CHAPTER 3

CORAL REEFS: THE ECOLOGICAL, FISHERIES AND SOCIAL CONTEXT

3.1 Introduction

This chapter describes the setting for management or, in the language of NEPA, the affected human environment. It forms the basis for the analysis of environmental consequences described and discussed in Chapters 4 and 5. This chapter is divided into three sections, which cover different aspects of the human environment. The first section details the biology and ecology of coral reefs in the Western Pacific Region, including the natural perturbations that can affect coral reef condition. The second section looks at the nature and value of fisheries currently managed by the Council. It also describes the other Council-managed fisheries. The third section details economic conditions and reef resource uses in each of the jurisdictions under the Council. It ends with a brief discussion of jurisdictional issues.

3.2 The Ecological Context

3.2.1 The Coral Reef Ecosystem

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

The corals and coral reefs of the Pacific are described in Wells and Jenkins (1988) and Veron (1995). The number of coral species declines in an easterly direction across the western and central Pacific in common with the distribution of fish and invertebrate species. Over 330 species are contained in 70 genera on the Australian Barrier Reef, compared with only 30 coral genera present in the Society Islands of French Polynesia, and 10 genera in the Marquesas and Pitcairn Islands. Hawaii, by virtue of its isolated position in the Pacific, also has relatively few species of coral (about 50 species in 17 genera) and, more importantly, lacks most of the branching or "tabletop" *Acropora* species that form the majority of reefs elsewhere in the Pacific. The *Acropora* species provide a large amount of complex three-dimensional structure and protected habitat for a wide variety of fishes and invertebrates. As a consequence, Hawaiian coral reefs provide limited 'protecting' three-dimensional space. This is thought to account for the exceptionally high rate of endemism among Hawaiian marine species. Further, many believe that this is the reason certain fish and invertebrate species look and act very differently from similar members of the same species found in other parts of the South Pacific (Gulko 1998).

Most forms of coral reef development can be found in the Western Pacific Region, including barrier reefs in Guam and Saipan, fringing reefs in the Samoas and Hawaii, and patch and submerged reefs, banks and shoals throughout the region, but particularly abundant in the NWHI and within the EEZ of the Northern Mariana Islands. Other habitats commonly associated with coral reefs include mangrove forests, particularly in estuarine areas. The natural eastern limit of mangroves in the Pacific is American Samoa, although the red mangrove *Rhizophora mangle*, was introduced into Hawaii in 1902, and has become the dominant plant within a number of large protected bays and coastlines on both Oahu and Molokai (Gulko 1998). Apart from the usefulness of the wood for building, charcoal, and tannin, mangrove forests stabilize areas where sedimentation is occurring and, from a fisheries perspective, are important as nursery grounds for peneaeid shrimps and some inshore fish species, and form the habitat for some commercially valuable crustaceans.

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

Reef Productivity

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

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

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

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

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

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

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

Estimating the recovery from, and reversibility of, fishing effects over large reef areas appears more difficult to determine. Where growth overfishing predominates, recovery following effort reduction may be rapid if the fish in question are fast growing, as in the case of goatfish (Garcia and Demetropolous 1986). However, recovery may be slower if biomass reduction was due to recruitment overfishing because it takes time to rebuild adult spawning biomasses and high fecundities (Polunin and Morton 1992). Further, many coral reef species have limited distributions; they may be confined to a single island or a cluster of proximate islands. Widespread heavy fishing could cause global extinctions of some such species, particularly if there is also associated habitat damage. Unfortunately, the majority of species with a limited range are also valuable to the aquarium trade, and in the future restrictions on capture, possibly through the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) listing, may be appropriate to prevent overfishing.

Extent and Distribution of Coral Reefs

Roughly 70% of the world's coral reefs, or 420,000 km^2 are located in the Pacific Ocean (Bryant *et al.* 1998). Of all reefs under U.S. jurisdiction, 94%, or an estimated 15,852 km^2 of reef area, are associated with U.S. Pacific Islands (Clark and Gulko 1999; Hunter 1995). Table 3.1 shows their geographical distribution. Note that many of these coral reefs are located in areas where there is no human population, like the NWHI and the PRIAs, or in island archipelagos, like American Samoa and the CNMI, where population is concentrated on one or two islands.

Table 3.1: Coral reef area (in km^2 <100m deep) in nearshore waters (0-3 nm from shore) and offshore waters (3-200 nm from shore) in each location in the Western Pacific Region (Hunter 1995).

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

*Midway is a PRIA located in the Hawaiian Archipelago.

Coral Reef Ecological Characteristics and Resource Dynamics

Coral reefs and reef-building organisms are confined to the shallow upper photic zone and area normally restricted to depths less than 50-100 m (25-50 fm) (Holthus and Maragos 1995). Maximum reef growth and productivity occurs between 5-15 m (Hopley and Kinsey 1988) and maximum diversity of reef species occurs at 10-30 m (Huston 1985).

Available biological and fishery data are poor for all species and areas covered by the CRE-FMP; therefore, it is not possible to implement the Fishery Ecosystem Plan action item 4, elaborated by EPAP.[1] Furthermore, high biological and environmental variability is a natural characteristic of coral reef ecosystems around the U.S. Pacific Islands, with or without fishing. Irregular pulses of new recruits (Walsh 1987) cause cycles in the abundance and harvest potential of individual reef species. Environmental variability is both spatial, related to differences in the quality of habitat (Friedlander and Parrish 1998a), and temporal, related to monthly moon phase, seasonal and longer-term environmental changes (Friedlander and Parrish 1998b).

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

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

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

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

Ecological Relationships

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

Complex symbiotic relationships for defense from predation, removal of parasites, building of domiciles, and other functions are also prevalent. About 32 of the 33 animal phyla are represented on coral reefs (only 17 are represented in terrestrial environments) and this diversity produces complex patterns of competition. The diversity also produces a disproportionate representation of predators, which have strong influences on lower levels of the food web in the coral reef ecosystem (Birkeland 1997a).

