuant to regulations in effect on the date of this order, shall be capped as follows:

(A) No commercial fishing may occur in Reserve Preservation Areas pursuant to section 8 of this order;

(B) There shall be no increase in the number of permits of any particular type of fishing (such as for bottomfishing) beyond the number of permits of that type in effect the year preceding the date of this order;

(C) The annual level of aggregate take under all permits of any particular type of fishing may not exceed the aggregate level of take under all permits of that type of fishing in the years preceding the date of this order, as determined by the Secretary, provided that the Secretary shall equitably divide the aggregate level into individual levels per permit, and further provided that the Secretary may make a one-time reasonable increase to the total aggregate to allow for the use of two Native Hawaiian bottomfishing permits;

(D) There shall be no permits issued for any particular type of fishing for which there were no permits issued in the year preceding the date of this order; and

(E) The type of fishing gear used by any permit holder may not be changed except with the permission of the Secretary, as provided under paragraph 3 of this section.

(2) *Recreational Fishing*. All currently existing (preceding the date of this order) levels of recreational fishing effort, as determined by the Secretary and pursuant to regulations in effect on the day of this order, shall be capped (i.e., no increase of take levels or levels of fishing effort, species targeted, or change in gear types) throughout the Reserve. However, fishing is further restricted as provided in section 8 of this order.

(3) The Secretary, after consultation with the Secretary of the Interior and Governor of the State of Hawaii, and after public review and comment and consideration of any advice or recommendations of the Reserve Council and Western Pacific Regional Fishery Management Council, may further restrict the fishing activities under subparagraphs (a)(1) and (a)(2) of this section if necessary to protect Reserve resources, or may authorize or require alternate gear types if such gear would offer equal or greater protection for Reserve resources.

(b) In addition to the conservation measures in paragraph (a) of this section, the following activities are prohibited throughout the Reserve:

(1) Exploring for, developing, or producing oil, gas, or minerals;

(2) Having a vessel anchored on any living or dead coral with an anchor, an anchor chain, or an anchor rope when visibility is such that the seabed can be seen;

(3) Drilling into, dredging, or otherwise altering the seabed; or constructing, placing, or abandoning any structure, material, or other matter on the seabed, except as an incidental result of anchoring vessels;

(4) Discharging or depositing any material or other matter into the Reserve, or discharging or depositing any material or other matter outside the Reserve that subsequently enters the Reserve and injures any resource of the Reserve, except fish parts (i.e., chumming material or bait) used in and during authorized fishing operations, or discharges incidental to vessel use such as deck wash, approved marine sanitation device effluent, cooling water, and engine exhaust; and

(5) Removal, moving, taking, harvesting, or damaging any living or nonliving Reserve resources, except as provided under paragraph (a) of this section and sections 8(a) and 9 of this order.

c) The Secretary may conduct, or authorize by permit the activities listed in subparagraphs (b)(3)-(5) of this section to the extent that they are necessary for research, monitoring, education, or management activities that further the Management Principles of section 4 of this order.

Sec. 8. *Reserve Preservation Areas.*

(a) To further protect Reserve resources, the following areas are hereby established as Reserve Preservation Areas until some or all are made permanent after adequate public review and comment, within which all activities referred to in paragraph (b) of this section are prohibited.

(1) From the seaward boundary of Hawaii State waters and submerged lands to a mean depth of 100 fathoms (fm) around:

(A) Nihoa Island, provided that bottomfishing in accordance with the requirements of section 7(a)(1) of this order shall be allowed to continue seaward of a mean depth of 10fm, unless and until the Secretary determines otherwise after adequate public review and comment;

(B) Necker Island, provided that bottomfishing in accordance with the requirements of section 7(a)(1) of this order shall be allowed to continue seaward of a mean depth of 20fm, unless and until the Secretary determines otherwise after adequate public review and comment;

(C) French Frigate Shoals;

(D) Gardner Pinnacles, provided that bottomfishing in accordance with the requirements of section 7(a)(1) of this order shall be allowed to continue seaward of a mean depth of 10fm, unless and until the Secretary determines otherwise after adequate public review and comment;

(E) Maro Reef, provided that bottomfishing in accordance with the requirements of section 7(a)(1) of this order shall be allowed to continue seaward of a mean depth of 20fm, unless and until the Secretary determines otherwise after adequate public review and comment;

(F) Laysan Island, provided that bottomfishing in accordance with the requirements of section 7(a)(1) of this order shall be allowed to continue seaward of a mean depth of 50fm, unless and until the Secretary determines otherwise after adequate public review and comment;

(G) Lisianski Island, provided that bottomfishing in accordance with the requirements of section 7(a)(1) of this order shall be allowed to continue seaward of a mean depth of 50fm, unless and until the Secretary determines otherwise after adequate public review and comment;

(H) Pearl and Hermes Atoll; and

(I) Kure Island.

(2) Twelve nautical miles around the approximate geographical centers of:

(A) The first bank immediately east of French Frigate Shoals;

(B) Southeast Brooks Bank, which is the first bank immediately west of French Frigate Shoals, provided that the closure area shall not be closer than approximately 3nm of the next bank immediately west;

(C) St. Rogatien Bank, provided that the closure area shall not be closer than approximately 3nm of the next bank immediately east, provided further that bottomfishing in accordance with the requirements of section 7(a)(1) of this order shall be allowed to continue, unless and until the Secretary determines otherwise after adequate public review and comment;

(D) The first bank west of St. Rogatien Bank, east of Gardner Pinnacles;

(E) Raita Bank; and

(F) Pioneer Bank, provided that bottomfishing in accordance with the requirements of section 7(a)(1) of this order shall be allowed to continue, unless and until the Secretary determines otherwise after adequate public review and comment.

(b) Activities Prohibited Within Reserve Preservation Areas.

(1) In addition to the conservation measures in section 7 of this order, which are applicable to the entire Reserve, the following activities are prohibited within the Reserve Preservation Areas listed in paragraph (a) of this section, except as expressly otherwise stated in this paragraph and sections (8)(a) and 9 of this order:

(A) Commercial and recreational fishing;

(B) Anchoring in any area that contains available mooring buoys, or anchoring outside an available anchoring area when such area has been designated by the Secretary;

(C) Any type of touching or taking of living or dead coral;

(D) Discharging or depositing any material or other matter except cooling water or engine exhaust; and

(E) Such other activities that the Secretary identifies after adequate public review and comment, and after consideration of any advice and recommendations of the Reserve Council.

(2) Notwithstanding the prohibitions in this paragraph, the Secretary may conduct, or authorize by permit, research, monitoring, education, or management activities within any Reserve Preservation Area that further the Management Principles of section 4 of this order.

(3) The Reserve Preservation Areas in this section are approximated using fathoms. The Secretary will develop straight line boundaries based on longitude and latitude coordinates to encompass each Reserve Preservation Area, to provide for clarity and ease of identification. The Secretary may make technical modifications to any such boundaries.

Sec. 9. *Native Hawaiian Uses.* Native Hawaiian noncommercial subsistence, cultural, or religious uses may continue, to the extent consistent with existing law, within the Reserve and Reserve Preservation Areas identified under section 8 of this order. The Secretary shall work with Native Hawaiian interests to identify those areas where such Native Hawaiian uses of the Reserve's resources may be conducted without injury to the Reserve's coral reef ecosystem and related marine resources and species, and may revise the areas where such activities may occur after public review and comment, and consideration of any advice and recommendations of the Reserve Council.

3.2.2 Executive Order 13196

Sec. 3. *Amendments to Sections 7 of Executive Order 13178.*

1. Section 7(a)(1) of Executive Order 13178 is hereby amended by revising the first sentence to read as follows:

“Commercial Fishing. All currently existing commercial Federal fishing permits and current levels of fishing effort and take, which also includes the non-permitted level of trolling for pelagic species by currently permitted bottom fishers, as determined by the Secretary and pursuant to regulations in effect on December 4, 2000, shall be capped as follows:”

2. Section 7(a)(1)(C) of Executive Order 13178 is hereby revised to read as follows:

“(C) The annual level of aggregate take under all permits of any particular type of fishing may not exceed the aggregate level of take under all permits of that type of fishing as follows:

- (1) Bottomfishing—the annual aggregate level for each permitted bottomfisher shall be that permittee’s individual average taken over the 5 years preceding December 4, 2000, as determined by the Secretary, provided that the Secretary, in furtherance of the principles of the reserve, may make a onetime reasonable increase to the total aggregate to allow for the use of two Native Hawaiian bottomfishing permits;
- (2) All other commercial fishing—the annual aggregate level shall be the permittee’s individual take in the year preceding December 4, 2000, as determined by the Secretary.”
3. A new section 7(a)(1)(F) is hereby added to Executive Order 13178 and reads as follows:
“(F) Trolling for pelagic species shall be capped based on reported landings for the year preceding December 4, 2000.”
4. Section 7(b)(4) is revised to read as follows:
“(4) Discharging or depositing any material or other matter into the Reserve, or discharging or depositing any material or other matter outside the Reserve that subsequently enters the Reserve and injures any resource of the Reserve, except:
(A) fish parts (i.e., chumming materia or bait) used in and during fishing operations authorized under this order;
(B) biodegradable effluent incident to vessel use and generated by a marine sanitation device in accordance with section 312 of the Federal Water Pollution Control Act, as amended;
(C) water generated by routine vessel operations (e.g., deck wash down and graywater as defined in section 312 of the Federal Water Pollution Control Act), excluding oily wastes from bilge pumping; or (D) cooling water from vessels or engine exhaust; and”.

Sec. 4. Amendments to Sections 8 of Executive Order 13178.

1. Section 8 of Executive Order 13178 is modified by substituting “provided that commercial bottomfishing and commercial and recreational trolling for pelagic species in accordance with the requirements of sections 7(a)(1) and 7(a)(2) of this order, respectively,” for “provided that bottomfishing in accordance with the requirements of section 7(a)(1)” everywhere the latter phrase appears in section 8.
2. Section 8(a)(1)(A) is modified by substituting “a mean depth of 25 fm” for “a mean depth of 10fm.”
3. Section 8(a)(1)(B) is modified by substituting “a mean depth of 25 fm” for “a mean depth of 20fm.”
4. Section 8(a)(1)(D) is modified by substituting “a mean depth of 25 fm” for “a mean depth of 10fm.”
5. Section 8(a)(1)(E) is modified by substituting “a mean depth of 25 fm” for “a mean depth of 20fm.”
6. Section 8(a)(1)(G) is modified by substituting “a mean depth of 25 fm” for “a mean depth of 50fm.”
7. Section 8(a)(1)(I) is revised to read “Kure Atoll.”
8. Sections 8(a)(2)(D) and (E) are hereby deleted and a new section 8(a)(3) is hereby substituted as follows:
“(3) Twelve nautical miles around the approximate geographical centers of
(A) The first bank west of St. Rogation Bank, east of Gardner Pinnacles, provided that commercial bottomfishing and commercial and recreational trolling for pelagic species in

accordance with the requirements of sections 7(a)(1) and 7(a)(2) of this order, shall be allowed to continue for a period of 5 years from the date of this order; and

(B) Raita Bank, provided that commercial bottomfishing and commercial and recreational trolling for pelagic species in accordance with the requirements of sections 7(a)(1) and 7(a)(2) of this order, shall be allowed to continue for a period of 5 years from the date of this order; and

(C) Provided that both banks described above in (3)(A) and (3)(B) shall only continue to allow commercial bottomfishing and commercial and recreational trolling for pelagic species after the 5-year time period if it is determined that continuation of such activities will have no adverse impact on the resources of these banks.’’

3.3 Alternative 2: Limited NWHI Sanctuary Fishing

Alternative 2 includes three aspects that address each of the regulatory regimes currently under consideration by NOAA for the proposed NWHI sanctuary. The first would allow limited fishing activities within the proposed sanctuary to continue indefinitely, the second would end such fishing by 2025, and the third would end it after five years following the (yet to be determined) effective date of the NWHI sanctuary designation. The first two variations include catch levels and permit limits for the proposed sanctuary. For the five year variation, the number of permits would be limited to those permits active at the time of designation.

Under all three scenarios, NWHI fisheries for crustaceans, precious corals and coral reef associated species would be subject to moratoriums on all harvests within a corridor that is 50 nautical miles from the geographic center of each of individual islands in the NWHI (i.e. throughout the proposed NWHI sanctuary, see Figure 19).

Also under all three scenarios, commercial fishing for NWHI bottomfish would continue to be managed under those limited access programs described in Alternative 1A. NWHI commercial bottomfish fishing permits would be non-transferable and if relinquished by the permit holder, would be reissued without delay by NMFS in accordance with the procedures set forth for the Ho’omalū Zone in Section 660.61 of the Code of Federal Regulations, and for the Mau Zone as described in an amendment to the Bottomfish FMP that has been recommended by the Council to establish a similar process to reissue Mau Zone permits that have been relinquished or revoked. Permit holders would not be subject to minimum landing requirements but would be required to maintain federal MSA logbooks.

Also included in all scenarios is the implementation of eligibility criteria for two Mau Zone limited access permits set aside under the Western Pacific Community Development Program for the use of indigenous communities. These would be allocated and managed as described in an amendment to the Bottomfish FMP that has been recommended by the Council.

Under all three scenarios, commercial fishing for pelagic species would continue to be allowed within the proposed sanctuary by use of trolling or handline hook-and-line gear, with longline, trawls, purse seines, and set nets prohibited. These pelagic fishing vessels would be subject to new federal MSA permitting and logbook requirements.

Finally, under all three scenarios all recreational (i.e. non-commercial) fishery participants within the proposed sanctuary would be subject to new federal MSA permitting and logbook requirements. The one exception would be Midway-based recreational fishing that takes place within a 12 mile circle surrounding Midway Atoll. These operations would be subject to the federal MSA permitting requirement but would otherwise continue to be managed by the U.S. FWS, who would collect fishery monitoring data and share it with NMFS.

The measures indicated under each scenario have been developed to be consistent with NOAA's policy and "sideboards" for the proposed NWHI sanctuary.

3.3.1 Scenario 1: Allow limited NWHI sanctuary fishing operations indefinitely

In addition to the measures common to all scenarios that are described above, under Scenario 1 federal MSA catch and permit limits would be implemented for all commercial NWHI fishery participants targeting bottomfish or pelagic species within the proposed NWHI sanctuary.

The number of permits available at any one time for commercial bottomfish fishing would be limited to seven for the Mau Zone (including two CDP permits) and seven for the Ho'omalū Zone. The total fleet-wide catch of bottomfish by these permit holders would be capped at 381,500 pounds per year. Based on the data shown in Figure 1, the average annual NWHI catch per vessel by non-longline commercial pelagic fishing vessels over the entire time series is about 5,600 lb per permit, based on the data where both catch and permit data pairs available. Thus this sector's total fleet-wide catch of pelagic fish would be capped at 78,400 pounds per year.

Recreational (i.e. non-commercial) fishery participants would be required to obtain annual federal MSA permits which would be issued on a case-by-case basis for no more than two years at which time the appropriate level of NWHI sanctuary recreational fishing catch and effort would be determined and capped.

A range of options are being considered under this scenario regarding the number of permits and catch limits for commercial non-longline pelagic fishing (by participants other than bottomfish permit holders) within the proposed NWHI sanctuary. These are discussed in Section 3.3.4.

Three options are being considered for the establishment of no-take MPAs in the NWHI under this scenario. These are discussed in Section 3.3.5.

3.3.2 Scenario 2: Allow limited NWHI sanctuary fishing operations until 2025

In addition to the measures common to all scenarios that are described above, under Scenario 2 federal MSA catch and permit limits would be implemented for all commercial NWHI fishery participants targeting bottomfish or pelagic species within the proposed NWHI sanctuary.

The number of permits available at any one time for commercial bottomfish fishing would be limited to seven for the Mau Zone (including two CDP permits) and seven for the Ho'omalū Zone. The total fleet-wide catch of bottomfish by these permit holders would be capped at

381,500 pounds per year. Their total fleet-wide catch of pelagic fish would be capped at 78,400 pounds per year.

Recreational (i.e. non-commercial) fishery participants would be required to obtain annual federal MSA permits which would be issued on a case-by-case basis for no more than two years at which time the appropriate level of NWHI sanctuary recreational fishing catch and effort would be determined and capped.

A range of options are being considered under this scenario regarding the number of permits and catch limits for commercial non-longline pelagic fishing (by participants other than bottomfish permit holders) within the proposed NWHI sanctuary. These are discussed in Section 3.3.4.

Three options are being considered for the establishment of no-take MPAs in the NWHI under this scenario. These are discussed in Section 3.3.5.

Effective December 31, 2024, no fishing of any type would be allowed in the corridor that is 50 nautical miles from the geographic center of each of individual islands in the NWHI (i.e. throughout the proposed NWHI sanctuary, see Figure 19).

3.3.3 Scenario 3: Allow limited NWHI sanctuary fishing for five years

In addition to the measures common to all scenarios that are described above, under Scenario 3 the number of permits available at any one time for commercial bottomfish fishing would be limited to those active as of the effective date of the NWHI sanctuary designation.

Commercial and recreational fishing for pelagic species, as well as recreational fishing for bottomfish, would continue to be regulated as described in Section 660 of the Code of Federal Regulations.

Effective five years from the effective date of the final rule implementing the designation of the NWHI sanctuary, no fishing of any type would be allowed in the corridor that is 50 nautical miles from the geographic center of each of individual islands in the NWHI (i.e. throughout the proposed NWHI sanctuary, see Figure 19).

These measures are summarized in Table 30

Table 30: Summary of Measures Under Each Scenario

Measure	Scenario 1	Scenario 2	Scenario 3
MORATORIUMS			
Moratoriums on crustacean, precious corals and coral reef ecosystem fisheries	X	X	X
COMMERCIAL BOTTOMFISHING			
Cap permits and landings	X	X	
Implement CDP program	X	X	X
Require federal logbooks	X	X	X
COMMERCIAL PELAGIC FISHING			
Cap permits and landings	X	X	
Require federal permits and logbooks	X	X	X
RECREATIONAL FISHING			
Allow case-by-case, cap after two years	X	X	
Require federal permits and logbooks	X	X	X
NO-TAKE MPAS			
Implement no-take MPAs	X	X	

3.3.4 Options for the NWHI commercial pelagic fishery

The following alternatives are being considered under Scenarios 1 and 2 for the commercial non-longline pelagic fishery sector in the proposed NWHI sanctuary.

3.3.4.1 No Action

Under this option, no new limits would be placed on non-longline commercial pelagic fishing vessels in the proposed NWHI sanctuary and catches would continue to be monitored by the completion of catch reports required of commercial marine license holders by the by the State of Hawaii.