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

Coral Reef Habitat

Even within a thriving coral reef habitat, not all space is occupied by corals or coralline algae. Reefs are typically patchworks of hard and sediment bottoms. A reef provides a variety of environmental niches, or combination of resources. The wide variety of survival strategies employed by coral reef organisms allows different species to exploit some combination of resources better than their competitors. The ecosystem is dynamic, however. If conditions change, a very specialized species may not be able to survive the rigors of the new environment or may be forced out by another species more adept at using the available resources, including space, food, light, water motion, and temperature.

Long-term Ecosystem Variability

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

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

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

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

When bleaching occurs, some corals are able to regain zooxanthellae by slowly re-infecting themselves with the algae, or through the reproduction of remaining zooxanthellae within the colony. Frequently, the loss of large amounts of symbiotic algae results in the colony becoming energy deficient; it expends more energy than it is consuming. If this occurs over the long term the colony dies (Brown 1997; Gulko 1999). Coral bleaching events require only a 1-2° C increase in water temperature. Thus, due to global warming, bleaching may become more common. According to Goreau *et al.* (1997), similar events in the Atlantic and the Indian Oceans suggest that worldwide corals are acclimated close to their upper temperature limits. As a result, they are unable to adapt rapidly to an anomalous warming (Goreau *et al.* 1997). Consequently, global warming represents a very serious threat to the survival of coral reefs.

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

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

Coral Reef Communities

Coral reef communities are among the most diverse and ecologically complex systems known. The structure of reef communities is usually defined in terms of the diversity and relative abundances of species characteristic of a habitat type. Commonly, only a few species compose over half the abundance, while hundreds of others are present in low numbers.

Life History

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

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

Species Distribution and Abundance

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

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

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

Reproduction and Recruitment

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

Growth and Mortality Rates

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

Community Variability

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

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

3.2.2 Ecosystem Models

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

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

ECOPATH

ECOPATH is a simple mathematical model that estimates mean annual biomass, production, and food consumption for major components—defined in terms of species groups—of a coral reef ecosystem (Polovina 1984). Polovina used the following species groups to model the ecosystem at French Frigate Shoals in the NWHI: tiger sharks, monk seals, seabirds, reef sharks, sea turtles, small pelagics, jacks, reef fish (and octopus), lobsters and crabs, deepwater bottomfish, nearshore scombrids, zooplankton, phytoplankton, herterotrophic benthos, and benthic algae. A box model illustrates a biomass budget schematic for major predator-prey pathways and lists annual production and annual biomass for each group. The model shows a high percentage of internal predation, which partially explains why fishery yields from coral reefs are generally low despite high primary productivity. The allocation of species to trophic compartments constrains the ECOPATH approach because it imposes an artificial structure that may not coincide with actual community structure. This approach is also data intensive and requires information on each species' diet, mortality, and growth rates.

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

ECOSIM

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

3.2.3 Ecosystem Overfishing

The special vulnerability of targeted coral-reef resources comes from life-history traits of these economically valuable species, which live in diverse communities with strong predatory and competitive forces. Coral reef species are adapted to reproduce often because so few of their progeny are likely to survive. Therefore, they grow slowly, delay first reproduction, and are more territorial than pelagic species. These life history traits make recovery from overfishing very uncertain. Some coral reef ecosystems, driven by biological interactions, have not recovered for decades following intensive harvest, and there are no indications that they will recover. In contrast, pelagic fisheries, driven by oceanographic processes, usually do recover. For example, black-lipped pearl oysters at Pearl and Hermes Atoll in the NWHI were over-harvested to commercial extinction in the late 1920s; according to recent surveys, stocks have still not recovered after 70 years. Holothuroids (sea cucumbers) were over-harvested in the late 1930s in Chuuk, Eastern Caroline Islands, and recent surveys there also show no recovery after 60 years. Dalzell *et al.* (1996) cite several other examples from the Pacific Islands where pearl oyster and sea cucumber populations have failed to recover from over-harvesting, even after several decades of no fishing.

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

Munro (1983) cites the north coast of Jamaica as an example of reefs almost entirely overgrown by macro-algae and where the cover of live coral is extremely low. Although scientists do not fully agree, it appears that this can be attributed to the long-term effects of overfishing. The very narrow island shelf (less than one kilometer wide) was covered by flourishing coral reefs until 1984. Then several events combined to change the situation. First, the herbivorous long-spined sea urchin, *Diadema antillarum,* spread rapidly throughout the Caribbean. Then the north coast of Jamaica took a direct hit from a major hurricane. The reefs were pulverized by heavy seas and large corals were stripped of tissue. Macro-algae colonized all these newly exposed surfaces. In the absence of sea urchins and herbivorous fish, the macro-algae have remained dominant (Hughes 1994). Other parts of the Caribbean with less heavily exploited fish stocks also lost their urchin populations and suffered hurricanes, but these reefs were not massively overgrown with algae. While it cannot be proven that overfishing was the cause of this catastrophe, the evidence points in that direction.

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

In concert with the ecosystem approach, an alternative overfishing definition seems most appropriate for the CRE-FMP. In contrast to the single-species approach, the ecosystem overfishing concept considers how fishing pressure can cause changes to species composition in a multi-species setting, often resulting in changes in ecosystem function (DeMartini *et al.* 1999). This can be detected by shifts in species composition or trophic web dynamics. Using this concept can also guard against single-stock recruitment overfishing, where applicable. There are other reasons for adopting this approach. First, the loss of some species in the multi-species coral reef ecosystem—due to overfishing or other human impacts—could allow often less valuable generalist species to predominate. As in the example cited above, these types of changes to heavily fished reefs have been reported for a number of tropical stocks from various areas around the world. Second, multi-species systems become more vulnerable to environmental fluctuations as exploitation increases.