3.3.4.2 Limit of 2 pelagic permits, and total pelagic catch limit of 11,200 lb

Under this option, the volume of pelagic fish which could be caught in the proposed NWHI sanctuary by non-longline commercial pelagic fishing vessels would be capped at 11,200 lbs, and the number of non-longline commercial pelagic fishing vessels would be capped at two permits.

Following the language of EO 13196 with respect to the non-longline pelagic fishing vessels, the number of permits might be set at either one or two, depending on how the phrase “the year preceding December 4, 2000” is interpreted. The average annual catch per vessel by non-longline commercial pelagic fishing vessels over the entire time series is about 5,600 lb per

permit, based on the data where both catch and permit data pairs available. Taking an upper limit of 2 permits gives a total of 11,200 lbs.

3.3.4.3 Limit of 6 pelagic permits and total pelagic catch of 33,600 lb

Under this option, the volume of pelagic fish which could be caught in the proposed NWHI sanctuary by non-longline commercial pelagic fishing vessels would be capped at 33,600 lbs, and the number of non-longline pelagic fishing vessel permits would be capped at six permits.

The average annual number of for non-longline pelagic fishing vessels operating in the NWHI over the entire data series is six permits per year, where there are data for both catch and permit data pairs available. The average annual catch per vessel by non-longline commercial pelagic fishing vessels over the entire time series is about 5,600 lb per permit, based on the data where both catch and permit data pairs available

3.3.4.4 Limit of 15 permits and total pelagic catch of 214,000 lb

Under this option, the volume of pelagic fish which could be caught in the proposed NWHI sanctuary by non-longline commercial pelagic fishing vessels would be capped at 214,000 lb, and the number of non-longline pelagic fishing vessel permits capped at 15 permits.

From the long-term data set for non-longline commercial pelagic fishing vessels, the maximum number of these permits operating in the NWHI was 15 in 1987, with a corresponding catch of 213,653 lbs. While this alternative does not aspire to closely match the intent of EO 13196, it still places stringent limits on the volume of pelagic fish catches in the NWHI, while being based on historic levels of participation and fishing activity in this section of the Hawaiian Archipelago. Although this level of fishing for pelagic fishes may be higher than contemplated in the EO and by the proposed marine sanctuary, this level of fishing activity appears to have had no impacts on the populations of coral reef associated species in the NWHI. Moreover, this alternative would allow realistic opportunities for Hawaii-based fishermen to fish for pelagic fishes in the NWHI,

3.3.4.5 Limit of 27 pelagic permits and total pelagic catch limit of 387,000 lb

Under this option, the volume of pelagic fish which could be caught in the proposed NWHI sanctuary by non-longline commercial pelagic fishing vessels would be capped at 387,000 lb, and the number of non-longline pelagic fishing vessel permits would be capped at 27 permits.

Both this and the next option factor in catches by the non-longline pelagic fishing vessels and the equivalent volume of fish represented by longline fishing which occurred historically within the bounds of the proposed marine sanctuary. The 1987 figures for the historic maximum permit number and catch by non-longline commercial pelagic fishing vessels in the NWHI gives an average of 14,244 lbs per permit. The average longline catch of pelagic fish between 1990 and 1991 amounted to 172,471 lbs, which is equivalent to a catch by 12 permits based on the 1987

data for non-longline commercial pelagic fishing vessels. Adding these 12 permits to the 15 permits issued in 1987 gives a grand total of 27 permits, with estimated landings of 387,000 lb. This option maximizes the potential pelagic catch from the NWHI for non-longline commercial pelagic fishing vessels, by incorporating the historic maximum catch by these vessels and accounting for pelagic longline catch as the equivalent production by the for non-longline pelagic fishing vessels. Clearly, this option is markedly less stringent than the intent of EO, but places pelagic fish catches from the waters of the proposed sanctuary within historical limits, and affords Hawaii fishermen opportunities to target pelagic fish in the NWHI.

3.3.4.6 Limit of 66 pelagic permits and total pelagic catch limit of 207,000 lb

Under this option, the volume of pelagic fish which could be caught in the proposed NWHI sanctuary non-longline commercial pelagic fishing vessels would be capped at 207,000 lbs, and the number of non-longline commercial pelagic fishing vessel permits would be capped at 66 permits.

This option follows similar rationale to the previous one, however, it uses the average of 6 permits per year and average annual catch of 34,455 lbs, where there are data for both catch and permit data pairs available in the long-term data set for non-longline commercial pelagic fishing vessels. Following the same computations, the average non-longline pelagic fishing vessel catch per permit (5,743 lbs) is divided into the average annual longline catch (172,471 lbs) to give an equivalent of 60 permits. This then would give a grand total of 66 permits and a catch limit of 207,000 lbs.

While this option does not maximize the potential pelagic catch from the NWHI for non-longline pelagic fishing vessels, it does maximize permit opportunities for Hawaii-based fishermen. Clearly, this option is also markedly less stringent than the intent of EO, but as with the previous option, it is based on historical trends within the NWHI fisheries and incorporates longline catches in terms of non-longline pelagic permit equivalents.

These options are summarized in Table 31:

Table 31: Options for Non-longline Commercial Pelagic Fisheries in the NWHI

Option	Action
1	No action
2	Limit of 2 pelagic permits, and total pelagic catch limit of 11,200 lb
3	Limit of 6 pelagic permits and total pelagic catch of 33,600 lb
4	Limit of 15 permits and total pelagic catch of 214,000 lb
5	Limit of 27 pelagic permits and total pelagic catch limit of 387,000 lb
6	Limit of 66 pelagic permits and total pelagic catch limit of 207,000 lb

These options are based for the most part on data from logbooks and logsheets for Hawaii-based commercial pelagic vessels operating within the proposed sanctuary. The logbook records for the troll/handline fisheries extend from the early 1950s to the present and are collected by the State of Hawaii's Division of Aquatic Resources as one of the requirements for a commercial marine

license to fish. By contrast, federal logbooks for the Hawaii-based longline fishery were only implemented in 1990. Although records for the longline fishery extend from 1990 to the present, records of longline fishing within the confines of the proposed 50 nm sanctuary boundary around the NWHI is restricted to 1990 and 1991. This is due to the 50 nm protected species zone from which longliners are excluded and which was implemented by the Council under its Pelagics FMP in late 1991 to avoid the accidental capture of Hawaiian monk seals. The proposed sanctuary conforms exactly to coordinates used to delineate the protected species longline exclusion zone.

A summary of the commercial catch data used to develop the alternatives in Table 31 is given in Figures 20 and 21. Figure 20 illustrates NWHI pelagic catches and participants on bottomfish and non-longline pelagic vessels combined (top), and on pelagic fishing vessels only (bottom). Figure 21 illustrates the species composition of NWHI pelagic catches by non-longline pelagic and bottomfishing vessels combined (top), by non-longline pelagic fishing vessels only (middle) and by longline vessels only (bottom). Data for bottomfish and non-longline pelagic vessels extends from 1950 to 2003, and for longliners from 1990 to 1991.

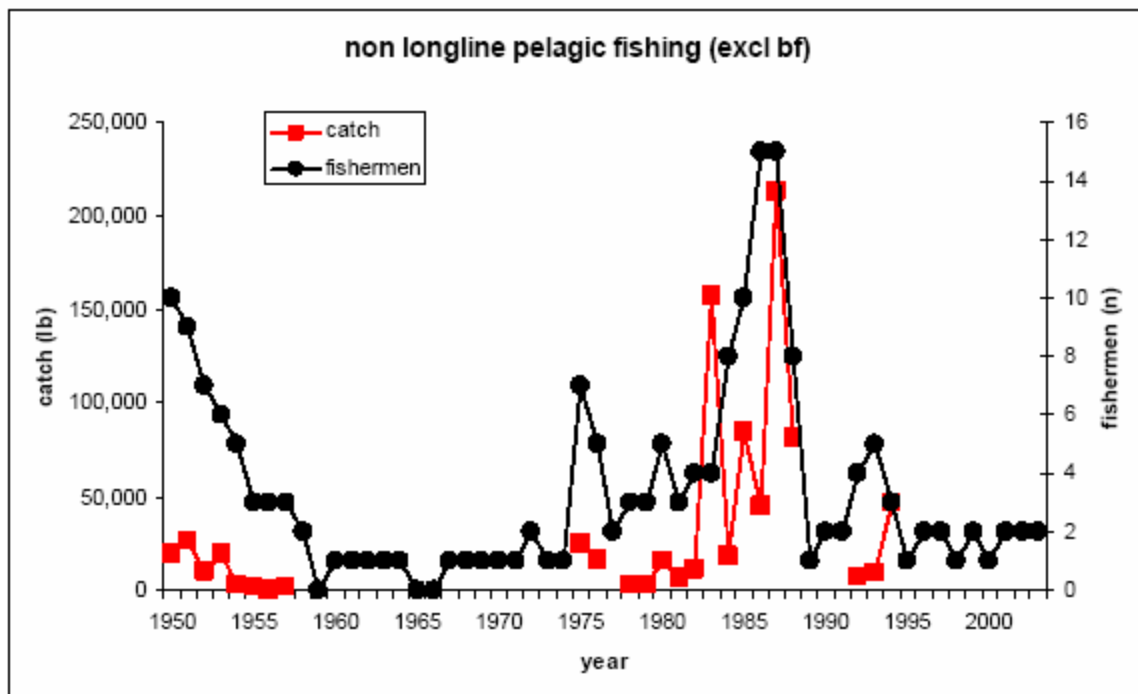
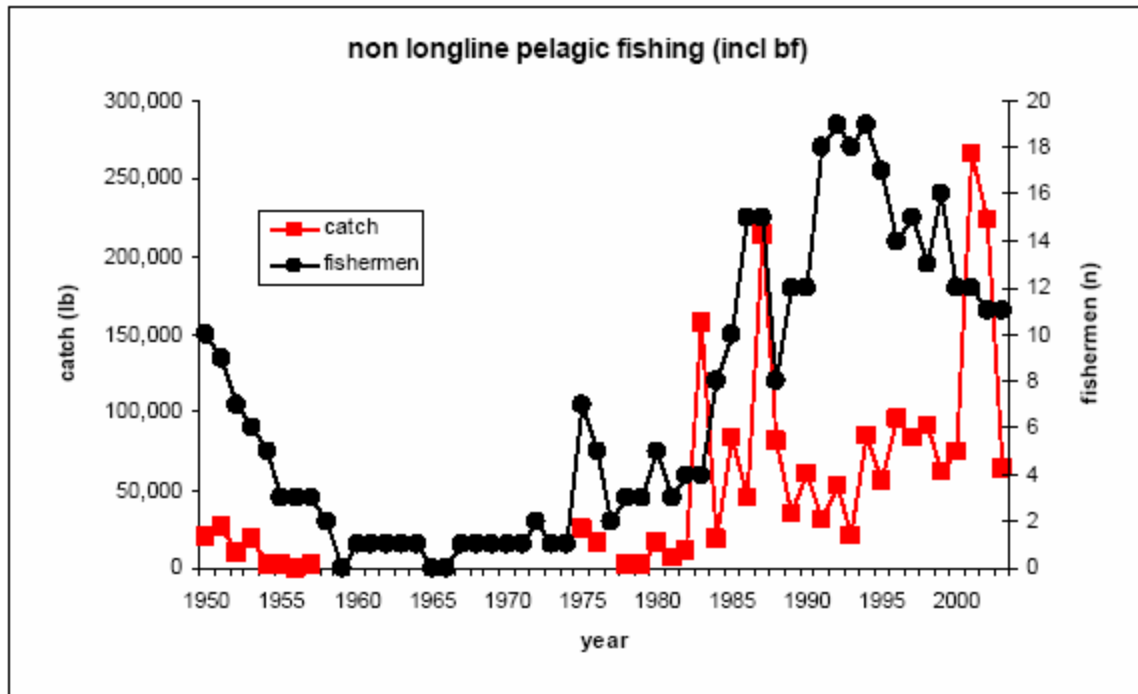


Figure 20: Time Series of Catch Records for NWHICommercial Pelagic Catches

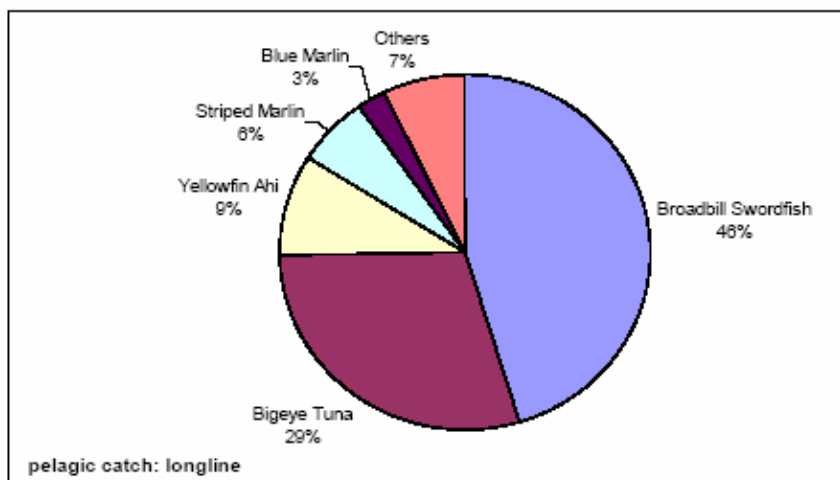
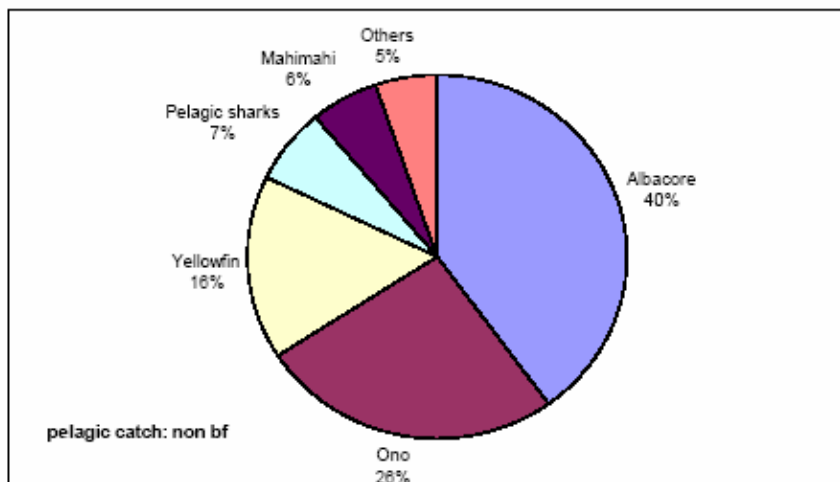
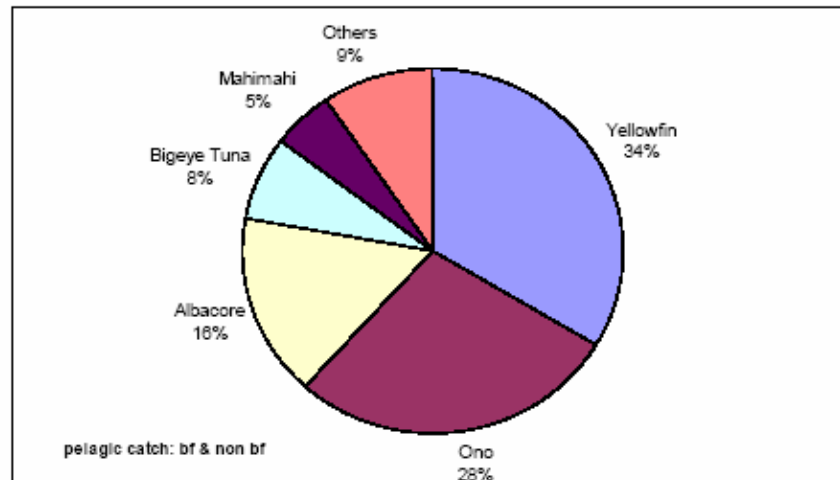


Figure 21: Species Composition of NWHI Commercial Pelagic Catches

The data in Fig. 20 show that the aggregate number of commercial bottomfish and non-longline pelagic fishermen increased markedly after the mid-1970s and reached a peak of about 19 fishermen by the early 1990s with a decline thereafter. Most of this increase was due to bottomfish vessels, apart from a period in the mid-1980s when non-longline pelagic fishermen numbers in the NWHI peaked at 15 fishermen. Numbers since then have been considerably lower, alternating between 1-2 fishermen per year since 1995. Catch composition for commercial pelagic fisheries operating in the NWHI is shown in Figure 2. The combined pelagic catch for bottomfish and non-longline pelagic vessels shows that catches were dominated by yellowfin, ono (wahoo) and albacore tuna, which formed almost 80% of catches. The same three species also comprise about 80% of the catch composition of non-longline pelagic vessels, although albacore rather than yellowfin is the largest component of the catch. Catches of albacore by the non-longline pelagic vessels is not evenly distributed through the records from the non-longline pelagic fishing vessels, and the dominance of this species in the data is due to large catches of this species in 1983, 1985 and 1987, with no other landings reported in any of the other years. The catch composition for the longline fishery is dominated by swordfish, which forms almost 50% of the catch, followed by bigeye tuna and yellowfin tuna, and reflects the targeting of the longline fishery for these species, fishing shallow for swordfish or deep for bigeye tuna.

It is important to note that the data discussed in the previous sections, although extensive, is incomplete for a number of years due to confidentiality protocols for catches by less than three fishing entities. This makes interpretation of the data for non-longline pelagic fishing vessels somewhat difficult, since catches for 27 years out of the total time series of 53 years have no catch reports, although one or two fishermen may have fished within those years. Consequently, a combination of average and maximum values were used to develop the options shown in Table 1. As described above, under some options, the historical longline catches in 1990 and 1991 have been factored in to generate upper limits for the number of pelagic permits and catches, by expressing this volume of catch as the equivalent that might be caught by non-longline pelagic fishing vessels.

Except for the no action option, the above options were developed to be consistent with NOAA's policy and "sideboards" for the proposed NWHI sanctuary.

3.3.5: Alternatives for No-take MPAs under Scenarios 1 and 2

The following options are being considered under Scenarios 1 and 2 for no-take MPAs in the proposed NWHI sanctuary. No fishing of any type would be allowed in these areas (with the exception of Midway-based recreational fishing and federally permitted research activities as described above. Except for the no action option, the following options were developed to be consistent with NOAA's policy and "sideboards" for the proposed NWHI sanctuary.

3.3.5.1 No Action

Under this option, no no-take MPAs would be established in the proposed NWHI sanctuary.

3.3.5.2 Option A

Under this option, no-take MPAs would be established as illustrated in Figure 22 utilizing the smaller area closure shown in the north (west of 174 W. longitude). No fishing of any type would be allowed within these areas, with the exception of federally permitted research activities and Midway-based recreational fishing as described above.

3.3.5.3 Option B

Under this option, no-take MPAs would be established as illustrated in Figure 22 utilizing the larger area closure shown in the north (west of 177 W. longitude). No fishing of any type would be allowed within these areas, with the exception of federally permitted research activities and Midway-based recreational fishing as described above.

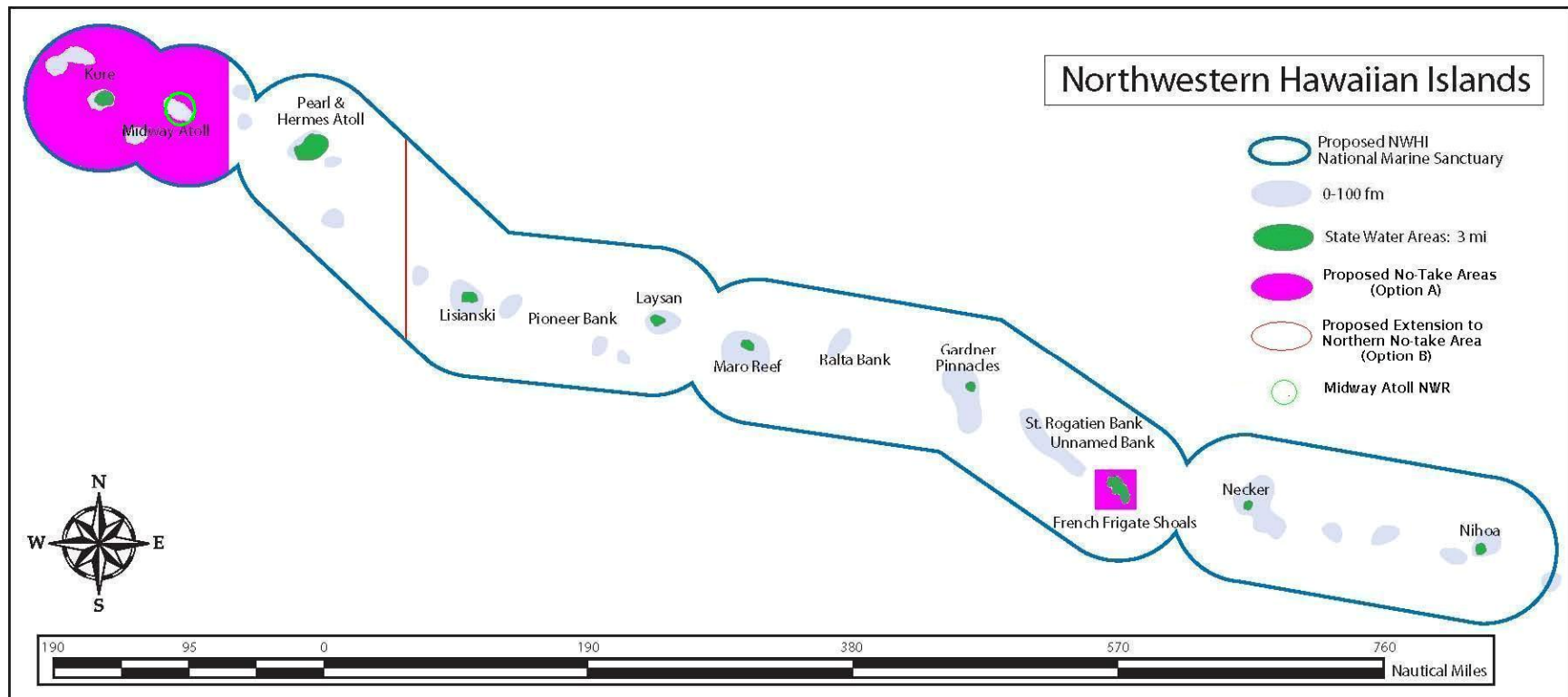


Figure 22: Potential NWHI No-take MPAs

Proposed No-Take Areas Option A

1. No-Take Area West of 174 ° long. (except at Midway Atoll)
2. No-Take around French Frigate Shoal
 - Point A: 24 ° 0' N lat; 167 ° 40' W. long
 - Point B: 24 ° 0' N lat; 166 ° 0' W. long
 - Point C: 23 ° 30' N lat; 167 ° 40' W. long
 - Point D: 23 ° 30' N lat; 166 ° 0' W. long

Proposed No-Take Areas Option B:

Same as Option A except, extend No-Take Area to West of 177 ° long (except at Midway Atoll)

4.0 CHAPTER FOUR: ANALYSIS OF THE ALTERNATIVES

This section presents a summary of the anticipated direct impacts of the above alternatives on the NWHI marine environment, ecosystem, and fisheries, as well as their indirect impacts on the region and nation.

Under all alternatives, the zero impacts of NWHI fisheries on protected species described in Chapter 2 are anticipated to remain unchanged. Alternatives that would reduce or eliminate fishing activities would reduce the potential for impacts, however this change is anticipated to be insignificant as no fishery interactions or other impacts have been observed or documented to date.

4.1 Alternative 1A: No Action A (FMP Status Quo)

Clearly all alternatives that result in the harvesting of marine species will immediately reduce that species' abundance in the NWHI. However the critical issue for managers is whether that reduction will have adverse population or ecosystem impacts. Under Alternative 1A (FMP Status Quo), fishery impacts to target and non-target stocks are anticipated to remain unchanged. Fisheries would continue to be managed under their respective fishery management plans and would be expected to retain their current resiliency and natural condition. Fisheries would continue to be managed under limited entry and harvest quota systems as described in Chapter 3 and the NWHI ecosystem would be anticipated to remain in the "pristine" condition observed in 2002 during the multi-agency NOWRAMP study, which followed more than a decade of active fishery management by the WPRFMC.

The maximum sustainable yield (MSY) of bottomfish MUS from the NWHI as a whole has recently been estimated to be 448,784 pounds, with the Ho'omalu Zone MSY comprising 348,385 pounds and the Mau Zone 100,399 pounds (PIFSC 2006, in press). In the most recent year for which complete data are available (2003) 145,000 pounds of bottomfish were harvested by four Ho'omalu Zone vessels and 77,000 pounds of bottomfish were harvested by five Mau Zone vessels. These landings represent 42 and 77 percent, respectively, of the Ho'omalu and Mau Zones' respective MSYs.

The Council's existing participation targets are seven vessels for the Ho'omalu Zone and ten vessels for the Mau Zone. Because there are only four active vessels in the Ho'omalu Zone at this time, under Alternative 1A NMFS could reissue the three inactive Ho'omalu Zone permits. A mechanism for reissuing these permits is in place however NMFS has declined to reissue any Ho'omalu Zone permits in the last five year and there is no reason to think that they would so under Alternative 1A. It is most likely that the number of active Ho'omalu Zone vessels would remain at four or less. There is no mechanism in place to reissue inactive Mau Zone permits so the number of active Mau Zone vessels would remain at the current five or less. These nine vessels are likely to continue their current fishing patterns and would be anticipated to continue to land approximately 42 percent of the Ho'omalu Zone MSY and 77 percent of the Mau Zone MSY.

As acknowledged in NOAA's 2004 Advice and Recommendations on Development of Draft Fishing Regulations under the National Marine Sanctuaries Act Section 304(a)(5) discussion of NWHI commercial bottomfish/pelagic trolling fishery "fishery statistics (spawning potential ration [sic], percent immature, average size, and CPUE) indicate a healthy, well managed and sustainable fishery...The allowable gear and fishing methods are highly selective, minimizing habitat impacts and unwanted bycatch" (NOAA 2004). Regarding the NWHI commercial pelagic trolling fishery, NOAA observes that "the current fishing gear and methods have little to no impact on the habitat and very low levels of bycatch" (NOAA 2004).

Under this alternative crustacean stocks would continue to be managed under the current FMP regulations, however a new model currently being developed by PIFSC would be used to determine exploitable populations. In addition it may be that under the new model, a harvest guideline of 13% of the exploitable population would not correspond to a 10% risk of overfishing and a new harvest guideline may need to be considered. Thus the risk of localized overfishing under this alternative would be dependent on the estimates of exploitable populations and the reliability of those estimates.

Impacts of the continuation of the current management regime for precious corals on target and non-target stocks are anticipated to be minimal as only selective gear is allowed and harvests are strictly controlled by the use of bed quotas, minimum sizes and other measures (see Chapter 3).

The harvest of pelagic fish under the current Pelagics FMP would represent a direct impact on the target species. As described in Chapter 2 however, this is small fishery and its presence or absence is not expected to have an appreciable impact on its target or non-target stocks.

Because the special permit case-by-case approval process, as well gear restrictions and other measures recommended by the Council for the NWHI in the Coral Reef Ecosystems Fishery Management Plan were disapproved by NMFS, this alternative could potentially result in overfishing of coral reef associated species. However given experience to date this is unlikely in the near- term as there has been little interest in this remote fishing area.

Under Alternative 1A, impacts on fishery participants, fishing related economic activities and the nation are anticipated to remain unchanged. The historical contribution of NWHI fisheries to Hawaii's economy is small. However, given the vulnerability of the economies of Hawaii and other U.S. Pacific Islands to sharp and sudden economic downturns, as evidenced by negative changes in the economic condition of most of these island areas during the past several years, the importance of economic diversification is apparent. Commercial fishing appears to be one of the few economic sectors outside the mainstay of tourism in which substantial economic growth is possible.

Alternative 1A would result in a mixed-use sanctuary in which sustainable and science-based management measures were applied to all NWHI fisheries.

4.2 Alternative 1B: No Action B (Reserve Status Quo)

Under Alternative 1B (Reserve Status Quo), short-run fishery impacts are anticipated to remain largely unchanged. Bottomfish landings would be capped to those made in 2000 through a series of fathom-based area closures around most NWHI, as well as the imposition of non-transferable vessel quotas. In the short-run the vessel quotas are likely to result in some level of discarding, as species targeting is difficult and participants may be motivated to discard less valuable species in favor of higher valued fish. However the fact that 2000 landings (262,000 lbs) were well below MSY for this fishery means that it is unlikely that these discards will have an adverse impact on species populations or the NWHI ecosystem. The implementation of area closures may result in local depletions of some species as fishery participants will be forced to concentrate their effort in smaller available open areas. In the long-run, the non-transferable nature of the vessel quotas means that as fishery participants age and leave the fishery, there will be no new entrants to take their place and the fishery will close. This will remove all actual and potential federal fishery impacts on NWHI bottomfish target and non-target stocks. It is unlikely to have an impact on their (currently positive) population trajectory or the (currently pristine) NWHI ecosystem. Similarly it is unlikely to have an impact on the MHI populations or ecosystem as evidence of mixing between the NWHI and MHI is limited. However, if significant transfer from the NWHI to the MHI does occur, the robust NWHI stocks should already be contributing to the MHI stocks. The degree to which this would increase under Alternative 1B is unknown but believed to be low, especially in light of recent findings indicating that larval transfer is more likely to flow from the MHI to the NWHI (see Chapter 2). Any positive impacts would be anticipated to be potentially offset by increases in MHI bottomfishing effort as a result of the highly efficient NWHI vessels relocating to the MHI, as well as existing MHI vessels increasing landings to fill the market void left by the closure of the NWHI fishery.

Alternative 1B would also close the NWHI crustacean, precious corals, and coral reef ecosystem fisheries. As described for bottomfish above, this will remove all potential federal fishery impacts and may have some positive effects on MHI stocks if significant transfer from NWHI stocks does occur. Again, if it does occur, the currently unfished NWHI stocks should already be contributing significantly to the MHI stocks. The degree to which this would increase under Alternative 1B is unknown but believed to be low, especially in light of recent findings indicating that larval transfer is more likely to flow from the MHI to the NWHI. Offsetting increases in MHI effort for these fisheries are unlikely as these NWHI fisheries are currently inactive.

Alternative 1B would allow some pelagic trolling to occur within limited areas by individuals who could demonstrate use in the year 2000. Landings would be limited to each individual's 2000 catch. In the short-term this will allow these individuals to continue fishing, in the long-term they will age and leave the fishery. There will be no new entrants to take their place and this fishery will close. Because this is such a small fishery, impacts on pelagic stocks will be insignificant whether it is open or closed. This alternative would also foreclose the opportunity for future harvests of NWHI pelagic species.

Under Alternative 1B both short and long-run impacts on fisheries and fishery participants are anticipated to be adverse. The implementation of area closures may result in local depletions of some species as fishery participants will be forced to concentrate their effort in smaller available open areas. These local depletions may reduce catch rates and associated fishery revenues. The use of fishing caps and vessel specific quotas will have varying impacts depending on each participant's catch record during 2000. Participants who were active and had higher landings will obviously fare better than those who were relatively inactive during 2000, with some in the latter group potentially being left with too small a quota to make fishing worthwhile. In the long-run, the non-transferable nature of the vessel quotas means as fishery participants age and leave the fishery, there will be no new entrants to take their place and the fishery will close. As these vessels leave the fishery, revenues to fishery supply shops, fuel, ice, bait and other vendors will be reduced as will revenues to wholesalers, retailers and other fish marketers. This alternative would also foreclose the opportunity for future harvests of NWHI bottomfish

It is possible that closed areas could serve as reservoirs to help augment stocks in surrounding fishing grounds and 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 has the potential to have a positive effect on fish populations and fishery productivity, it may take several years after the implementation of area closures for this effect to be realized because of the high age of first reproduction for most bottomfish species. Given this time lag, it is unlikely that the potential economic benefits of area closures would accrue to the current (and under this alternative, the last) generation of bottomfish fishermen.

Under Alternative 1B, impacts on the nation are anticipated to be mixed as reactions to actions such as closing NWHI fisheries will be negative for those who believe the resources are healthy and well managed, and positive for those who believe fishery closures are the best way to manage these resources. In addition, many of the nation's residents are largely uninformed about NWHI fisheries and likely won't have any reaction. The proportion of the population in each group is unknown. This alternative will limit and eventually end the supply of NWHI fishery products to Hawaii which will obviously affect consumers of these products who will have to switch to other species or imported fish. For some this will be unimportant, however others value these fish highly. Reductions or a loss of Hawaii-caught bottomfish such as opakapaka and onaga may also reduce revenues both in Hawaii and in the continental United States to restaurants that depend on these world-renowned "signature" dishes. At the same time, reductions in fishing effort will correspondingly reduce crew and support industry employment opportunities. The closure of NWHI fisheries will negatively impact the nation's social and technical fisheries capital, meaning that not only will a way of life be closed off, but the knowledge of how to successfully fish in these remote fisheries will also be lost. Experience in other Pacific island areas has illustrated that this knowledge can be lost in one generation and often cannot be regained.

4.3 Alternative 2: Limited NWHI sanctuary fishing

As discussed in Chapter 2, Alternative 2 includes three aspects that address each of the regulatory regimes currently under consideration by NOAA for the proposed NWHI sanctuary. None of the alternatives are expected to have a significant impact on stocks of pelagic fish, including yellowfin and bigeye tuna, which are subjected to unsustainable levels of fishing mortality elsewhere in the Pacific. The highest anticipated pelagic catch by commercial non-longline pelagic fishing vessels and bottomfish vessels under these various alternatives would be 465,000 lb. Based on the average species composition in Figure 2, this would include 139,400 lb of yellowfin tuna and 32,800 lb of bigeye tuna. Average annual Pacific-wide catches of yellowfin and bigeye tunas between 2000 and 2004 amounted to 782,000 mt and 239,000 mt respectively. Catches of yellowfin and bigeye in the NWHI would thus represent only 0.008% and 0.006% of the Pacific wide total catches of these species respectively.

4.3.1 Scenario 1: Allow limited NWHI sanctuary fishing operations indefinitely

As discussed above, the maximum sustainable yield (MSY) of bottomfish MUS from the NWHI as a whole has recently been estimated to be 448,784 pounds, with the Ho'omalulu Zone MSY comprising 348,385 pounds and the Mau Zone 100,399 pounds (PIFSC 2006, in press). In the most recent year for which complete data are available (2003) 145,000 pounds of bottomfish were harvested from the Ho'omalulu Zone and 77,000 pounds of bottomfish were harvested from the Mau Zone. These landings represent 42 and 77 percent, respectively, of the Ho'omalulu and Mau Zones' respective MSYs.

Under Scenario 1, the target numbers of commercial bottomfish permits for the Ho'omalulu and Mau Zones would each be seven (for a total of 14 vessels) and NMFS would reissue inactive permits to qualifying applicants. The total fleet-wide catch of bottomfish by these permit holders would be capped at 381,500 pounds per year (a potential catch of 85 percent of MSY). These caps on permits and harvests of commercial bottomfish in the proposed NWHI sanctuary are anticipated to be consistent with NOAA's policy and "sideboards" regarding this fishery.

Scenario 1 would also close the NWHI crustacean, precious corals, and coral reef ecosystem fisheries. This will remove all potential federal fishery impacts and may have some positive effects on MHI stocks if significant transfer from NWHI stocks does occur. However if it does occur, the currently unfished NWHI stocks should already be contributing significantly to the MHI stocks. The degree to which this would increase under Scenario 1 is unknown but believed to be low, especially in light of recent findings indicating that larval transfer is more likely to flow from the MHI to the NWHI. Offsetting increases in MHI effort for these fisheries are unlikely as these NWHI fisheries are currently inactive.

The implementation of no-take areas under Scenario 1 would provide refuge for fish stocks. Providing area closures in both the northern end of the chain and at French Frigate Shoals may result in the provision of "stepping stones" to aid any larval, juvenile, or adult transport of fish

stocks. Genetic and oceanographic studies have indicated that NWHI species may “land” at French Frigate Shoals and subsequently move throughout the NWHI.

The implementation of no-take areas may result in local depletions of some species as fishery participants will be forced to concentrate their effort in smaller available open areas. These local depletions may reduce catch rates and associated fishery revenues. It is possible that closed areas could serve as reservoirs to help augment stocks in surrounding fishing grounds and increase harvests, thereby mitigating the revenue reductions from the closed areas. However, the ability of closed areas to increase yields has not been demonstrated for bottomfish or pelagic fisheries in Hawaii. It should also be noted that, even if a closed area has the potential to have a positive effect on fish populations and fishery productivity, it may take several years after the implementation of area closures for this effect to be realized because of the high age of first reproduction for most bottomfish species. Given this time lag, it is unlikely that the potential economic benefits of area closures would accrue to the current generation of fishery participants. Pelagic species and fisheries are less likely to benefit from the no-take areas as these fish are highly mobile and would be expected to move relatively quickly through the no-take areas.