3.2.4 Status of Protected Species Listed Under the ESA

Several species listed as endangered or threatened under the Endangered Species Act (ESA) occur in and around the coral reef ecosystem, and in the region where Council-managed fisheries operate. These include marine mammals, sea turtles and seabirds. Other species of concern are terrestrial-based birds and terrestrial plants because of the possibility of ship wreck and the threat of invasive species introductions. The species of concern are:

Marine Mammals	**Status**
Hawaiian monk seal (*Monachus schauinslandi*)	Endangered
Humpback whale (*Megaptera novaeangliae*)	Endangered
Sperm whale (*Physeter macrocephalus*)	Endangered
Blue whale (*Balaenoptera musculus*)	Endangered
Fin whale (*Balaenoptera physalus*)	Endangered
Sei whale (*Balaenoptera borealis*)	Endangered
North Pacific right whale (*Eubalaena glacialis*)	Endangered

Sea Turtles	
Green turtle (*Chelonia mydas*)	Threatened/Endangered
Hawksbill turtle (*Eretmochelys imbricata*)	Endangered
Leatherback turtle (*Dermochelys coriacea*)	Endangered
Loggerhead turtle (*Caretta caretta*)	Threatened
Olive Ridley turtle (*Lepidochelys olivacea*)	Threatened/Endangered

Seabirds	
Short-tailed albatross (*Phoebastria albatrus*)	Endangered
Newell's shearwater (*Puffinus auricularis newelli*)	Endangered
Terrestrial-based birds	
Laysan duck (*Anas platyrhynchos laysanensis*)	Endangered
Laysan finch (*Telespyza cantans*)	Endangered
Nihoa millerbird (*Acrocephalus familiaris kingi*)	Endangered
Nihoa finch (*Telespyza ultima*)	Endangered
Micronesian megapode (*Megapodius laperouse laperouse*)	Endangered
Terrestrial Plants (in NWHI)	
Sesbania tomentosa (legume)	Endangered
Schiedea verticillata (fleshy root herb)	Endangered
Pritchardia remota (palm)	Endangered
Amaranthus brownii (weedy herb)	Endangered
Mariscus pennatiformes (sedge)	Endangered
Cenchrus agriminioides (kamanomano)	Endangered

Endangered Marine Mammals

Marine mammals that occur in and around the coral reef ecosystem, and that are listed as endangered under the ESA, include the Hawaiian monk seal (*Monachus schauinslandi*), humpback whale (*Megaptera novaeangliae*), sperm whale (*Physeter macrocephalus*), blue whale (*Balaenoptera musculus*), fin whale (*B. physalus*), the sei whale (*B. borealis*) and the North Pacific right whale (*Eubalaena glacialis*). With the exception of the Hawaiian monk seal, there have been no reported interactions between endangered marine mammals and Council-managed fisheries or by other fishing vessels operating in the proposed coral reef management areas of the region.

Hawaiian Monk Seal

The Hawaiian monk seal is the most endangered pinniped in U.S. waters and is second only to the northern right whale as the nation's most endangered marine mammal (MMC 1999). It was designated depleted in 1976 under the Marine Mammal Protection Act (MMPA), and was listed as endangered under the ESA following a 50% decline in beach counts from the late 1950s to the mid-1970s.

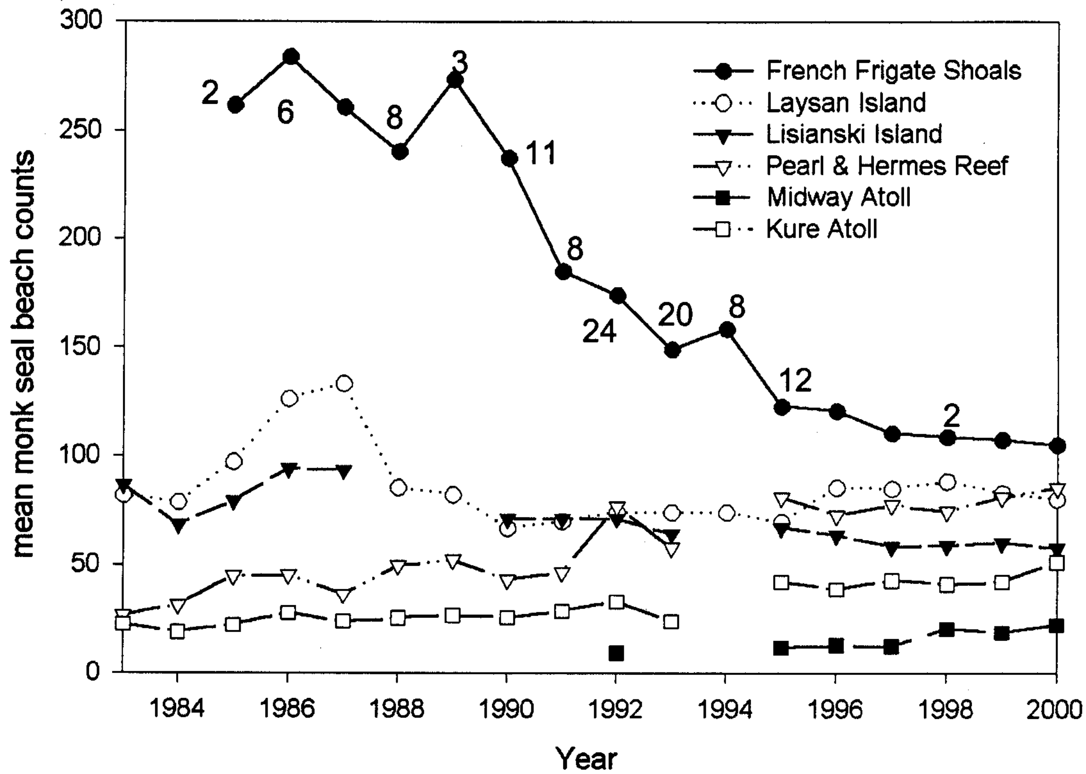
The historical abundance of the Hawaiian monk seal is unknown, The first estimate of monk seal numbers was made in 1958, when a total of 1,206 seals were counted. However, the beach counts conducted were of aerial surveys of the leeward islands only, and during these beach counts researchers estimated that approximately one third of the population remained at sea (Kenyon and Rice 1959; Rice 1960a).

The Hawaiian monk seal breeds only in the Hawaiian Archipelago, with most monk seals inhabiting the remote, largely uninhabited atolls and surrounding waters of the NWHI. More than 90% of all pups are born at six major breeding colonies located at French Frigate Shoals, Laysan Island, Pearl and Hermes Reef, Lisianski Island, Kure Atoll and Midway Atoll. A few births also occur annually at Necker, Nihoa, and Niihau Islands and in the main Hawaiian Islands. Although monk seals occasionally move between islands, females generally return to their natal colony to pup. Since 1990, there has been an increase in the number of monk seal sightings and births in the main Hawaiian Islands (MMC 2000; Johanos and Baker 2000).

Little is known about Hawaiian monk seals or their population status before the 1950s. As a result of natural constraints, the species was probably never very abundant, presumably numbering, at most, in the thousands (as opposed to hundreds of thousands) (Ragen and Lavigne 1999). The arrival of humans in the Hawaiian Islands may have reduced the range of the Hawaiian monk seal largely to the NWHI and contributed to its current endangered status. In historic times, human-related mortality appears to have caused two major declines of the Hawaiian monk seal (MMC 2000). It generally is acknowledged that the species was heavily exploited in the 1800s during a short-lived sealing venture. Several island populations may have been completely eliminated during that period. The second major decline occurred after the late 1950s and appears to have been determined by the pattern of human disturbance from military activities at Kure Atoll, Midway Atoll, and French Frigate Shoals. Such disturbance caused pregnant females to abandon prime pupping habitat, and nursing females to abandon their pups. The result was a decrease in pup survival, which led to poor reproductive recruitment, low productivity, and population decline (MMC 2000).

The decline in monk seal numbers seemed to have slowed by the early 1980s, due primarily to a sevenfold increase in monk seal counts at French Frigate Shoals between the 1960s and mid-1980s. By 1985, the French Frigate Shoals colony had grown to a point where it included nearly half of the entire population (MMC 2000). However, the overall population again began to decline in the late 1980s and early 1990s (see Figure 3.1). The downward trend was driven primarily by a high mortality of juveniles at French Frigate Shoals, where the species' largest breeding colony resides (MMC 2000). Since the mid-1990s total monk seal numbers appear to have stabilized at about 1,300 to 1,400 individuals. The first-year survival of pups at French Frigate Shoals increased significantly in 1998 (MMC 2000).

Figure 3.1: Mean beach counts of Hawaiian monk seals (no pups) at six major breeding colonies from 1983 - 2000. Note that there are missing data points for some years at some locations. Beach counts are not necessarily a good indicator of population abundance as monk seals migrate between islands. In addition, monk seals have been captured and translocated between colonies. For instance, the numbers above the mean beach counts for French Frigate Shoals represent monk seals removed and/or moved to other areas for recovery purposes. (Source: NMFS, SWFSC Honolulu Laboratory unpubl. data).



Contributing to the species' decline over the past four decades have been (1) human disturbance, (2) reduced prey availability, shark predation, (3) attacks by aggressive adult male monk seals on females and immature seals of both sexes (called "mobbing"), (4) entanglement in derelict fishing gear, and (5) recovery efforts (MMC 1999). At each colony, differing combinations of these factors likely have contributed to local trends in abundance, with relative importance of individual factors changing over time (MMC 2000). Factors contributing to the changes in monk seal abundance are described in greater detail in the following sections.

Human Disturbance

As noted above, human disturbance was probably the principal cause of monk seal population declines before the 1980s. Between 1958 and the mid-1970s, monk seal colonies at the western end of the archipelago between Kure Atoll and Laysan Island declined by at least 60%, and the colony at Midway Atoll all but disappeared (MMC 1999). Most human activity was concentrated at the westernmost atolls of the chain during this period, suggesting that human disturbance contributed to the decline. The Navy undertook a major expansion of its air facility on Midway Atoll during the 1950s. The U.S. Coast Guard established LORAN stations at Tern Island, French Frigate Shoals, in 1952, and Kure Atoll in 1960, which were was occupied year-round. Ownership of Midway Atoll was transferred from the Navy to the U.S. Fish and Wildlife Service (USFWS) in 1996, and the atoll is now managed as the Midway Atoll National Wildlife Refuge. The U.S. Coast Guard (USCG) closed the LORAN station at Kure Atoll in 1992, and removed most of the manmade structures by 1993. The Tern Island LORAN station was decommissioned in 1979, and returned to the U.S. Fish and Wildlife Service.

The human population of approximately 160 people at Midway Atoll has decreased substantially in the last two decades, but year-round human habitation of the atoll has continued. Since 1996, there has been limited ecotourism and public use within the Midway Atoll National Wildlife Refuge in the form of charter boat and shore fishing, diving and wildlife observation. A privately owned corporation was awarded a concession to develop and manage the tourist facilities in the refuge. The number of visitors allowed on the atoll at any one time is limited to 100 to reduce impacts to wildlife. The Hawaiian Monk Seal Recovery Team indicated that it supports the efforts of the USFWS to provide compatible visitor opportunities and educational programs at the refuge. It is also important to note that the Midway Atoll monk seal population has increased since the atoll was transferred to the USFWS. However, some monk seal researchers have expressed concern about the possible long-term impacts of developing Midway Atoll as a tourist destination:

> Such developments will of course yield benefits to the management bureaucracy, providing continued support for the Fish and Wildlife Service station on the island. It will also ease the logistical problems for scientists who wish to study the animals on the islands, and it will provide an opportunity for public education. But the conservation benefits of tourism for monk seals at Midway will not be measured by the numbers of visitors or their vacation experience, only its effects on the seals. Although these remain to be determined, one can only wonder what would happen if humans simply vacated Midway entirely (Lavigne 1999, page 260).

Similarly, NMFS (1997) noted that as the tourism venture develops, so does a potential conflict of interest. The economic success of the venture may depend on the nature and variety of human activities permitted on the island. Importantly, those activities that are intended to enhance the Midway experience may be disruptive or detrimental to the refuge and its wildlife. It is clear from several documented cases in the MHI that the sportfish fishery occurring on Midway Atoll has the potential to interact with the monk seals. For instance, in 1994 a monk seal was found dead with a recreational hook lodged in its esophagus (Henderson 1998). In addition, at least seven other monk seals have been hooked by recreational fishermen in the main Hawaiian Islands (MHI), with at least three of these fishermen targeting *ulua* (Henderson 1998). As the monk seal population increases in the Hawaiian Archipelago, it is likely that this may also increase the potential for interactions between the species and sportfisheries, including the recreational fishery operating on Midway.