4.3.2 Scenario 2: Allow limited NWHI sanctuary fishing operations until 2025

Under Scenario 2 NWHI fisheries would be managed as in Scenario 1, however all NWHI fishing would end as of December 31, 2024. The short-term impacts of Scenario 2 would be similar to those of Scenario 1, however in the long-term (i.e. after 2024), all fishery impacts in the proposed NWHI sanctuary would be removed. NWHI resources would continue to be impacted by natural events as well as marine research, ecotourism and other non-fishing activities.

4.3.3 Scenario 3: Allow limited NWHI sanctuary fishing for five years

Under Scenario 3, the number of permits available at any one time for commercial bottomfish fishing would be limited to those active as of the (as yet to be determined) effective date of the NWHI sanctuary designation. Assuming that all current participants remain active until that date, there will be five Mau Zone vessels and four Ho’omalau Zone vessels. Under this assumption, the short-term impacts of Scenario 3 will be similar to those of Alternative 1A, however in the long-term (i.e. five years after sanctuary designation), all fishery impacts in the proposed NWHI sanctuary would be removed. NWHI resources would continue to be impacted by natural events as well as marine research, ecotourism and other non-fishing activities.

4.3.4 Anticipated Impacts of the Alternatives on Hawaii’s Communities

In addition to their economic returns to fishery participants and support industries, Hawaii’s fisheries contribute to Hawaii’s broader communities as described in Chapter 2. Under all alternatives impacts on these communities are anticipated to be mixed as reactions to actions such as closing fisheries within the proposed NWHI sanctuary will be negative for those who believe the resources are healthy and well managed, and positive for those who believe fishery closures are the best way to manage these resources. In addition, many of Hawaii’s residents are

largely uninformed about NWHI fisheries and likely won't have any reaction. The proportion of the population in each group is unknown. Alternatives that limit or end the supply of NWHI fishery products to Hawaii will obviously affect consumers of these products who will have to switch to other species or imported fish. For some this will be unimportant, however others value these fish highly, especially for Hawaii's traditional Christmas and New Year celebrations. Reductions or a loss of Hawaii-caught bottomfish such as opakapaka and onaga may also reduce revenues to restaurants that depend on these world-renowned "signature" dishes. Alternatives that limit or reduce fishing effort will correspondingly reduce crew and support industry employment opportunities for Hawaii residents.

A study of workers that were laid off following the shut down of the sugar industry on the island of Hawaii found that more than a year after the loss of their jobs 35 percent of the interviewees were still unemployed and seeking work (DeBaryshe et al. undated). Moreover, anecdotal evidence suggests that many of those who had found employment were in temporary or seasonal jobs. Although three-quarters of the plantation workers who were laid off made use of state-sponsored job training services, use of these services did not increase the chance of finding a new job. Demographic characteristics such as age, former plantation job grade and education were also largely unrelated to the likelihood of re-employment. It is likely that individuals who lose their jobs as a result of closure of fisheries within the proposed NWHI sanctuary would encounter similar difficulties in finding suitable alternative jobs.

Deckhands would arguably be the most severely impacted by termination of NWHI fisheries, they will probably be the first to lose their jobs and they may have the greatest difficulty in finding alternatives. Pooley and Kawamoto (1990) indicate 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 termination of fisheries in the proposed NWHI sanctuary results in a reduction in net revenues, captain/owners may partly try to make do by decreasing the pay of deckhands or laying them off. Appropriate employment opportunities outside of fishing may be limited for affected individuals, and for many the income losses may be long-term.

Those who become unemployed would face the social and psychological costs of job loss. Individuals who lose their jobs typically experience heightened feelings of anxiety, depression, emotional distress and hopelessness about the future, increases in somatic symptoms and physical illness, lowered self-esteem and self-confidence and increased hostility and dissatisfaction with interpersonal relationships (DeBaryshe et al. undated). In addition, both spouses and children of such individuals are at risk of similar negative effects. The aforementioned study of workers displaced from the sugar industry found many families reported difficulty in paying bills and in affording transportation, health care and even food and clothing (DeBaryshe et al. undated). The results of this financial strain were high levels of psychological distress among some family members as well as an increase in physical health problems. It is probable that a similar level of stress would be experienced by individuals who lose their jobs as a result of closure of fisheries.

It is likely that many families that depend on fishing and the seafood industry in Hawaii are already economically, socially and psychologically stressed because of fluctuating catch rates,

increasing competition and unstable markets. In Hawaii, there have been a number of highly publicized clashes between the owners of large and small fishing boats and between fishermen who are newcomers and those who are established residents. Contributing to this stress is the imposition of ever more restrictive state and federal regulations. 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 (Pooley 1993a; Hamilton et al. 1996; Polovina and Haight 1999). 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 fisheries within the proposed NWHI sanctuary would further confine fishermen and could jeopardize the long-term economic viability of their fishing operations. Obviously the loss of potential income from the unfished precious corals and coral reef fisheries will be easier to bear than the loss of historical income from the lobster fishery, however all groups are likely to be angry and frustrated at the closure of fisheries which they believe to be responsible and carefully regulated and unlikely to adversely impact NWHI marine resources.

In addition to potential economic losses associated with the cessation of NWHI fishing, there would be the loss of lifestyle to contend with, assuming that displaced fishermen cannot find an equally satisfactory alternative way of life. 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 is an important motivation for fishing among fishery participants. This survey also found that half of the respondents who fish in the Ho’omalau Zone are motivated by a long-term family tradition. Some fishermen would be able to continue their fishing lifestyle by switching to other fisheries, but the aspects of the maritime culture associated specifically with fishing in the NWHI (place names, stories associated with the NWHI, fishing strategies, etc.) would be lost. Fishermen who have invested many years learning to fish in the area would lose the opportunity to connect with that landscape and apply their locale-specific fishing skills and knowledge.

Closure of NWHI fisheries would also likely have a negative impact on those who value the continued existence of Hawaii’s maritime tradition and culture. Hawaii’s commercial fishing industry dates back nearly 200 years, and fishermen have engaged in commercial fishing in the NWHI since at least the early part of the last century. By reducing the diversity and economic viability of the commercial fishing life way in Hawaii, the closure of NWHI fisheries would diminish the influence of Hawaii’s maritime culture. They will also negatively impact Hawaii’s social and technical fisheries capital, meaning that not only will a way of life be closed off, but the knowledge of how to successfully fish in these remote fisheries will also be lost. Experience in other Pacific island areas has illustrated that this knowledge can be lost in one generation and often cannot be regained.

Native Hawaiian fishery participants that would be forced to leave the NWHI fishery under some alternatives will face a loss of livelihood and income and are likely to experience feelings of anger and frustration as they believe their fishery to be responsible and highly regulated and having no adverse impacts on NWHI marine resources. Any permanent closure or loss of access of resources to Native Hawaiians represents a complete loss of traditional rights.

Closure of fisheries within the proposed NWHI sanctuary could have environmental justice implications under Executive Order 12898, as it may result in disproportionately high and adverse human health or environmental effects on minority or low income populations. A survey by Hamilton and Huffman (1997) of small-boat owners who engage in Hawaii's commercial and recreational fisheries, including the troll, pelagic handline and bottomfish fisheries, found that a high proportion of the survey respondents were members of minority groups. A survey of bottomfish fishing vessel owners and crews revealed that nine of 16 vessels are owned and/or captained by Caucasians, two by Portuguese-Americans, three by Hawaiians, one by a Japanese-American and one by an Asian-American (specific ethnicity unknown). Less is known about the ethnicity of the crews, and these tend to change much more rapidly than vessel owners or captains. At the time of the survey, three vessels were crewed by Hawaiians, five by Caucasians, and two by a mixture of ethnicities. Regardless of ethnicity, fishermen, especially crew, are likely to be classified as low income.

Furthermore, the Hawaii seafood market includes a particular cultural interest in opakapaka, onaga and other species of bottomfish. Members of certain minority groups in the state consider these species to be showy and auspicious fish for festive occasions. A decrease in the availability of high quality bottomfish during culturally important events would cause a loss in well-being among these consumers, although an assessment of this loss is not possible with available data.

4.3.5 Anticipated Impacts on Other Fisheries

All alternatives that limit or prohibit the use of Hawaii's marine resources will likely result in substitution to other species or sources of fish by consumers. Increased consumption of fish imported from poorly managed, unsustainable, or overfished fisheries will negatively impact these fisheries, as well as their participants, communities, and nations. On the other hand, increased and focused consumption of fish from well managed and sustainable fisheries will provide further economic incentives for such practices.

4.3.6 Anticipated Impacts on the Nation

Impacts on the nation of the alternatives are anticipated to be mixed as reactions to closures of NWHI fisheries will be negative for those who believe the resources are healthy and well managed, and positive for those who believe fishery closures are the best way to manage these resources. In addition, many of the nation's residents are largely uninformed about Hawaii's fisheries and likely won't have any reaction. The proportion of the population in each group is unknown. Alternatives that would reduce the supply of Hawaii-caught fish will obviously affect consumers of these products who will have to switch to other species or imported fish. For some this will be unimportant, however others value these fish highly. Reductions or a loss of Hawaii-caught bottomfish such as opakapaka and onaga may also reduce revenues both in Hawaii and in the continental United States to tourism and restaurants that depend on these world-renowned "signature" dishes. At the same time, reductions in fishing effort would correspondingly reduce owner, captain and crew, as well as support industry employment and revenue opportunities. The closure of NWHI fisheries would also negatively impact the nation's social and technical fisheries capital, meaning that not only will a way of life be closed off, but the knowledge of how

to successfully fish in these remote fisheries will also be lost. Experience in other Pacific island areas has illustrated that this knowledge can be lost in one generation and often cannot be regained.

5.0 CHAPTER FIVE: REFERENCES

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Appendix A: January 18, 2006 Letter to the Council from NOAA

**Appendix B: October 28, 2004 Letter Establishing the Council's NWHI Sanctuary Goal
and Objectives**

**Appendix C: September 2005 Summary of Hawaii Bottomfish and Seamount Stocks
(PIFSC, undated)**



UNITED STATES DEPARTMENT OF COMMERCE
The Under Secretary of Commerce
for Oceans and Atmosphere
Washington, D.C. 20230

JAN 18 2006

Mr. Frank McCoy
Chair, Western Pacific
Fishery Management Council
1164 Bishop Street
Honolulu, Hawaii 96813

Dear Mr. McCoy:

Thank you for your letter regarding the National Oceanic and Atmospheric Administration's (NOAA) findings concerning the Western Pacific Fishery Management Council (Council) recommendations for regulation of fishing in the proposed Northwestern Hawaiian Islands (NWHI) sanctuary. I assure you that we carefully considered the Council's recommendations and your comments on our findings. However, NOAA appropriately concluded the recommendations did not fulfill the goals and objectives of the proposed sanctuary and the purposes and policies of the National Marine Sanctuaries Act (NMSA).

As noted in my October 24, 2005, letter, NOAA is developing alternatives in the Draft Environmental Impact Statement (DEIS) for the proposed sanctuary that would enable the Council to continue to recommend management measures for the commercial bottomfish/pelagic fisheries through regulations under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), consistent with the goals and objectives of the proposed sanctuary. While the preferred alternative has not been selected, the range of alternatives under consideration includes a regulatory regime allowing commercial bottomfishing and non-longline pelagic fishing to continue either: (1) indefinitely, (2) until 2025, or (3) for 5 years with a ban on fishing thereafter. For (1) and (2), interim catch levels and permit limits for the sanctuary consistent with the Executive Orders that created the NWHI Coral Reef Ecosystem Reserve (Executive Orders 13178 and 13196) would be established pending the development and implementation of an ecosystem management plan. For the 5-year phaseout alternative, the number of permits would be limited to those permits active at the time of designation.

In November 2005, NOAA initiated discussions with the Council regarding the possibility of establishing these catch levels and permit limits (collectively "limits") under the MSA consistent with these possible alternatives, and the timing of action to implement such limits given the anticipated designation of the proposed sanctuary by early 2007.

NOAA's first step was to determine if there is a legal basis to propose issuance of these limits under the MSA. While a factual record supporting such limits has not been fully developed, NOAA believes there is a credible basis to move forward with proposing such limits through amendment of the Bottomfish and Pelagics Fishery Management Plans (FMPs), and adoption of corresponding regulations. Of course, further record development and administrative process



would be needed under the MSA and the Administrative Procedure Act before any FMP amendment or corresponding regulations could receive final approval from the Secretary of Commerce. Nevertheless, NOAA stands ready to work with the Council in pursuit of these limits under the MSA.

In June 2006, NOAA plans to publish the DEIS and its proposed sanctuary regulations under the NMSA. If, by May 1, 2006, the Council transmits for Secretarial review an amendment to the Bottomfish and Pelagics FMPs and corresponding proposed regulations implementing these limits, and if one of the alternatives outlined above is selected as a preferred alternative, NOAA would review those MSA regulations as a potential mechanism for implementation of the limits under the preferred alternative, rather than implementing the alternative via the NMSA. To meet that timeline, the Council would need to adopt a proposed FMP amendment and corresponding regulations no later than its March 2006 meeting, with final adoption of the FMP amendment and corresponding regulations by April 14, 2006.

In pursuing an FMP amendment and corresponding regulations, the Council must be guided by MSA requirements. The Council may ultimately choose to propose MSA regulations with limits different from those included in the alternatives outlined above, or take no action. I wish to reiterate that the sanctuary designation process is ongoing, and a preferred alternative has not yet been selected. Given that fact, we must recognize the possibility that limits proposed under a preferred alternative in the sanctuary designation process may differ from those proposed by the Council. Moreover, the final outcome of the sanctuary designation process may lead NOAA to issue final regulations that differ from the proposed sanctuary regulations. Notwithstanding these potential outcomes, NOAA is offering this opportunity so the Council may give consideration to undertaking the actions outlined above, to ensure the Council has every opportunity to continue managing the bottomfish and pelagic fisheries consistent with the sanctuary designation.

I appreciate the Council continuing to work with NOAA as we proceed towards designation of the NWHI Sanctuary. Mr. Bill Robinson, Regional Administrator, will contact the Council in the next week to determine if you are interested in pursuing this approach. I look forward to your response.

Sincerely,

A handwritten signature in black ink, reading "Conrad C. Lautenbacher, Jr." in a cursive script.

Conrad C. Lautenbacher, Jr.
Vice Admiral, U.S. Navy (Ret.)
Under Secretary of Commerce for
Oceans and Atmosphere



**Western
Pacific
Regional
Fishery
Management
Council**

October 28, 2004

Mr. Daniel J. Basta
Director
National Marine Sanctuary Program
1305 East West Highway
SSMC-4
Silver Spring, MD 20910

Dear Dan,

Thank you for your letter of September 20, 2004 which accompanied the National Marine Sanctuary Program's *Proposed Northwestern Hawaiian Islands National Marine Sanctuary - Advice and Recommendations on Development of Draft Fishing Regulations Under the National Marine Sanctuaries Act Section 304(a)(5)*.

Given our many conversations concerning the requirement for a full analysis of the likely environmental impacts of management measures prior to any decision making, we were disappointed not to receive a preliminary draft environmental impact statement or comparable analytical document from your office prior to your request for Council action. This requirement appears consistently in several applicable Acts and their implementing regulations (e.g. Sections 301, 303 and 304 of the Magnuson-Stevens Fishery Conservation and Management Act, Sections 304 and 305 of the National Marine Sanctuaries Act, and Sections 101 and 102 of the National Environmental Policy Act¹) and is intended to ensure that environmental information is available to public officials before recommendations or decisions are made and before actions are taken. In addition, the National Environmental Policy Act instructs that its requirements be integrated with other planning and environmental review procedures required by law or by agency practice so that all such procedures run concurrently rather than consecutively.

Although your office may view the Council's recommendation on draft fishing regulations as the "first step" in the environmental review process, they represent the "last step" in decision making for the Council and are therefore subject to the same procedural and analytical requirements applicable to any other Council decision or recommendation.

¹ Section 105 of the National Environmental Policy Act affirms that its requirements are "supplementary to those set forth in existing authorities of Federal Agencies" which would include the National Ocean Service and its National Marine Sanctuaries Program.

It is unfortunate that the document which we received on September 20, 2004 consisted of a cursory and in many instances, factually incorrect review of available information on the affected environment, and accompanied by a seriously flawed examination of the potential impacts of several fishery management alternatives.

Additionally, the fishing goal and objectives are highly prescriptive statements that lack rationale or analyses and appear to have been written with the explicit intention of constraining management options to those actions predetermined to be desirable. Further, the inclusion of the undefined and highly subjective phrase "As appropriate to maintain the natural character or biological integrity of any ecosystem of the region" results in a series of fishing objectives that are completely undefined and unmeasurable. The lack of definitions for "natural character," and "biological integrity" once again leaves decision makers and the public with no basis on which to evaluate the desirability or likely outcomes of adopting this proposal. Given this wording, it is the Council's belief that the majority of fishing restrictions proposed are unnecessary as the Northwestern Hawaiian Islands have been recently evaluated as "near pristine" despite their long history of fishing and other uses. Clearly existing management regimes have been successful in protecting the resources and ecosystem of the area.

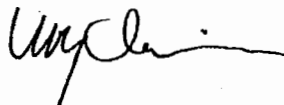
Attached is a detailed review of the September 20, 2004 *Advice and Recommendations* document as provided by the Council's Scientific and Statistical Committee and Council staff. In summary, reviewers found that the document is fraught with factual errors, undefined terms, unclear methodologies, subjective analyses and unsupported and conflicting statements, and as such does not provide decision makers with the necessary information on which to base effective recommendations or decisions.

Given this lack of available analyses the Council will be unable draft fishing regulations within the 120 day time period indicated in your letter and hereby requests an extension to April 4, 2004. This will allow for the preparation and review of a draft environmental impact statement focused specifically on fishery issues, and draft fishing regulations prior to final action by the Council at their March 2005 meeting.

Please contact me at your earliest convenience if you anticipate any problems with this approach. I am aware of statutory language in the National Marine Sanctuaries Act indicating a 120 day timeline, however there is no requirement, policy or guidance that I am aware of which indicates that this timeline must begin prior to the preparation of the appropriate analytical documents that enable fully informed decision making called for by the Magnuson-Stevens Fishery Conservation and Management Act, the National Environmental Policy Act and the National Marine Sanctuaries Act. Such an extension would also be consistent with your commitment to the Council at its October 2002 meeting at Aloha Tower.