During World War II, the Navy enlarged Tern Island, one of several small islets at French Frigate Shoals, from its original 4.5 hectares (11 acres) to about 16.2 hectares (40 acres) to accommodate a landing strip (MMC 1999). To do so, the Navy constructed a sheet metal bulkhead around most of the island and backfilled behind the structure with dredged spoil and coral rubble from the surrounding lagoon. The island was artificially enhanced by 23 acres and the surrounding coral reefs destroyed and used as fill material. The Coast Guard took over the island from 1952 to 1979 to operate a LORAN station. Since then, it has been used by the USFWS as a field station for the Hawaiian Islands National Wildlife Refuge.

The continued existence of the runway and field station at Tern Island—in fact, the integrity of the entire island—is in doubt because the sheet metal bulkhead, now more than 50 years old, is badly deteriorated (MMC 1999). If the bulkhead fails, the airstrip would be lost, the field station would have to be abandoned, most of the island would erode away, buried debris would be exposed and create entanglement hazards to wildlife, and erosion pockets behind the rusted-out seawall would become serious entrapment hazards for monk seals and other wildlife. In 1991, a monk seal died after becoming trapped behind the eroding sea wall (USFWS 2000a). In 1999, the USFWS began NEPA assessment for sea wall construction at Tern Island. The total cost of the project is estimated to be about $15 million (MMC 1999).

Another legacy of past human use of the NWHI is environmental pollution from abandoned landfill areas and debris sites that could work its way into atoll food chains (MMC 2000). Most notably, the presence of a point source of contaminants at Tern Island has been identified as a threat to monk seals and other components of the ecosystem at French Frigate Shoals. A recent analysis of risks to Hawaiian monk seals, based on dietary exposure and contaminant concentrations in blubber and blood, shows that no contaminants are present at concentrations believed to present a risk to the seals (CH2M Hill 2000). However, due to the dynamic nature of the environment at the site, an episodic storm event could pose a risk if part or all of the contaminants in the landfill were redistributed into the lagoon.

Reduced Prey Availability

In the early 1980s, steps were taken to prevent human disturbance of monk seals, and the western colonies began to increase slowly (MMC 2000). As noted earlier, however, the breeding colony of monk seals at French Frigate Shoals experienced a high juvenile mortality from 1989 to the mid-1990s. Whereas first-year survival rates for pups at the atoll in the early 1980s were between 80% and 90%, they dropped significantly between 1989 and the mid-1990s (MMC 2000). It was also during this period when the Marine Mammal Research Program translocated seals from French Frigate Shoals to Midway Islands and Kure Atoll (see section on recovery efforts).

One of the potential explanations of the poor juvenile survival at this site during this time period is limited prey availability and subsequent effects on both adults and juveniles. There are two factors related to food that influence weaned pup survival: (1) the amount of food (milk) pups acquire from their mothers prior to weaning; and, (2) the amount of food available to pups immediately after weaning (G. Antonelis, pers. comm.). The first factor is related to the mother's condition and ability to forage successfully prior to parturition and may be viewed as an indicator of prey availability during gestation. The second factor is related to the pup's ability to forage successfully after weaning. Evidence of limited prey availability at French Frigate Shoals included small and, in some cases, emaciated pups, juveniles that were smaller and thinner than those at other colonies and delayed sexual maturity of adult females (Craig and Ragen 1999; MMC 2000).

Further evidence of limited prey availability at French Frigate Shoals has been provided by satellite-linked, time-depth recorders that have been used to track movements and record diving patterns of Hawaiian monk seals at various locations. All but one of the animals tracked at Pearl and Hermes Reef foraged either within the fringing reef or just outside the reef (Stewart 1998). Most dives were to depths of 8-40 m, though there was a secondary mode at 100 to 120 m, and the seals appeared to segregate diving behavior by age and sex. Seals at Lisianski also segregate diving behavior by age and sex, where females and juveniles tend to dive shallow during the day while reproductive males make deeper dives at night (DeLong *et al.* 1984). Monk seals studied at French Frigate Shoals, where the population of seals is considerably larger, exhibited more variation in their habitat use (Abernathy and Siniff 1998). The most prevalent pattern, particularly among males, was use of the banks to the northwest (some of which are more than 200 km from haul-out sites), with daytime diving in the 50-80 m range and a nocturnal or crepuscular shift to the 110-190 m range. The next most common group included seals that did not leave the vicinity of French Frigate Shoals and rarely dived deeper that 80 m. Finally, a small number of seals made many dives greater than 300 m. Abernathy and Siniff (1998) suggested that reduced prey availability could account for the greater variety of foraging patterns at French Frigate Shoals as some individuals are forced to venture to new areas and alter their prey base.

The two leading hypotheses to explain the lack of prey at French Frigate Shoals are: (1) the local population reached its carrying capacity during the mid-1980s, and essentially diminished its own food supply; and, (2) carrying capacity was simultaneously reduced by large-scale natural perturbations in ecosystem productivity (NMFS 1997; MMC 2000). Declines in Hawaiian monk seal, seabird and lobster reproductive success in the late 1980s appear to have been linked to a large-scale climatic event (Polovina *et al.* 1994). From the mid-1970s to late 1980s, the central North Pacific experienced increased vertical mixing, with a deepening of the wind-stirred surface layer into nutrient-rich lower waters and probable increased injection of nutrients into the upper ocean. Resulting increased primary productivity likely provided a larger food base for fish and animals at higher trophic levels. In the NWHI changes of 60% to 100% over baseline levels in productivity for lobsters, seabirds, reef fish and monk seals were observed and attributed to deeper mixing during 1977-1988 (Polovina *et al.* 1994). The variation in the geographical position of this vertical mixing is in turn related to the position of the Aleutian low-pressure system.[2] As this system deviates from its long-term average position, productivity may be more or less affected in the waters around the NWHI.

Polovina *et al.* (1994) suggested that the average position of the Aleutian low-pressure system moved northward in the mid- to late-1980s. The "declines" in productivity observed at Midway Atoll and French Frigate Shoals after 1988 actually represented returns to more "normal," lower levels of productivity. Productivity may have been most affected at French Frigate Shoals, the southernmost reproductive colony of Hawaiian monk seals (Craig and Ragan 1999). Furthermore, the adverse impact of a return to less productive oceanographic conditions on monk seal reproduction and survival could presumably have been greater at French Frigate Shoals because that island's monk seal population was closer to carrying capacity (Ragen and Lavigne 1999).

The general decreases in reef fish abundance observed at Midway Atoll and French Frigate Shoals in 1992-1993 may also have been influenced by interdecadal changes in ecosystem productivity in the central Pacific, at and above the latitudes of the NWHI (DeMartini *et al.* 1996a). In 1995, a dramatic increase in recruitment and availability of reef fish was detected at both French Frigate Shoals and Midway Atoll (DeMartini *et al.* 1996a,b). No further increase in apparent abundance of reef fish since that time has been found (DeMartini and Parrish 1998), but from the mid- to late-1990s there was an improvement in the condition of monk seal pups at weaning and in local pup births at French Frigate Shoals and other major island populations (NMFS 1997; MMC 2000). Trends in pup girth measurements indicate that prey resources may have started to increase during the 1990s, most notably at Laysan Island, Lisianski Island, and French Frigate Shoals (NMFS 1997; MMC 2000).

Fisheries also have the potential of reducing the prey available to Hawaiian monk seals. Hawaiian monk seals have the capability to dive to depths at which many species targeted by the bottomfish fishery occur. It is suspected that monk seals may strip bottomfish from handlines and consume them (Nitta 1999). Observers reported that seals appeared to prefer *opakapaka*, but

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[2]There are also considerable biological data showing higher fish and zooplankton densities in the Gulf of Alaska during the 1970s and 1980s compared to earlier decades, as well as correlations between biological indices and an index of the strength of the Aleutian low-pressure system (Polovina *et al.* 1995).

would also eat *onaga*, *butaguchi*, and *kahala*. However, the results of dietary studies suggest that these species do not constitute a significant component of the natural diet of monk seals (Goodman-Lowe 1998).

An analysis of fecal and regurgitate samples from Hawaiian monk seals at five islands in the NWHI demonstrated that monk seals are opportunistic predators that feed on a wide variety of available prey in comparison to the case of other seals, whose diet is mainly made up of only a few species (Goodman-Lowe 1998). The analysis revealed that teleosts (bony fish) were the most represented prey (78.6%), followed by cephalopods (15.7%) and crustaceans (5.7%). The most common teleost families found were marine eels (22.0%), Labridae (20.6%), Holocentridae (14.4%), Balistidae (13.1%), and Scaridae (10.5%). All teleosts found were common, shallow-water reef fishes, except for the beardfish family, Polymixiidae (1.0%), which is recognized to consist of deep-water benthic fish. The deep-water Polymixiidae are not caught in the bottomfish fishery, either as target or non-target species. Evidence of target species, such as snapper and grouper, appeared infrequently in fecal and regurgitate samples.

A recent study contracted by NMFS used quantitative fatty acid signature analysis to identify which prey items are most important to the various age and sex components of the several island populations of monk seals. Initial estimates of diet suggest an array of prey species that are in some cases comparable to that found in the analysis of fecal and regurgitate samples. To date, the study has focused on the identification of fatty acids of lobster species and not on identification of the fatty acids of the fish species most commonly targeted by the NWHI bottomfish fishery.

Shark Predation and Mobbing

Evidence suggests that during the mid- to late-1990s, shark predation and male monk seal aggression contributed significantly to the mortality of weaned and pre-weaned pups at French Frigate Shoals (MMC 2000). Predation by Galapagos sharks (*Carcharhinus galapagensis*) and perhaps tiger sharks (*Galeocerdo cuvieri*) of monk seal pups seems to be increasing in occurrence, as 17 (18%), 16 (15%) and 25 (27%) pup mortalities or disappearances were believed to be associated with shark attacks at French Frigate Shoals in 1997, 1998, and 1999, respectively (Laurs *et al.* 2000). In 1999, shark predation may have accounted for the deaths of 51% (23 of 45) of the pups born at Trig Island in French Frigate Shoals (G. Antonelis, pers. comm.). A preliminary analysis of the impacts of shark predation on the recovery of the French Frigate Shoals population of monk seals indicates that the mitigation of this interaction is essential to the recovery of this population. The Hawaiian Monk Seal Recovery Team (HMSRT) has recommended that NMFS undertake a program to remove Galapagos and/or tiger sharks observed patrolling beaches where monk seal pups are present within French Frigate Shoals.

Aggressive behavior or mobbing of females and immature seals by adult males is a source of mortality at French Frigate Shoals, Laysan Island, and Lisianski Island. The deaths can be a direct result of injuries inflicted by the aggressive males or as a result of later shark attacks on wounded seals or pups chased into the water by aggressive males. The primary cause of mobbing is thought to be an imbalance in the adult sex ratio, with males outnumbering females (Ragen and Lavigne 1999). Such imbalances are more likely to occur when populations are reduced. In 1997, 14 incidents of individual adult male aggression toward pups were documented at French Frigate Shoals, and eight pups subsequently died (MMC1999). In 1998, there were 13 documented cases of male aggression toward females, juveniles or pups that resulted in injury or death. Of these, three were at French Frigate Shoals, one of which resulted in a death; two were at Laysan Island, one of which resulted in a death; and eight were at Lisianski Island, one of which resulted in a known mortality. The subsequent removal and relocation of aggressive male monk seals has reduced or eliminated deaths caused by males at French Frigate Shoals and Laysan Island (MMC 2000).

While aggressive male monk seal mobbers can be removed to reduce attacks, shark predation on the population is more difficult to control and monitor. For instance, great white shark (*Carcharodon carcharias*) sightings have been recorded and photographed near Kauai, Nihoa, and Necker Islands since 1995, and ecotourist charter operators note that the behavior of the seals in the area changes when a great white shark is present (L. Bail, pers. comm.). The distribution and migratory patterns of the great white shark in the NWHI, or if the shark has preyed upon monk seals, are unknown. Great white sharks are known to prey upon pinniped species in other regions, and a loss of even one adult Hawaiian monk seal per month to this single shark might represent a significant impact on the population. Although, monk seals can survive shark attacks, as evidenced by seals with healed bite marks, the presence of the shark could modify monk seal foraging behavior. As shown by satellite tracking of seals, adult females with nursing pups, weaned pups and immature seals may prefer shallow water protected by reefs because it excludes larger sharks (DeLong *et al.* 1984). Adult monk seals at French Frigate Shoals may have learned to avoid sharks by retreating to underwater caves at La Pérouse Pinnacles, where scuba divers see seals breathing from bubbles of air trapped at the ceiling of the cave (Rauzon 2001). In addition to physically harming seals, sharks have been seen to steal food away from foraging monk seals (F. Parrish, pers. comm.). To control future shark attacks on weaned pups and juveniles, the NMFS Marine Mammal Research Program, Honolulu Laboratory, has applied for permits to cull aggressive sharks known to prey on monk seals. However, to date, there are no studies investigating the impact of changes in shark abundance with monk seal survival.