As you know the Council supports the establishment of a National Marine Sanctuary in the Northwestern Hawaiian Islands and is committed to working cooperatively with your office to design and implement fishery management measures that are based on the best available information and meet our Nation's environmental, social and economic needs. To achieve this end, the Council has begun a cooperative and participatory process beginning with a meeting on October 29, 2004 with staff from the National Marine Sanctuary Program, the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve, NOAA Fisheries, the US Fish and Wildlife Service, the State of Hawaii and the NWHI fishermen. I remain hopeful that we can work together in the spirit of transparent and participatory democracy which is so important to all Americans.

Sincerely,



Roy Morioka
Council Chair

cc: Western Pacific Congressional Delegation
Admiral Conrad Lautenbacher
Bill Hogarth
Michael Weiss
Bill Robinson,
Sam Pooley
Aulani Wilhelm
Peter Young
Jerry Leinecke

enclosed: Reviewers' comments on the *Proposed Northwestern Hawaiian Islands National Marine Sanctuary Advice and Recommendations on Development of Draft Fishing Regulations Under the National Marine Sanctuaries Act Section 304(a)(5)*.



WESTERN
PACIFIC
REGIONAL
FISHERY
MANAGEMENT
COUNCIL

**Comments on the September 20, 2004
Proposed Northwestern Hawaiian Islands National Marine Sanctuary
- Advice and Recommendations on Development of Draft Fishing
Regulations Under the National Marine Sanctuaries Act Section
304(a)(5)**

Unfortunately this document consists of a cursory and in many instances factually incorrect review of available information on the affected environment, accompanied by a seriously flawed and conflicting examination of the potential impacts of several fishery management alternatives.

Further, the fishing goal and "objectives" are highly prescriptive statements that lack rationale or analyses and appear to have been written with the explicit intention of constraining management options to those actions predetermined to be desirable as described in NMSP Alternative 3 and its "model regulations". As a general rule, "objectives" are intended to state the concrete outcome of a series of actions, consistent with an overarching goal. This document instead combines actions and objectives into "objectives" with the apparent intent of setting the context for the Council's determination of appropriate fishery regulations to achieve the proposed sanctuary's goals.

In addition, the process described for the implementation of fishing regulations in the proposed Northwestern Hawaiian Islands (NWHI) sanctuary is impracticable and conflicted. For example the document is titled "*Proposed Northwestern Hawaiian Islands National Marine Sanctuary - Advice and Recommendations on Development of Draft Fishing Regulations Under the National Marine Sanctuaries Act Section 304(a)(5)*" and the majority of its text references goals, objectives, and alternatives for the proposed NWHI sanctuary. However the National Marine Sanctuary Program (NMSP) Alternative 3 would actually consist of a temporary management regime followed by the establishment of a new task force which would develop yet another management strategy within 1 year. "The task force shall develop an annual aggregate level of harvest not to exceed catch levels for commercial bottomfish/pelagic trolling and commercial pelagic trolling based on recorded landings for each fisherman operating from December 4, 1999 to December 4, 2000."

The document goes on to state that "In the interim between designation and adoption of a revised fishery management plan, the Sanctuary shall manage fishing based on a formula for individual fishing caps as provide for by the Executive Orders 13178 and 13196 (EO). The formula will be based on the recommendations of the Reserve Advisory Council, which takes the 5-year period prior to the EO, removes the highest and lowest-year catch data, and averages the remaining years fished during that period."

Yet a third variation is added in the model regulations for NMSP Alternative 3 which state that "Commercial bottomfishing and associated fishing for pelagics by handline or trolling shall be limited to an amount equal to the Magnuson-Stevens Act permittee's average catch in pounds for bottomfish [definition includes certain pelagics] and the species catch ratio over the best three of the five calendar years from December 4, 1995 to December 4, 2000 in which the permittee was active in the fishery, as determined by the Director."

No reviewer was able to discern the actual meaning or anticipated chronology of these varying regimes, which will control the economic prospects of fishery participants for the foreseeable future. This is the worst type of management as it only continues the five years of confusion experienced by affected parties and reduces their opportunities for intelligent and well-informed decision making.

In addition, the proposals themselves do not make sense or achieve the document's own stated objectives or those of the National Marine Sanctuaries Act (NMSA).

For example, any regime which does not provide for new participants (as fisherman-specific caps or quotas would do) will lead to the ultimate demise of the fishery as current participants retire. This would conflict with Objective 7e which would "allow bottomfishing to continue except within sensitive habitats".

Regimes which seek to control harvests through caps or quotas are generally regarded as a last resort by fishery managers as they are known to lead to highgrading, which is the discarding at sea of fish that are of lesser value than other individuals of the same species. Economically, caps and quotas can be expensive to administer as they require dockside inspections, and can lead to foregone opportunities in pulse fisheries such as NWHI uku. By comparison, the current limited entry program and vessel size limit serves to constrain overall effort in a manner that allows individual participants to avoid depleting stocks by carefully rotating their effort over a very large area and range of species depending on local abundance and conditions.

Although the idea of further restricting landings (it is only landings that can be restricted, as species specific targeting in this fishery is not completely possible) to a given species ratio has initial appeal as perhaps balancing ecosystem removals. However experience has shown that such an approach results in even more highgrading as participants are forced to discard species for which they are over quota while they continue to fill their remaining available quotas. Basing these species ratios on historical catches makes sense only if one has reason to believe that these catches were coincidentally in some ecologically preferable balance. No evidence is supplied to indicate that this is the case.

In fact no evidence is supplied that the existing fishery is adversely impacting the proposed sanctuary resources or that any of these conflicting restrictions are necessary, and no credible rationale for their selection is presented. In fact the document itself states that "Data show that in over a decade of fairly stable fishing operations (Figure 6), the target species populations have remained high based on traditional management measures, including MSY (WPRFMC 2004a)."

This is hardly an example of the proposed sanctuary's stated management principles to recognize that the resources of the NWHI are held as a public trust, and to incorporate and integrate best practices and available science. Neither is it consistent with the purposes and policies of the NMSA to both enhance public awareness, understanding, appreciation and wise and sustainable use of the marine environment and the natural, historical, cultural, and archeological resources of the National Marine Sanctuary System, and to facilitate to the extent compatible with the primary objective of resource protection, all public and private uses of these marine areas not prohibited pursuant to other authorities.

Several reviewers further commented on the specific draft goals and objectives for the proposed NWHI sanctuary as follows.

Proposed Goal 2 *Provide for comprehensive and coordinated conservation and management that recognizes and complements existing jurisdictional boundaries and management regimes and stakeholder communities.*

Although laudable, evidence to date strongly indicates a lack of commitment to this goal. Fishermen and local fishery managers have attended numerous meetings and voiced a myriad of concerns both orally and in writing to no apparent effect. To the contrary, public statements by the NMSP have sought to convey an atmosphere of collaboration and consensus when in fact fishery participants and managers have been denigrated and misrepresented in both public and private meetings, threatened with fishery closures if they do not compromise their positions, and disenfranchised from participating in the management process.

Proposed Goal 3 *Manage, minimize, or prevent negative human impacts by allowing access only for those activities that do not threaten the natural character or biological integrity of any ecosystem of the region.*

This is a highly subjective statement that can be understood only in context of the definitions of natural character and biological integrity, neither of which is defined. Further the de facto attempt to extend sanctuary authority to impacts on “any ecosystem of the region” is in direct conflict with the spirit of the NMSA’s implementing regulations which state that “The size of a National Marine Sanctuary, while highly dependent on the nature of the site’s resources, will be no larger than necessary to ensure effective management”. These are key failures of the document and result in an entirely undefined and ambiguous proposal concerning management of the proposed sanctuary. Lacking such definitions, decision makers and the public are unable to gauge the desirability or likely outcomes of adopting this sanctuary proposal.

Associated text indicates that resources shall be used only for direct personal consumption while in the NWHI, and the sale of any marine resources would be prohibited. However “the customary practice by Native Hawaiian Niihau and Kauai families to travel to the NWHI and bring back ocean resources for community sharing” would be permitted. Historical documents indicate that, in addition to fishing activities, Native Hawaiians utilized the NWHI for the collection of feathers, turtle eggs, turtles and albatross wing bones. If these activities are denied then the benefits of cultural access rights are greatly reduced. Any credible analysis should include a discussion of the traditional role and importance of these activities, their potential impacts on the marine ecosystem of the proposed sanctuary and why it is necessary or desirable for them to be prohibited.

Proposed Goal 5 *Support Native Hawaiian cultural, religious, and subsistence practices that are consistent with the long term conservation and protection of the region.*

Associated text indicates that, in addition to the consumption of fish within the sanctuary (defined elsewhere as sustenance use), subsistence harvests would be allowed only by Niihau and Kauai Native Hawaiians who will “bring back ocean resources for community sharing”. No rationale is presented for this measure which would effectively disenfranchise all other Native Hawaiians by denying them access to NWHI resources that many regard as their birthright. This is clearly in conflict with proposed goal 5 as it would limit rather than support Native Hawaiian cultural, religious and subsistence practices. Decision makers should be supplied with an explanation of the rationale, necessity and impacts of excluding Native Hawaiians residing on other islands from accessing the NWHI for such purposes.

Proposed Goal 6 *Support, promote, and coordinate research and long-term monitoring that improves management decision-making and is consistent with the conservation and protection of the region.*

Again, this is a laudable idea but it is contradicted by the lack of research and science presented to support the document’s proposals. This does not bode well for achievement of this goal.

Proposed Goal 7 *Maintain ecosystem integrity by limiting and controlling fishing activities using an ecosystem-based management approach. Maximize ecosystem protection while minimizing adverse socioeconomic impacts. Limit fishing activities to areas that minimize or prevent interactions with corals, seabirds, endangered Hawaiian monk seals, and other protected wildlife, or that do not threaten the natural character or biological integrity of any ecosystem of the region.*

Objectives: As appropriate to maintain the natural character or biological integrity of any ecosystem of the region:

7a. Prohibit non-subsistence crustacean fishing.

7b. Prohibit commercial precious coral fishing.

7c. Prohibit harvest of all coral species, live rock, all aquaria species and live fish trade species, and algae, sponges, and other invertebrates.

7d. Allow recreational fishing for pelagic species except within sensitive habitats.

7e. Allow bottomfishing to continue except within sensitive habitats.

7f. Allow commercial pelagic fishing using handline, pole and line and trolling gear except within sensitive habitats.

7g. Prohibit subsistence use within the sanctuary except for Native Hawaiian subsistence use

7h. Allow sustenance fishing for pelagic and bottomfish species using pole and line, trolling and handline methods within the Sanctuary except within sensitive habitats.

7i. Allow spearfishing without the use of SCUBA for pelagic species except within sensitive habitats.

7j. All fishing not specifically allowed shall be prohibited.

7k. When there is uncertainty in available information regarding the potential impacts of any fishing activity, err on the side of resource protection.

In general these highly prescriptive objectives lack rationale or analyses and appear to have been written with the objective of constraining management options to those actions predetermined by the NMSP to be desirable. Further, the inclusion of the undefined and highly subjective phrase "As appropriate to maintain the natural character or biological integrity of any ecosystem of the region" results in a series of objectives that are completely undefined and unmeasurable. Lacking definitions for "natural character" and "biological integrity" this once again leaves decision makers and the public with no basis on which to evaluate the desirability or likely outcomes of adopting this sanctuary proposal.

Regarding Objective 7a, the document implies that an active lobster fishery would remove stocks that serve as a potential food source for the endangered monk seal however available information indicates that crustaceans made up only 5.7% of fecal and regurgitated samples collected from the NWHI with over 78% of the monk seal diet consisting of teleost species. The document also cites the number of species found as "bycatch" in NOAA's research traps, however given its acknowledgment that these traps do not have the escape vents required on commercial traps, the relevance of this information is not clear. Further the absolute quantity of this bycatch, as documented in the Council's comprehensive Sustainable Fisheries Act bycatch amendment, is functionally trivial. In addition, NOAA has previously successfully defended this fishery from these precise charges in Federal Court. The statement that rebuilding of the NWHI lobster population may be occurring, but likely not enough to support a substantial fishery is wholly speculative and unsupported by any theory, data or scientific references. Regarding the claim that "Maintaining a closure of the lobster fishery will not create significant additional socio-economic impact because it is not currently in operation and catch declined 90% while the fishery was open - fluctuating dramatically as it dropped", the NWHI lobster fishery is not presently nor permanently closed. To the contrary no harvest guidelines have been issued since 2000 while NOAA resolves uncertainty in its population models. A regulatory closure would indeed have significant additional socioeconomic impacts as it would foreclose opportunities for future harvest by NWHI limited entry lobster fishery permit holders who are still financially vested in the fishery. This would represent a loss not only to those permit holders but also to shoreside support industries, consumers, and Hawaii's economy.

Regarding Objective 7b, associated text contains a series of factual errors and contradictions and fails to acknowledge the Council's recommendations that would address the issues raised. For example it is stated that "Little is known about the size of the standing stock, habitat requirements, growth rates, and many life history traits of targeted species" and "MSY cannot be accurately measured."

To the contrary extensive research has documented that Hawaii's natural populations are relatively stable, and a wide range of age classes are generally present. Further, it is known that western Pacific precious corals share several ecological characteristics: they lack symbiotic algae in tissues (they are ahermatypic) and most are found in deep water below the euphotic zone; they are filter feeders, and many are fan shaped to maximize contact surfaces with particles or microplankton in water column. Most species are uni-sexual or dioecious (sexes are separate) and the age at reproductive maturity is 12-13 years for *secundum* and *dichotoma*, with fertilization appearing to take place in the water column. Western Pacific precious coral larvae are more affected by light and temperature than are adults, with larvae of both *Anipathes* in Hawaii are known to be negatively phototactic which is why they are not found at depths less than 30 meters. The duration of the larval stage is unknown for most species, but Mediterranean studies of *Corallium rubrum* suggest that their larvae remain competent for several weeks. Species of *corallium* exist below the euphotic zone at depths between 350 and 1500 meters where temperature varies between 14 and 3 C. These larvae may avoid settling deeper where lower temperatures may prevent reproduction. Similarly, the lower limit of the *dichotoma* and *grandis* black corals coincides with top of thermocline in the high Hawaii islands. Microzooplankton and particulate organic matter are important in the diets of related *gorgonians*, and like other anthozoan species they are associated with numerous kinds of commensal invertebrates. They are also associated with many species of other anthozoans. They have not been observed to be consistently associated with any kind of finfish or free-swimming invertebrate. Eucidarid sea urchins are known to prey upon precious corals. Because of the great depths at which they live, the precious corals would be expected to be insulated from some short-term drastic changes in the physical environment. For the same reason, it is difficult to imagine circumstances in which man-made pollution would affect their environment, except in the unlikely event that large quantities of heavy material, such as waste from manganese nodule refining, were dumped directly on a bed. Nothing is known of the long-term effects of changes in environmental conditions, such as water temperature or current velocity, on the reproduction, growth, or other life activities of the precious corals. The oldest corals observed at Makapu'u are thought to be 75 years old, and it is believed that black corals may live even longer. Hawaii populations of *Corallium secundum* and *A. dichotoma* appear relatively stable implying a balance between recruitment and mortality. To date, beds of pink, gold and/or bamboo coral have been found at seven locations in the Council's jurisdiction, all in the EEZ around Hawaii. There are also two known major beds of black coral in the Council's area, as well as several minor beds. Most of these are located in Hawaii's state waters, however the largest (the Au'au Channel Bed) extends into the EEZ. The approximate areas of the seven identified beds of precious corals have been determined. These beds are small; only two of them have an area greater than 1 square kilometer, and the largest is 3.6 square kilometers in size. Undocumented reports of large past commercial production by Japanese vessels on the

Milwaukee Banks, some 500 miles beyond the northwestern extreme of the Leeward Hawaiian Islands, and the large physical area of those banks lead to conjecture that precious corals may at some locations occur in much larger aggregations than have as yet been demonstrated by scientific surveys. Asian coral fishers, who have roamed the western and central Pacific for decades, undoubtedly have undocumented and unorganized information on precious coral beds that is unavailable to U.S. researchers and administrators. *Makapu'u Bed*: This bed has experienced the greatest exploitation and thus is the source of much of the available information about the region's precious corals. Estimates of the densities of occurrence of precious coral colonies in their habitat based on in site observations made at the Makapuu Bed, indicated a sparse, widely separated habit of growth. Surveys of this bed were made in the 1970s, and again in 1997. In 1971 densities of commercial species were determined in an unexploited section of the bed and the size frequency distribution of pink coral was determined. The average density of pink coral in the Makapu'u Bed was 0.022 colonies per square meter. Extrapolation of this figure to the entire bed (3.6 million square meters) results in a standing crop of 79,200 colonies. The 95% confidence limits of the standing crop are 47,200 to 111,700 colonies. Conversion of standing crop colonies to biomass produced an estimate of 43,500 kg for *C. secundum* in the Makapu'u Bed. The estimates of density for gold coral (*Gerardia* sp.) and bamboo coral (*Lepidisis olapa*) in the Makapu'u Bed were 0.003 colonies/m² and 0.01 colonies/m² respectively. However, the distributional patterns of both of these species were found to be very patchy, much more so than *C. secundum*, and the area where they occurred was only about half that for pink coral, or 1.8 m². The corresponding estimates of unfished abundance for gold and bamboo colonies were 5,400 and 18,000 colonies respectively. Data for the mean weight of colonies in the populations of gold and bamboo coral in the Makapu'u Bed were lacking, but rough estimates were 2.2 kg for gold coral and 0.6 kg for bamboo coral. Multiplying mean weights by densities led to rough estimates of standing crop of about 11,800 kg for *Gerardia* sp. and 10,800 for *Lepidisis* sp. An analysis of growth rings in the cross sections of pink coral branches suggests that colony height increases about 0.9 cm/year, at least to an age of about 30 years. The largest colonies of pink gold found at Makapu'u were rarely more than 60 cm in height. Gold coral colonies were seen to reach a height of about 250 cm, while *Lepidisis olapa* was observed at about 300 cm. The natural mortality rate for pink coral was calculated by first converting the size-frequency distribution of the unfished stock to an age-frequency distribution and then determining the rate of diminution in progressively older age classes. The best estimate of the annual instantaneous mortality rate of *C. secundum* in the Makapu'u Bed is 0.66. This is equivalent to an annual survival rate of about 93% in the absence of fishing. Mortality rates for gold and bamboo coral were not available because their growth rates and age structures were unknown. Pink corals reach sexual maturity at a height of about 12 cm (13 years). The reproductive cycle is annual with spawning taking place during June and July. The relationship between parent stock and recruitment in pink coral is unknown. However, because pink coral is long lived, and the population is composed of many year-classes, the standing stock should be relatively stable even with moderate year-to-year fluctuations in recruitment. An estimate of steady state recruitment of the unexploited Makapu'u stock was obtained by multiplying the virgin stock size (79,200 colonies) by the best estimate of instantaneous mortality (0.066). Given steady state, the instantaneous rate of recruitment should equal the instantaneous rate of natural mortality. This gives an estimate of recruitment to the Makapu'u Bed of 5,277 colonies. Biomass per recruit as a function of age

was calculated in the absence of fishing using a cohort production model. In this model, the cohort gains weight until an age is reached where growth gains are overtaken by natural mortality losses. This is the "critical age" at which the cohort reaches its maximum biomass in the absence of fishing. For pink coral the maximum biomass per recruit, attained by a cohort at age 31.4 years is 237 gm. Maximum sustainable yields for precious corals are calculated using a Beverton and Holt cohort production model where data is available for *Corallium secundum*, and the Gulland Model ($MSY = 0.4 M B_o$, where m =natural mortality and B_o is virgin biomass) for *Gerardia* and *Lepidisis*. According to the FMP, the estimated MSY for pink coral at Makapu'u Bed is 1,000 kg/yr, the estimated area of Makapu'u Bed is 3.6 km². When fishing is done in such a way that all colonies of a cohort are removed at once, then the yield per recruit is identical to the biomass per recruit at the harvest age. Therefore the maximum yield per recruit is achieved by harvesting all survivors in a cohort of pink coral exactly at the critical age of 31.4 years, and in this case the maximum yield per recruit is 237 gm. In practice this would require an infinite instantaneous fishing mortality rate exactly at 31.4 years. Since this is not feasible, the 237 gm/recruit is a theoretical upper limit to the harvest that may actually be obtained. More realistic figures of yield per recruit are obtained by considering a fishery which applies a steady finite fishing mortality rate to all ages in a cohort above a specified minimum harvest age. With a minimum harvest age of 30 years the maximum yield per recruit is essentially equal to the upper limit of 237 gm, whereas with a minimum harvest age of zero years the greatest yield per recruit possible is only 119 gm. Hence, if non-selective measures are employed, the highest yield per recruit that can be expected is only half the maximum yield per recruit theoretically possible under selective harvesting. As long as recruitment is constant or independent of stock size, a fishing policy which maximizes the yield per recruit will also maximize the total yield on a sustained basis, i.e. it will also produce the maximum sustainable yield. *Brooks Bank Bed*: The current harvest for pink coral at Brooks Bank is 444 kg/yr.³ This figure was calculated using the following formula provided in the FMP for setting the quota for conditional beds for which site specific data is unavailable.