Entanglement in Marine Debris

Marine debris, particularly derelict fishing nets, poses a serious risk of injury and death to Hawaiian monk seals. The inquisitive nature of seals, particularly pups and juveniles, tends to make them attracted to debris. Subsequent interactions can lead to entanglement and, unless they are able to free themselves quickly, entangled seals risk drowning or death through injuries caused by the entangling gear. In 1998, 18 seals were found entangled in debris (MMC 1999). Of these, five were able to disentangle themselves, 12 were disentangled by field crews and one was found dead in a fishing net caught on the reef at Laysan Island. In 1999, a record 25 monk seals were reported to have been found entangled in marine debris (Laurs *et al.* 2000). Most of the net debris in the NWHI appears to be trawl webbing. Although its origin is unclear, no trawl or gillnet fishing occurs in the NWHI, and it is assumed that virtually all of the debris has been transported by ocean currents from distant fisheries around the rim of the North Pacific Ocean (MMC 2000).

In 1998, NMFS organized a multi-agency cleanup effort to remove derelict fishing nets and other debris from the reefs surrounding French Frigate Shoals and Pearl and Hermes Reef. NMFS was able to remove only a small proportion of this debris, and the agency estimates that 38,000 pieces of netting remain in the waters surrounding each of these locations (MMC 2000). NMFS continued the task of cleaning up this marine debris in 1999 and 2000.

Recovery Efforts

The Hawaiian monk seal was listed as an endangered species on November 23, 1976, and the first recovery plan was issued in 1983. Critical habitat for the monk seal was designated in 1988, and included all beach areas, including beach crest vegetation, lagoon waters, and ocean waters out to a depth of 20 fm around Kure Atoll, Midway Islands (except Sand Island and its harbor), Pearl and Hermes Reef, Maro Reef, Lisianski Island, Laysan Island, Gardner Pinnacles, French Frigate Shoals, Necker Island, and Nihoa Island.

Hawaiian monk seal recovery efforts include monitoring the seals and assessing their abundance, distribution and health status. Other recovery efforts have focused on reducing the high ratio of males to females at Laysan Island, a condition thought to elicit mobbing of females and pups by aggressive males. For instance, in 1994, 21 adult male monk seals, identified as participating in mobbing attacks on females seals, were collected and translocated from Laysan Island to selected locations throughout the MHI. Since the male seals were removed from Laysan Island, the remaining seals showed an improvement in reproductive success.

Monk seal research activities can also inadvertently have a negative impact on monk seals. Since 1982, for instance, three seals have died from research efforts, and an additional 22 seals have died during translocation and rehabilitation efforts (G. Antonelis, pers. comm. 2000). However, many of the seals chosen for rehabilitation were in poor health before inclusion in the program, and therefore it is assumed their risk of mortality from natural causes was already high (G. Antonelis, pers. comm.). According to a recent study by the NMFS Honolulu Laboratory, with current handling procedures, research handling of monk seals will not result in mortality if the seals are released in a healthy condition (Baker and Johanos 2000). Still, between 1982 and 1998, a total of 157 seals have been handled and/or translocated from one island area to another by researchers during recovery efforts, and these recovery efforts need to be taken into consideration when assessing changes in population trends (Figure 3.1). According to some researchers, it is also possible that continuous human habitation of research field camps in the NWHI could have an adverse effect on monk seals if not carefully monitored and controlled.

In 1996, NMFS completed a Section 7 consultation Biological Opinion in association with Amendment 9 to the Fishery Management Plan for Crustaceans. This consultation considered impacts to protected species from the crustacean fishery. Species considered that may occur in the management area included the Hawaiian monk seal, green sea turtle, leatherback turtle, and humpback whale. It concluded that Amendment 9 was not likely to jeopardize the continued existence of the listed species within the management areas or adversely affect any designated critical habitats. In addition, conservation recommendations were developed identifying those activities that NMFS and the Council could pursue to further reduce the adverse effects of fishing activities to listed species and their critical habitats.

In 1999, NMFS conducted an informal Section 7 Consultation regarding the establishment of permanent lobster fishing areas and allocation of the 1999 harvest guideline for the commercial lobster fishery in the NWHI. This also concluded there was no evidence to suggest that the proposed 1999 harvest guideline for lobster, or establishment of permanent lobster fishing areas in the NWHI, would likely adversely affect Hawaiian monk seals, and that the 1996 Biological Opinion remains valid.

In June 2001, the Council endorsed voluntary measures to reduce potential interactions between the Hawaiian monk seal and the bottomfish fishery. These monk seal measures were proposed by the bottomfish fishermen, and require fishermen to immediately stop fishing and retain all gear on deck whenever a monk seal is sighted within a ten yard radius of fishing operations. If the monk seal remains in the designated area for more than two hours, the captain of the vessel will relocate to other fishing grounds where there are no monk seals. Bottomfish fishermen also proposed to voluntarily retain all injured and/or dead catch and discard offal only after fishing operations have ceased and only if there are no monk seals in the area.

Other Endangered Marine Mammals

Other marine mammals listed as endangered under the Endangered Species Act that have been recorded in waters in which Council managed fisheries operate are the humpback whale (*Megaptera novaeangliae*), sperm whale (*Physeter macrocephalus*), blue whale (*Balaenoptera musculus*), fin whale (*B. physalus*), sei whale (*B. borealis*) and the North Pacific right whale (*Eubalaena glacialis*). With the exception of the Hawaiian monk seal, there have been no reported interactions with other endangered marine mammals in the bottomfish or crustacean fisheries of the region. There was one reported interaction of a sperm whale with the Hawaii longline fishery in 1999. The whale was released alive.