$$\frac{\text{MSY for Makapu'u Bed}}{\text{Area of Makapu'u Bed}} = \frac{\text{MSY for Conditional Bed}}{\text{Area of Conditional Bed}}$$

The estimated MSY for pink coral at Makapu'u Bed is 1,000 kg/yr, the estimated area of Makapu'u Bed is 3.6 km² and the estimated area of Brooks Bank is 1.6 km². A survey of this bed was done in September of 1998. Transects on this survey were 2.1 kilometers in length, and conducted at a depth of 350-505 meters. Red coral (*C. regale*) was observed to be very abundant with thousands of colonies present. Colonies occurred in patches from one to five square meters in size, and were located in waters between 430-517 meters deep. These colonies were up to 50 cm in height and averaged 1 cm in diameter. Extrapolation of this data suggests that a conservative standing crop of 8,000 kg of *C. regale* exists at this bed. If it is assumed that this species of precious coral has the same natural mortality rate as *C. secundum* at the Makapu'u Bed (6.6%), an estimate of the MSY can be derived from the

³ The final rule implementing the FMP published on 20 August 1983 lists the harvest quota for pink coral at Brooks Bank as 17 kg. This is a typographical error.

formula provided by Gulland : $MSY = 0.4MB$, where M is the natural mortality rate and B is the standing crop biomass. Rounding down, it is estimated that 200 kg of *C. regale* could be harvested annually on a sustainable basis based on these data and assumptions. Pink coral (*C. secundum*) was observed to be moderately abundant on the east side of the bank at depths of 363-427 meters, but were generally small (less than 20 cm in height). Gold coral was abundant with 250 large colonies found between 392-467 meters. It was estimated that there was a standing stock of 2,000 kg of live gold coral, with an equal amount observed dead. Observations of finfish in the area were rare, and there was no evidence of predation by sea urchins at this bed. *Wespac Bed*: This bed was also surveyed in 1998. Transects of 3.2 km were made between depths of 360-500 meters. No red coral was observed, however pink coral was abundant, with thousands of colonies in patches ranging from 0.3 to 1.0 square meters in size. Gold coral was rare, with only 2 colonies observed. Finfish (mostly *Polymixia*) were abundant, and there was high predation by Eucidarid sea urchins, with 50% of colonies showing signs of predation. *French Frigate Shoals-Gold Pinnacles Bed*: Using monk seal telemetry, the 1998 survey also located a previously unknown bed near French Frigate Shoals which has been named the FFS-Gold Pinnacles Bed. Transects 2.9 km in length at a depth of 360-575 meters found no red coral (*C. regale*), and a low abundance of pink coral (*C. secundum*.) The pink coral which was observed was generally small, averaging less than 12 cm in height (Grigg 1998b). Both live and dead gold coral was found in abundance, and 300 colonies were observed in scattered patches at depths of 365-406 meters. Extrapolation of the transect data suggests that a standing crop of 3,000 kg of gold coral exists at the FFS-Gold Pinnacles Bed. If it is assumed that this species of precious coral has the same natural mortality rate as *C. secundum* at the Makapu'u Bed (6.6%), an estimate of the MSY can be derived from the formula provided by Gulland (1970): $MSY = 0.4MB$, where M is the natural mortality rate and B is the standing crop biomass. Rounding down, it is estimated that 80 kg of gold coral could be harvested annually on a sustainable basis based on these data and assumptions. Few finfish were observed at this bed, no arrowtooth eels were seen. *Black coral beds*: Grigg and Apresko reported 14 species of black coral known to occur in Hawaiian waters. Historically however commercial fishermen have harvested only three species, *Anthipathes dichotoma* (almost 90% of commercial harvest), *A. grandis* (10%), and *A. ulex* (1%). The two major species (*A. dichotoma* and *A. grandis*) are found in coastal waters from Hawaii to Niihau and may extend up to the Northwestern Hawaiian Islands. *A. dichotoma* exists at depths from 30 to 110 meters while *A. grandis* exists at depths from 45 to 110 meters. Within their depth ranges, both species can be found highly aggregated on, or under, vertical dropoffs, terraces, or undercut notches. The growth rates for *A. dichotoma* and *A. grandis* have been estimated to be 6.42 cm per year and 6.12 cm per year respectively. Plotting gonad diameter versus colony height, Grigg estimated the size of reproductively mature *A. dichotoma* colonies to range from 64 to 80 cm. This implies an age at reproduction of 10 to 12.5 years.

The document also states that "The importance of deep-water precious coral beds as a refuge for eels and bottomfish, and consequently as monk seal foraging habitats is unresolved and may be significant." We do not disagree with this statement, however the document fails to acknowledge that monk seal foraging has been associated with deep-water gold corals and that in response the Council's recommendation would prohibit all harvest of NWHI gold corals, as well as prohibiting harvests of any precious corals at the French Frigate Shoals bed.

Instead Objective 7b (as well as NMSP Alternative 3) proposes to prohibit all NWHI precious corals harvests, again relying on vague and unsupported statements that such activity would be “considered inconsistent with the relevant provisions of the NMSA and goals for the proposed sanctuary” rather than providing a detailed analysis of available information, likely impacts of each alternative, and a rationale as to the necessity of a blanket prohibition. In addition, the statement that the closure of this fishery would likely have no socioeconomic impacts again ignores the fact that this would lead to the loss of the opportunity to harvest available resources and represent a loss not only to future fishery participants but also to shoreside support industries, consumers, and Hawaii’s economy. In all cases, evaluation of impacts must consider not only impacts on the current generation, but impacts that will be felt by future generations.

Regarding Objective 7c the document lacks an assessment of the specific impacts of such harvests on the ecosystem or a rationale for the necessity of a prohibition of these activities. Reference is made to adverse impacts resulting from historical fisheries however no acknowledgement is made that these were largely unregulated fisheries as compared to the carefully controlled coral reef fisheries recommended by the Council. Again the document takes the position that managers are faced with an “all or none” choice in which fisheries are either completely unregulated or closed. This ignores the many management techniques in use by fishery managers to allow controlled harvests of marine resources such that socioeconomic benefits are maximized while adverse ecological impacts are avoided. Analysis of Objective 7 (and NMSP Alternative 3) again includes the statement that the closure of this fishery would likely have no socioeconomic impacts. This ignores the fact that this would lead to the loss of the opportunity to harvest available resources and represent a loss not only to future fishery participants but also to shoreside support industries, consumers, and Hawaii’s economy.

Objectives 7d, 7e, 7f, 7h, and 7i would allow various types of fishing “except within sensitive habitats”. Because the term “sensitive habitats” is undefined, these objectives are highly subjective and their rationale, desirability, necessity and impacts are impossible for decision makers and the public to gauge.

Other issues surrounding Objectives 7e and 7g are discussed above.

Objective 7j conflicts with the NMSA’s implementing regulations which state that “all activities (e.g. fishing, boating, diving, research, education) may be conducted unless prohibited or otherwise regulated...”. Clearly the intent of this statement is to clarify that the default position is that activities are allowed unless specifically prohibited, however Objective 7g would take the reverse position and prohibit all activities unless specifically allowed.

The Council supports Objective 7k as stated, however the associated text indicates that the NMSP interprets this to mean that managers are faced with an “all or none” choice in which fisheries are either completely unregulated or closed. Again, this ignores the many management techniques in use by fishery managers to allow controlled harvests of marine resources such that socioeconomic benefits are maximized while adverse ecological impacts

are avoided. In addition, the document lacks any discussion regarding what scientific information is needed to assess the impacts of activities on the NWHI ecosystem, nor is there a proposition for scientific research and long-term monitoring to improve management and decision making. Without such research, fisheries will remain forever closed due to "uncertainty in available information".

In conclusion, the objectives of Goal 7 read as very specific regulatory language which restricts flexibility in management approaches. The objectives of Goal 7 should be rewritten to describe the desired state of the sanctuary and not prescribe mechanisms to achieve that state. Therefore Goal 7 and its associated objectives should be revised as follows:

Goal 7: Maintain ecosystem integrity by applying ecosystem-based management and research principles to fishing activities. Sustain ecosystem protection while minimizing adverse socioeconomic impacts

Objectives:

- 7a. Protect ecosystem integrity by applying a precautionary approach and continuing research on crustaceans and precious corals fisheries to determine if, and how, harvests can be allowed without damaging the integrity of the NWHI ecosystem.*
- 7b. Protect the substrate of the NWHI ecosystem through prohibitions on the collection of reef building corals and live rock.*
- 7c. Protect ecologically valuable areas from damage resulting from fishing activities, consistent with available biological and ecological information.*
- 7d. Protect Hawaiian monk seals, sea turtles, seabirds and other protected wildlife by controlling fishing activities in areas where interactions are known to occur.*
- 7e. Maintain ecosystem integrity by controlling the harvests of pelagic, bottomfish, and coral reef associated species consistent with available biological and ecological information.*
- 7f. Maintain ecosystem integrity while minimizing adverse socioeconomic and cultural impacts.*
- 7g. Employ principles of equity and fairness when allocating fishing rights.*
- 7h. Protect Native Hawaiian cultural rights by promoting access for non-commercial fishing uses by Native Hawaiians to the extent possible without damaging the integrity of the NWHI ecosystem.*
- 7i. Promote increased understanding of the NWHI ecosystem through comprehensive and coordinated research.*

7j. Apply ecosystem-based principles through coordinated management with NWHI management and research partners.

Reviewers provided comments on other sections of the document as follows:

The specific methodology underlying the development and application of “screening criteria” is poorly described, circular, and does not withstand scientific scrutiny. For example nowhere does the document assess how various activities would actually impact NWHI marine resources, instead “sensitive ecological areas” are identified based on loosely identified criteria and subjectively ranked. These are then compared to a “bottomfish ranking” of areas in the NWHI which is based on the purported pounds landed from each area. Not only are the landings data incorrect for several areas, there is no consideration given to variations in value by species or interannual variations. Following these ranking exercises, areas in which ecological ranking is “high” while bottomfish ranking is “low” are recommended to be closed despite the lack of any information that bottomfishing has any actual adverse impacts on the area’s resources. Lobster, precious coral and coral reef fisheries are summarily dismissed as inconsistent with the sanctuary’s goals.

In the analyses of fishing alternatives commercial fisheries are required to meet a “burden of proof” that fishing activity does not affect ecosystem/ecological integrity. This policy is not embodied or required in the NMSA or the Goals and Objectives of this Sanctuary. Further, this requirement can never be realized unless there is a definition of ecosystem/ecological integrity and a quantitative threshold for the level of harm. In addition, recreational catch and keep requires reporting while recreational catch and release, sustenance, and Native Hawaiian cultural and subsistence use do not require reporting, yet all involve fish mortality. Also, no caps are proposed for these activities nor do they need to meet the same “burden of proof” required of commercial fishing. Such inconsistencies reveal a lack of a well thought out analytical or management approach to the proposed sanctuary.

The document relies heavily on concerns for monk seals, sea turtles and seabirds, however it largely fails to acknowledge the existence of extensive research and monitoring programs indicating that NWHI fisheries have little to no interactions with these species and that there is no evidence linking these fisheries to adverse impacts on protected or endangered species. In another instance of self-contradiction, although the existing Biological Opinion on the lack of impacts of the NWHI bottomfish fishery on endangered species is noted, the document nevertheless cites concerns for monk seals as a significant reason for constraining this fishery.

The document also contains numerous unsupported statements. For example the document states, “Nevertheless, current fishery management practices, interactions with monk seals, overfishing of susceptible species, and impacts to the coral reef environment have been voiced as ongoing concerns.” No citation or supporting evidence is given for this provocative statement.

Similarly the document states, "Others have noted concern over fishing for *uku* and *hapu* 'u because they are reef-related species, as opposed to *onaga*, *opakapaka* and *ehu*, which are deep slope species." Again, no citations or supporting evidence are provided for this vague statement.

In summary, reviewers found the document to lack a coherent analytical or management framework and to appear to have been written to fulfill a pre-existing agenda to severely restrict (and ultimately prohibit) all commercial fishing in the NWHI. Given the lack of supporting documentation that such activities would inherently threaten or damage the area's marine resources, this agenda must be seen as a philosophical opposition to commercial fishing. While such philosophies are certainly legitimate, they should be clearly and publicly debated rather than hiding behind pseudo-analyses and ambiguous presentations that leave decision makers, fishery participants, managers and the public confused and misinformed as to the necessity and impacts of such initiatives. This document is wholly inadequate in its description, rationale and analyses of management measures for the proposed NWHI sanctuary and should not be relied upon for any rational decision making concerning NWHI resource management.

Summary of Hawaii Bottomfish and Seamount Groundfish Stocks September 2005

GENERAL BACKGROUND

Bottomfish

- Hawaiian bottomfish are a collection (“complex”) of deep slope snappers, groupers, and jacks.
- Fishery features a range of vessel sizes (15-70 feet in length) that fish in deep waters (200-1,200 feet) using vertical handlines (hook and line, not longline or trawls).
- Northwestern Hawaiian Island (NWHI) bottomfish is highly valued in the Hawaii fresh fish market due to larger sizes of fish (for fillets), important for tourism-based restaurants and local cultural holiday activities.
- Fishery has been in operation at various levels since 1913. Currently there are 9 active commercial bottomfish vessels in the NWHI, 325 commercial vessels in the MHI.
- Fishery features minimal finfish by-catch and very few protected resource interactions. The most recent observer placements (2004-2005) did not observe any protected resource interactions. Submersible surveys at two NWHI bottomfishing banks found very little damage that could be associated with fishing activities.
- Imports of snappers and groupers have varied over the years in terms of volume, value, and location. In 2004, using U.S. Customs data, 765,000 pounds (\$1,959,000) were imported, most from Tonga (44%), Australia (29%), and New Zealand (18%), compared to a total of 494,600 pounds (\$2,177,000) from the Hawaii bottomfish fishery as a whole in 2004.

Bottomfish Stock Status Statistics				
	Management Zones			Full Archipelago
	MHI	Mau	Ho-omalua	
<i>These are current values in real units.</i>				
2003 CPUE	190	476	488	-
2003 Effort	1628	199	305	-
<i>These are the reference values in real units.</i>				
MSY CPUE	407	470	431	-
MSY Effort	868	208	789	-
<i>These are current values expressed as ratio of the reference values.</i>				
CPUE Ratio	0.47	1.01	1.13	0.82
Effort Ratio	1.88	0.96	0.39	1.13
<i>Full archipelago ratios use weighting factors based on bottomfish habitat in the management zones.</i>				
Weights	0.447	0.124	0.429	-
<i>These are the threshold values for MSST and MFMT.</i>				
MSST (CPUE Ratio)	0.7	0.7	0.7	0.7
MFMT (Effort Ratio)	1	1	1	1
<i>(at CPUE ratios < 0.7, MFMT declines linearly from 1 to 0.)</i>				
Definitions:				
CPUE = catch per unit effort (pounds per day)				
Effort = fishing effort (days)				
MSST = minimum stock size threshold, overfished defined as lower than this threshold				
MFMT = maximum fishing mortality threshold, overfishing defined as higher than this threshold				

Seamount Groundfish

- Seamount groundfish fishery at Hancock Seamounts is distinct from NWHI bottomfish fishery – different species – different locations – different habitat – different gear.
 - A different complex of species (armorhead, alfonsoin, and Japanese butterfish)

- Caught with different types of fishing gear (trawls) in deeper waters by distant-water foreign fishing vessels.
- Most of the fishery was in international waters but some fishing was within the U.S. Exclusive Economic Zone (EEZ) at Hancock Seamounts – roughly 150 miles west of Kure Atoll in the far western end of the NWHI.
- Seamount groundfish fishery has been subject to a fishing moratorium since 1986, when the fishery was determined to be over-fished due to over-harvesting by foreign trawlers prior to implementation of the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) in 1976.
- No Federal permits were issued to domestic or foreign entities for this fishery.

BOTTOMFISH FISHERY MANAGEMENT

- Managed under the Western Pacific Regional Fishery Management Council’s (WPRFMC’s) Bottomfish and Seamount Groundfish Fishery Management Plan (FMP). [See <http://www.wpcouncil.org/bottomfish.htm>]
- 3 bottomfish fishery management zones in Hawaii established to distribute local fishing effort (see Figure 1):
 - All zones include the same multispecies bottomfish stock complex (see Appendix A).
 - **Main Hawaiian Islands (MHI)** – waters surrounding inhabited Hawaiian Islands
 - 80% of MHI fishing grounds are inside State waters. The zone is managed by the State of Hawaii although the WPRFMC has made recommendations to the State over time concerning management in the MHI.
 - Unlimited entry; approximately 3,600 vessels are registered with the State of Hawaii to conduct bottomfishing in the MHI. Of these vessels, commercial landings are reported from only 325 vessels. No other licenses or permits are required.
 - Maximum landings occurred in 1988, at 1,166,000 pounds (\$3,288,000).
 - Essentially impossible to separate MHI commercial catch into State and Federal portions with the existing data (State of Hawaii catch reports) which record catch in reporting “blocs” which range from 0 to 2 miles, 2 to 20 miles, and 20 miles out.
 - Recreational bottomfish catch data are just now being collected by the cooperative NMFS and State of Hawaii Marine Recreational Fishing Statistics Survey (HMRFSS) intercept creel census program, but few bottomfish fishers have been intercepted by the HMRFSS field staff to date. No estimates have yet been compiled of recreational bottomfish landings in Hawaii.
 - The State of Hawaii and the WPRFMC are also supporting a targeted survey of registered bottomfish fishers to: 1) determine the level of recreational bottomfishing in the MHI; and 2) obtain comments on bottomfish management options for MHI. This survey is on-going.

- **Northwestern Hawaiian Islands (NWHI)**
 - **Mau** zone – a small zone at the eastern end of the NWHI encompassing the islands of Nihoa and Necker. The fishery operates on trips lasting up to 2 weeks).
 - Essentially 100% of habitat in Federal waters.
 - Managed under the WPRFMC’s Bottomfish and Seamount Groundfish FMP.
 - 4 vessels had permits to fish in the Mau zone when the zone was established in 1988. Maximum number of vessels was 14 in 1990-1991.
 - In 1999, limited entry program established with 7 vessels participating.
 - Currently, a total of 5 vessels can be permitted and 5 are currently permitted.
 - Maximum landings occurred in 1990 (14 active permitted vessels) at 249,000 pounds (\$630,000).
- **Ho‘omalu** zone – a larger limited entry zone at the center and western end of the NWHI ranging from French Frigate Shoals to Kure Atoll. The fishery is a distant water fishery and fishing activity is limited by weather and the fresh seafood nature of the fishery.
 - Essentially 100% of habitat in Federal waters.
 - Managed under the WPRFMC’s Bottomfish and Seamount Groundfish FMP.
 - In 1987, fishery established with limited entry program; 12 vessels participating at that time.
 - Currently, a total of 4 vessels can be permitted and 4 are currently permitted
 - Maximum landings were in 1992 (5 active permitted vessels) at 353,000 pounds (\$1,030,760).
- Other management measures include limitations on vessel size, prohibitions on certain gear types, mandatory catch reporting, and mandatory observer coverage in the NWHI.
- Status of the fishery and stocks is assessed annually, and management measures enacted as deemed necessary.

Despite delineation of these three management zones, Hawaiian bottomfish are evaluated under MSFCMA National Standard 1 guidelines as a single archipelagic-wide multispecies stock complex or population. Management criteria, such as whether the stock complex is overfished or whether overfishing is occurring, apply to the stock complex as a whole population rather than to individual management zones.

However, historically and currently bottomfish population status indicators have been compiled for each of the three zones as a guide to local fishery management.

HAWAII BOTTOMFISH STOCK STATUS

Historical Stock Status and Trends

- Fishery status was evaluated based on a species-specific 20% SPR threshold (spawning potential ratio, an index of the reproductive capability of the stock), from 1986-2003. Species-specific SPR values were reported for the archipelago, as well as individual zones,

but stock status was determined at the archipelago level. While there are limitations to the SPR approach, it was the best available method for tracking year-to-year changes in the fishery until mid-2003 when the revised National Standard 1 guideline approach was put in place.

- Under the SPR approach:
 - No stocks of bottomfish in the Hawaiian archipelago were overfished. However, in the MHI, *ehu* and *onaga* populations were reported to be locally depleted. This led to a suite of State of Hawaii regulations in 1998, including recreational bag limits and 20 closed areas throughout the MHI.
 - In the NWHI, local depletion was not reported for any species. SPRs were well above 20% for all species.

Based on the SPR measures, the bottomfish stock complex was not overfished in any year from 1986 to 2003.

Current Stock Status

- After mid-2003, under the new MSFCMA National Standard 1 guidelines, “overfishing” and “overfished” definitions were established for the Hawaii bottomfish fishery. Hawaii bottomfish are assessed as a single archipelagic multispecies stock complex for these purposes, however the status of bottomfish in each of the 3 zones continues to be assessed annually to facilitate effective conservation and management decision making.
- National Standard 1 guidelines define:
 - Overfishing -- too much fishing (relative to fishing mortality at maximum sustainable yield (MSY)); we use fishing effort (expressed as days fished) as a proxy for fishing mortality and assess overfishing annually by comparing the current overfishing metric to an established threshold (maximum fishing mortality threshold (MFMT)) for bottomfish.
 - Overfished -- not enough fish (relative to biomass at MSY); we use catch per unit effort (CPUE) expressed as pounds caught per day as a proxy for abundance; overfished status is determined annually by comparing the current overfished metric to an established threshold (minimum stock size threshold (MSST)) for bottomfish.
- Under the National Standard 1 guidelines:
 - The Hawaiian bottomfish stock is **not** overfished (the *biomass* standard); however, overfishing (the *fishing* mortality standard using fishing effort as a proxy) is occurring as reported in the 2003 annual report of the WPRFMC and in the 2004 NOAA Fisheries Status of Stocks report to Congress
[\[http://www.nmfs.noaa.gov/sfa/domes_fish/index.htm\]](http://www.nmfs.noaa.gov/sfa/domes_fish/index.htm).
 - The WPRFMC is currently developing options within its Bottomfish and Seamount Groundfish FMP to address this situation. Under the MSFCMA, the WPRFMC has one year to develop a plan to address this overfishing concern.

In summary:

Based on nationally- and legally-accepted definitions, in 2003, overfishing was occurring on the Hawaii bottomfish stock complex on an archipelagic basis but the bottomfish stock complex was not overfished, i.e., sufficient biomass remained. Further, as reported below, this over-fishing situation is reflected by the situation in the MHI, not the NWHI.

Projected Stock Status and Trends

- **Archipelago-wide trends:**
 - The fishing mortality ratio indicator (i.e., fishing effort) for the archipelago has experienced significant fluctuations; since 1998 it has continually declined (see Figure 2).
 - The biomass ratio indicator for the archipelago has manifested a more stable trend with no significant change (see Figure 2).
 - Mean weights for individual fish are declining, which is expected with fishing; however, mean weights in both NWHI zones remain significantly higher than those in the heavily fished MHI. Alternative explanations exist for changes in captured fish size, such as gear configuration, gear competition, size targeting, fishing location, and fishing ability. Anecdotal information from fishermen and submersible observations of size/age related segregation of fish over the fishing grounds tend to confirm that weights are associated with fishing style.
 - Trends in landings of particular species are not used as a measure of abundance or fishery health because landings of one species can change dramatically with species targeting, market incentives, gear competition, or natural changes in the ecosystem. Good examples are the pig-lipped *ulua* (*butaguch*, a jack) and *uku* (a grey snapper), which are targeted at various times of the year in response to seasonal fluctuations in demand.
- Trends in the **MHI** (see Figure 3)
 - CPUE in the MHI is relatively stable over the past decade.
 - Since 1998, reported commercial fishing effort in the MHI zone has declined by 50%; commercial participation also has declined.
 - Because of the overfishing status of the Hawaii bottomfish fishery, the WPRFMC is currently evaluating effort reduction alternatives in the EEZ portion of the MHI.
- Trends in the **Mau Zone** (see Figure 4)
 - CPUE in the Mau zone was relatively stable over the past decade but has been increasing in recent years as participation has dropped.
 - Participation in the Mau zone has declined by approximately 70% from 14 vessels in 1990 to 5 vessels in 2003 as anticipated under the limited entry system.
 - Participation is capped at current participants (however, regulatory changes have been proposed by the WPRFMC to enable new Mau zone entrants)
 - Further attrition is anticipated due to current use-or-lose permit policy and the on-going uncertainty in the status of the NWHI fishery under the Executive Order.

- Significant restrictions in or closure of the Mau zone bottomfish fishing grounds are expected to concentrate effort in open areas, possibly causing further depletion in the MHI.
- Trends in the **Ho‘omaluku Zone** (see Figure 5)
 - CPUE has declined over time as consistent with a sustainable fisheries population dynamics model.
 - Since 1990, participation has remained fairly constant, while effort has fluctuated and shows no discernible trend.
 - Significant restrictions in or closure of the Ho‘omaluku zone bottomfish fishing grounds would be expected to concentrate effort in open areas, possibly causing increased depletion in the MHI.

DATA AND METHODOLOGY

Stock Assessment Data Sources and Data Collection Frequency

- PIFSC scientists conduct bottomfish biological stock assessments annually; these assessments are conducted under “data poor” conditions. Data poor refers to the quantity of data, not quality, and suitable assessment methodologies are available for application under such conditions.
- From 1984 to 1990, NMFS relied on shoreside monitoring at the Honolulu auction to estimate catch per trip and to track fishing effort (number of trips).
- Currently, PIFSC uses two sets of State of Hawaii commercial fishery-dependent catch data:
 - Fishing “bloc” data compiled per vessel per day for the MHI
 - Logbook data for the NWHI (available since 1991)
- From 1984-1990 PIFSC utilized shoreside monitoring to compile size composition and other biological and economic information from the NWHI; recently electronic data reporting through Honolulu seafood dealers has come on-line and is available for this purpose.
- The results of the stock assessments are presented to the WPRFMC’s Bottomfish and Seamount Groundfish plan team for review and compiled in an annual report by the WPRFMC (see <http://www.wpcouncil.org/bottomfish.htm#AnnualReports>)
- The most current annual report is for the data year 2003. Data for 2004 are currently being compiled and evaluated.

Data and Methodology Uncertainties, Gaps, Needs

- To date, NWHI CPUEs have been reported in terms of catch per day and have not been standardized by vessel fishing power
 - NWHI fleets are extremely small (5 vessels in the Mau zone and 4 vessels in the Ho‘omaluku zone). Entry or departure of one or more vessels can greatly influence the overall fishing performance of the fleet, the resultant CPUE, and as a result, estimates of biomass based on those CPUEs.
 - As a result, current CPUEs in this very small and very specialized handline fishery may be related more to fishing ability or skill, rather than fish abundance; careful standardization of commercial catch data is necessary prior to interpretation

- CPUE data at the line-hour level (optimal) for each NWHI vessel can be generated from 1997 to the present from new State of Hawaii logbook
- PIFSC staffers have developed algorithms to incorporate this improved data and will have results by November 2005 to use these new measures in calculating National Standard 1 reference points
- In January 2004, a Bottomfish Stock Assessment Workshop was held in Honolulu co-sponsored by the WPFMC and PIFSC, bringing together an *independent scientific panel* of stock assessment experts
 - The objective of the workshop was to evaluate the existing bottomfish data and stock assessment techniques and make recommendations for future assessments
 - Some of the recommendations included:
 - Collect biological data such as length, weight, sex, maturity, and age for key species in order to update important life history parameters
 - Implement a tagging program to determine the extent of movements
 - Initiate a routine fishery-independent survey to provide unbiased estimates of abundance (biomass)
 - Apply several stock assessment models to the data
 - If feasible, create an operational model of the fishery
 - Assess the extent of spatial structuring in Hawaiian bottomfish populations and incorporate this complexity in future assessment and management models
 - The results from this workshop are in the midst of being implemented with the assistance of independent academic stock assessment experts under contract to PIFSC who will: 1) evaluate existing bottomfish data collection programs and if necessary provide recommendations to enhance these programs; and 2) advance population modeling and stock assessment methodologies through the incorporation of spatial structure and ecosystem principles
- In the future, PIFSC will be conducting a three-stage peer-reviewed process to development of significant stock assessments: 1) a detailed review and “certification” of the available data; 2) evaluation and testing of the stock assessment models and assumptions; and 3) review of stock status and implications. This will require more formality in the stock assessment process, and as a result, lengthier time-frames until the new procedures are routinized.

-- Compiled by PIFSC fishery biology staff, September 2005, from public information sources

Glossary:

CPUE – Catch per unit effort, an index of fishing performance often utilized as a measure of fish abundance, after careful standardization.

EEZ -- Exclusive economic zone, generally the region 3 to 200 miles offshore.

FMP – federal Fishery Management Plan.

HMRFSS – Hawaii Marine Recreational Fishing Statistics Survey.

MHI – Main Hawaiian Islands, the inhabited islands in the lower portion of the Hawaiian Archipelago (Middle Bank, Niihau, Kauai, Oahu, Molokai, Kahoolawe, Maui, Lanai, Hawaii).

MFMT – Maximum fishing mortality threshold, a reference point for overfishing status in the NMFS National Standard 1 guidelines, values higher than this threshold are overfishing by definition.

MSFCMA – Magnuson Stevens Fishery Conservation and Management Act (1976 as subsequently amended).

MSST – Minimum stock size threshold, a reference point for overfished status in the NMFS National Standard 1 guidelines, values lower than this are overfished by definition.

MSY – Maximum sustainable yield, a reference point in fisheries describing a degree of resource utilization which allows maximum removal while ensuring long term sustainability.

NWHI – Northwestern Hawaiian Islands, the portion of the Hawaiian Archipelago stretching from Nihoa to Hancock Seamount.

PIFSC – NOAA Fisheries Pacific Islands Fisheries Science Center

SPR – Spawning potential ratio, a stock assessment index related to the reproductive health of a stock, no longer utilized by NMFS as a measure of “overfished” status, but remains an important stock indicator and remains in the Control Rule as a second (species specific) layer.

WPRFMC – Western Pacific Regional Fishery Management Council, the policy-making organization for the management of fisheries in the EEZ around the Territory of American Samoa, Territory of Guam, State of Hawaii, the Commonwealth of the Northern Mariana Islands, and US Pacific island possessions.

Convenient information sources

Pacific Islands Fisheries Science Center

<http://www.pifsc.noaa.gov/>

NOAA Fisheries Office of Sustainable Fisheries

http://www.nmfs.noaa.gov/sfa/domes_fish/index.htm

Western Pacific Fishery Management Council

<http://www.wpcouncil.org/>

Figure 1. Map of Hawaiian Archipelago showing location of bottomfish management zones.

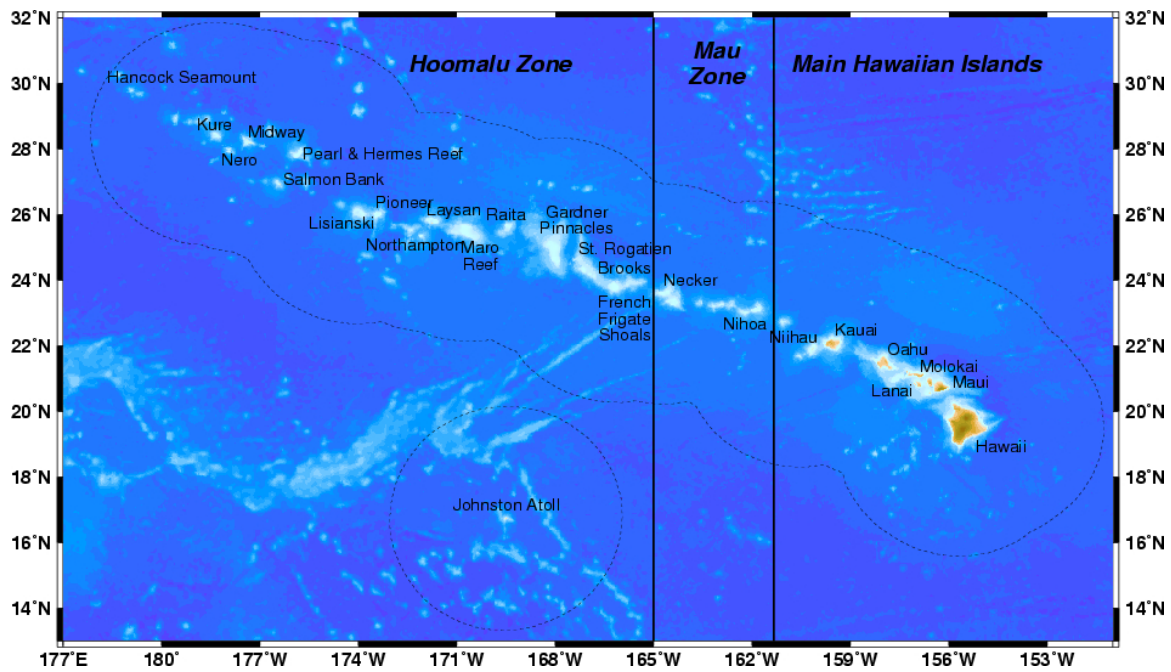


Figure 2. Hawaii bottomfish effort and biomass ratios (archipelago-wide, including all management zones).

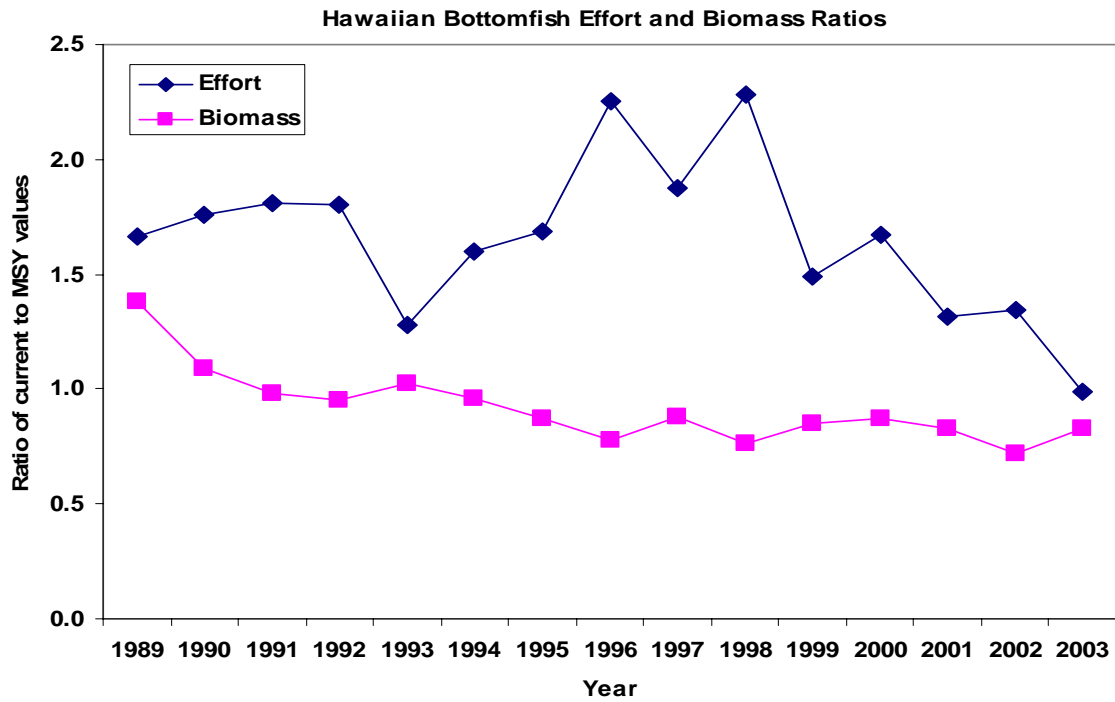


Figure 3. MHI zone fishery time series [nominal data]

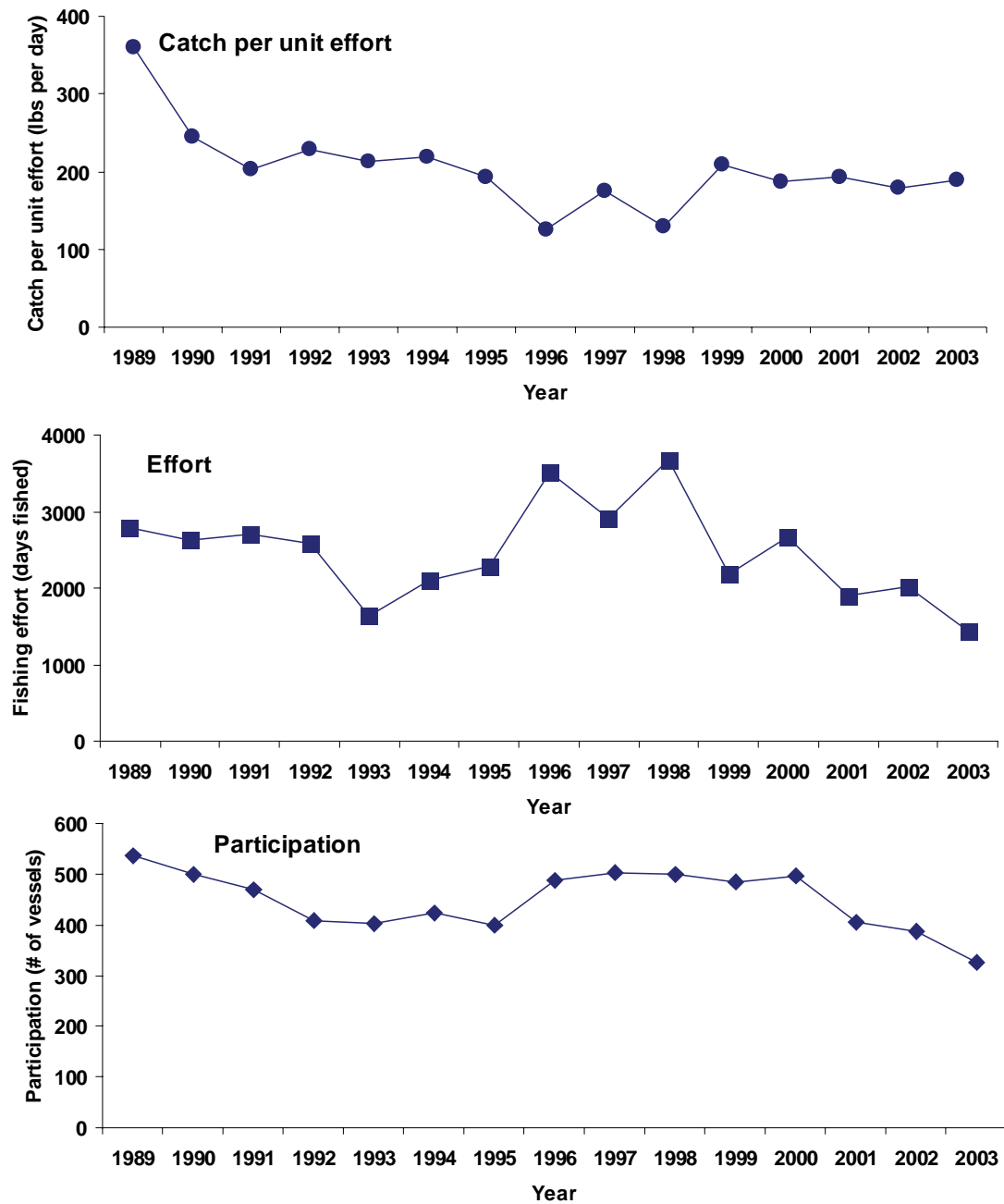


Figure 4. Mau zone fishery time series [nominal data]

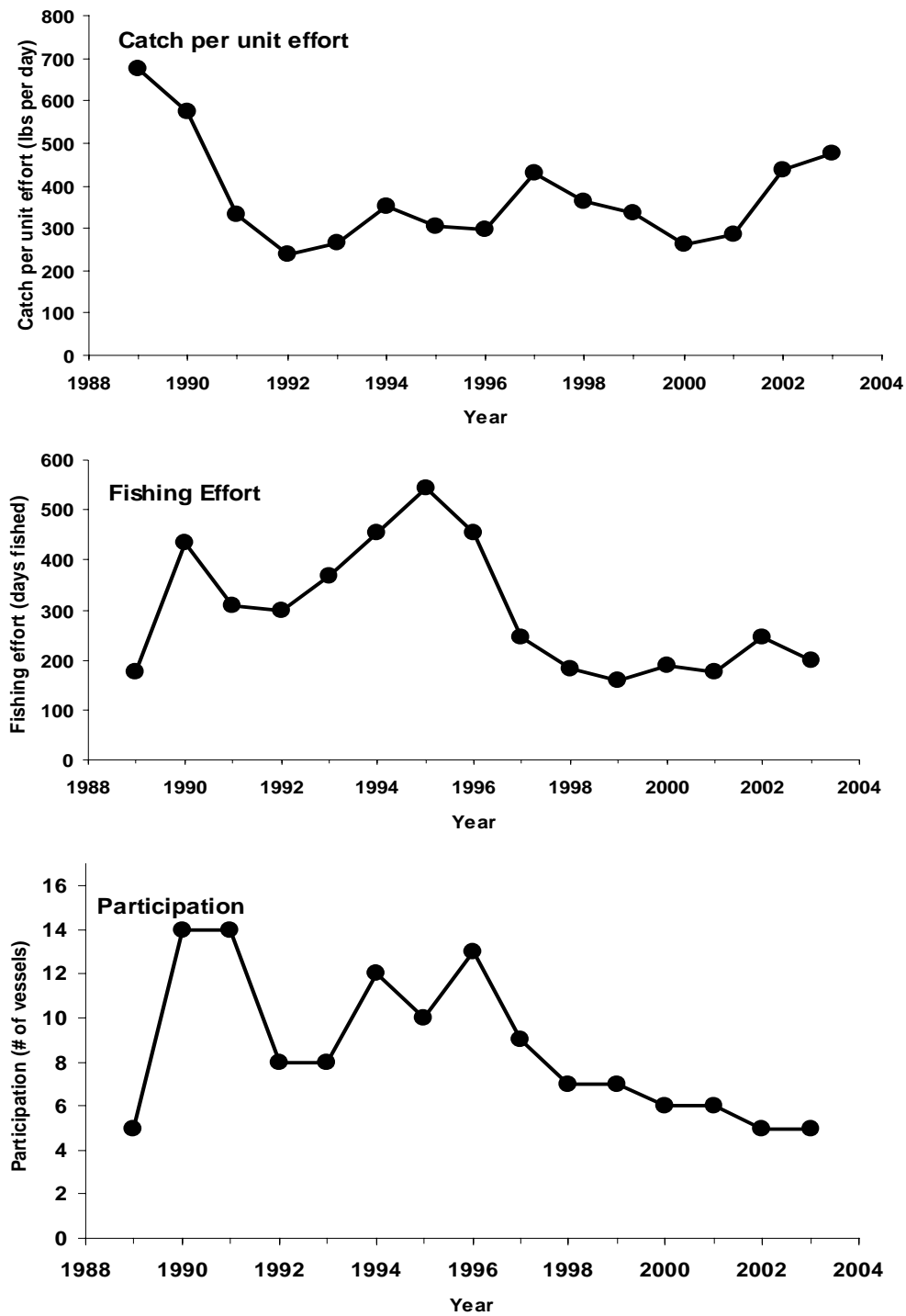
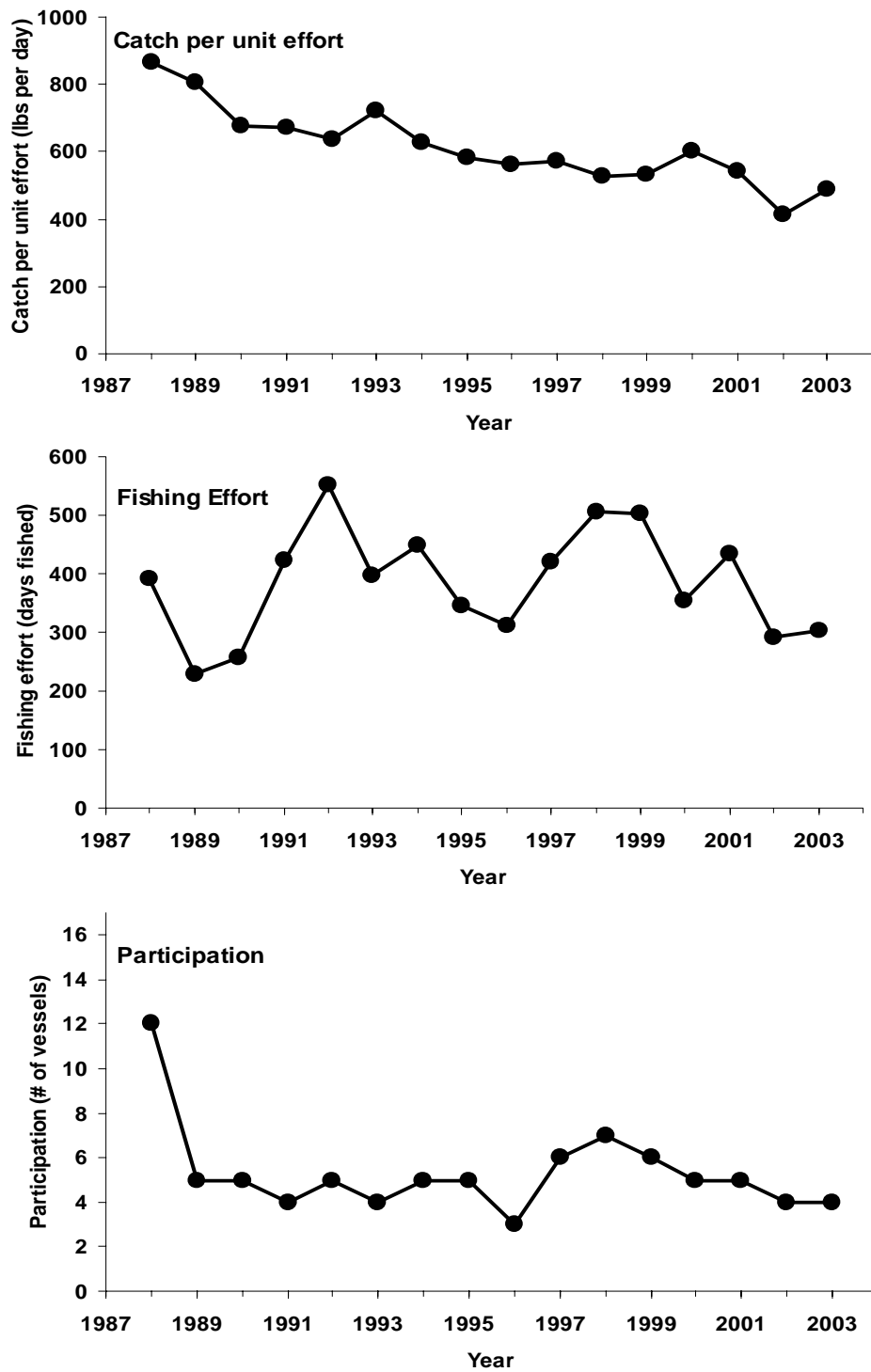


Figure 5. Ho‘omalau zone fishery time series [nominal data]



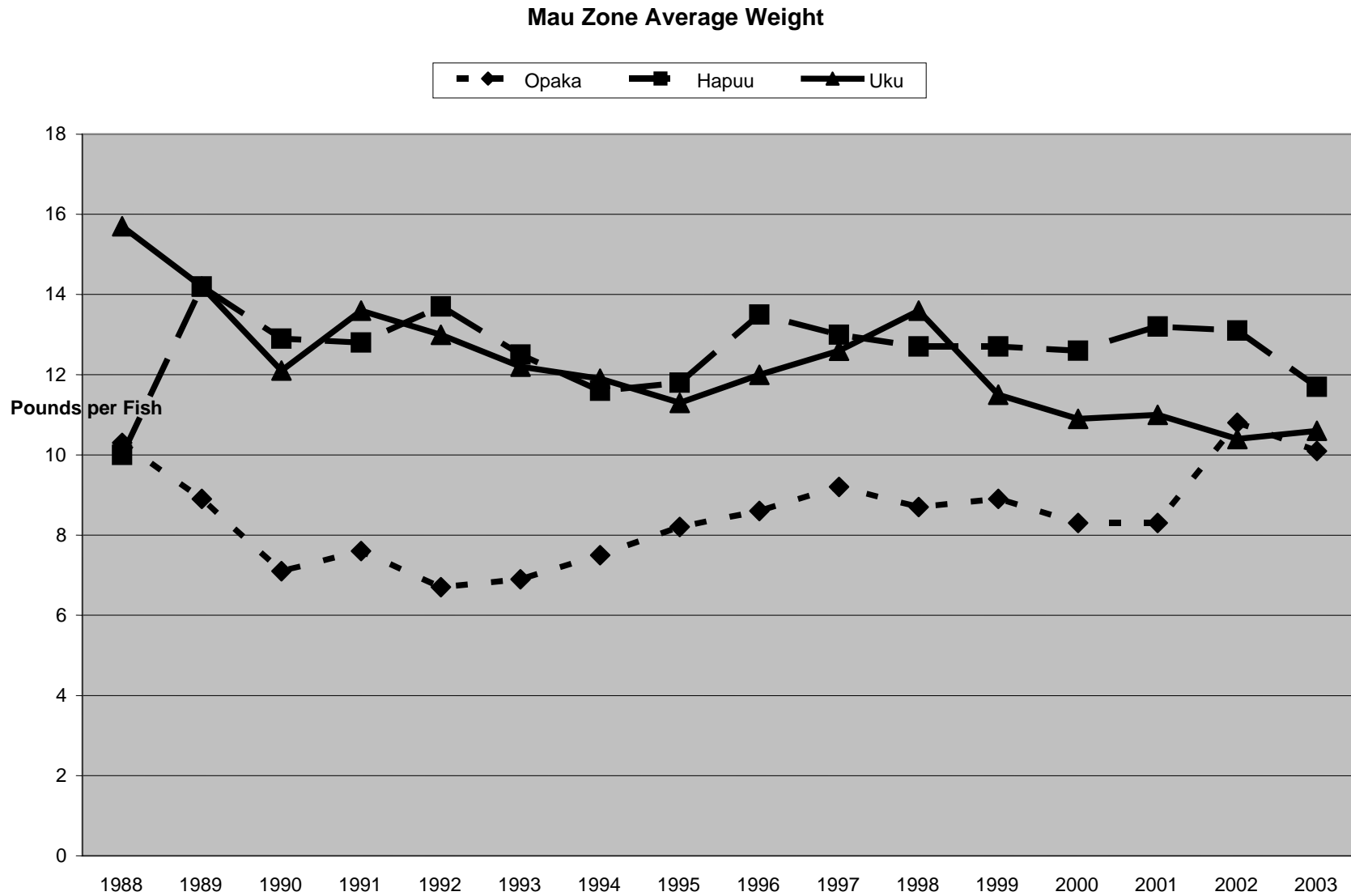
Appendix A: Hawaii Bottomfish and Seamount Groundfish Species

Scientific	English Common	Hawaii Common
Bottomfish:		
<i>Aphareus rutilans</i>	red snapper/silvermouth	lehi
<i>Aprion virescens</i>	gray snapper/jobfish	uku
<i>Caranx ignobilis</i>	giant trevally/jack	white ulua/pau'u
<i>C. lugubris</i>	black trevally/jack	black ulua
<i>Epinephelus fasciatus</i>	blacktip grouper	
<i>E. quernus</i>	sea bass	hapu'upuu
<i>Etelis carbunculus</i>	red snapper	ehu
<i>E. coruscans</i>	red snapper	onaga
<i>Lethrinus amboinensis</i>	ambon emperor	
<i>L. rubrioperculatus</i>	redgill emperor	
<i>Lutjanus kasmira</i>	blueline snapper	ta'ape
<i>Pristipomoides auricilla</i>	yellowtail snapper	yellowtail kalekale
<i>P. filamentosus</i>	pink snapper	opakapaka
<i>P. flavipinnis</i>	yelloweye snapper	yelloweye opakapaka
<i>P. seiboldi</i>	pink snapper	kalekale
<i>P. zonatus</i>	snapper	gindai
<i>Pseudocaranx dentex</i>	thicklip trevally	butaguchi/pig ulua
<i>Seriola dumerili</i>	amberjack	kahala
<i>Variola louti</i>	lunartail grouper	
Seamount Groundfish:		
<i>Beryx splendens</i>	alfonsin	kinmedai (Japanese)
<i>Hyperoglyphe japonica</i>	ratfish/butterfish	medai (Jap.)
<i>Pseudopentaceros richardsoni</i>	armorhead	kusakari tsubodai (Jap.)

Representative Summary Statistics from the NWHI Mau Zone

2 figures attached based on data from the WPFMC annual reports

NOAA Fisheries Pacific Islands Fisheries Science Center



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