Humpback Whale

Humpback whales (*Megaptera novaeangliae*) can attain lengths of 16 m. These whales are black or gray, and have very long flippers, with white on the underside. The fins of the humpback have knobs on the edges. Four stocks of humpback whales inhabit the north Pacific basin, based on genetic and photo identification studies. Two stocks are recognized as eastern north Pacific stocks. One stock is recognized as a central north Pacific stock. Another stock is recognized as a western Pacific stock. The central north Pacific stock of humpback whales winters in the waters of the MHI and feeds on the summer grounds of Southeast Alaska and Prince William Sound (Hill *et al.* 1997). Humpback whales feed on krill and small schooling fish. The two known feeding areas for the central north Pacific stock are Prince William Sound and southeastern Alaska. In Hawaiian waters, their distribution is almost exclusively within the 1,000 fm isobath and usually within 100 fm (Nitta and Naughton 1989). It is not unusual to observe humpback whales during the months of October to May in the nearshore waters off of the island of Oahu.

A population estimate of 1,407 whales for the north Pacific stock was derived using capture-recapture methodology (95% C.I. 1,113-1,701) for data collected in 1980-83 (Baker and Herman 1987). The current humpback whale population is estimated at between 3,500 and 5,000 individuals for the north Pacific (Calambokidis *et al.* 1997).

In 1995, a humpback whale in Maui waters was found trailing and entangled in numerous mooring lines (not fishery-related). The whale was successfully released, but subsequently stranded and was attacked and killed by tiger sharks in the surf zone. In 1996, one humpback whale calf was found stranded on Oahu with evidence of vessel collision (propeller cuts) (NMFS unpubl. data). In 1991, a humpback whale was observed entangled in longline gear and released alive (Hill *et al.* 1997). In 1998, a humpback whale was fouled in longline fishing gear. It was released alive. Very few observations of interactions with longline and other Hawaii fisheries have been documented (Dollar 1991; Nitta and Henderson 1993).

Sperm Whale

The sperm whale (*Physeter macrocephalus*) is the most easily recognizable whale with a darkish gray brown body and a wrinkled appearance. The head of the sperm whale is very large, comprising up to 40% of its total body length. These whales have a single blowhole on the left side of their head. The current average size for male sperm whales is about 15 m, with females reaching up to 12 m. Sperm whales primarily eat squid, but also some fish including salmon (*Oncorhynchus* spp.), rockfish (*Sebastes* spp.), and lingcod (*Ophiodon elongatus*).

Sperm whales are found in tropical to polar waters throughout the world (Rice 1989). The Hawaiian Islands marked the center of a major nineteenth century whaling ground for sperm whales (Gilmore 1959; Townsend 1935). Since 1936, at least five strandings have been reported from Oahu, Kauai (Nitta 1991), and Kure Atoll (Woodward 1972). Sperm whales have also been sighted around several of the NWHI (Rice 1960b), off the main islands of Hawaii (Lee 1993), in the Kauai channel and in the Alenuihaha Channel between Maui and the island of Hawaii (Shallenberger 1981). In addition, the sounds of sperm whales have been recorded throughout the year off Oahu (Thompson and Freidl 1982).

The stock identity of sperm whales in the north Pacific has been inferred from historical catch records (Bannister and Mitchell 1980) and from trends in CPUE and tag-recapture data (Ohsumi and Masaki 1977), but much uncertainty remains. The status of sperm whales within Hawaiian waters in unknown.

There was one reported interaction of a sperm whale with the Hawaii longline fishery in 1999. A NMFS observer aboard a Hawaii longline vessel reported a whale hooked and entangled in a longline, and then released alive (NMFS Observer Program unpubl. data).

Blue Whale

The blue whale (*Balanoptera musculus*) is the largest living animal. Blue whales can reach lengths of 30 m and weights of 160 mt with females usually larger than males of the same age. Blue whales migrate long distances to forage for food. Their migration routes are well known and well studied by researchers. They are shallow feeders, primarily eating krill found within the top 100 m. They occur in all oceans, usually along continental shelves, but can also be found in the shallow inshore waters, and the high seas. There are three major populations of blue whales: the north Pacific, north Atlantic, and southern hemisphere populations. The north Pacific population tends to summer from central California to the Gulf of Alaska, and winter in the open waters of the mid-temperate Pacific at about 20° N latitude.

No sightings or strandings of blue whales have been reported in Hawaii. Acoustic recordings made off Oahu and Midway (Northrop *et al.* 1971; Thompson and Freidl 1982) islands have reported blue whales somewhere within the U.S. EEZ off of Hawaii. The recordings made on Oahu showed bimodal peaks throughout the year, suggesting the animals were migrating to the area in summer and winter. There have been no reported incidences of blue whales interacting with the Hawaii-based longline or other western Pacific regional fisheries.

Fin Whale

Fin whales (*Balanoptera physalus*) are found throughout all oceans and seas of the world from tropical to polar latitudes. They are rare in Hawaiian waters. There have been only two confirmed sightings off Oahu and a single stranding on Maui (Shallenberger 1981). Balcomb (1987) observed 8-12 fin whales in a multi species assemblage in May 1966 about 250 miles south of Honolulu. Thompson and Freidl (1982; and see Northrop *et al.* 1971) suggested that fin whales migrate into Hawaiian waters mainly in fall and winter, based on acoustic recordings off Oahu and Midway Islands. Although the exact positions of the whales producing the sounds could not be determined, at least some of them were almost certainly within the U.S. EEZ.

The status of fin whales in Hawaiian waters is unknown. Some of the whales taken by the commercial whalers in the north Pacific may have been from populations that migrate seasonally into the Hawaiian EEZ. There have been no reported interactions between fin whales and the Hawaii-based longline fishery or other Western Pacific Regional fisheries.

Sei whale

Sei whales (*Balanoptera borealis*) are rare in Hawaiian waters. They are distributed far out to sea in temperate regions and do not appear to be associated with coastal features. The harvest of sei whales has been distributed continuously across the north Pacific between 45° N and 55° N latitudes (Masaki 1977). Sei whales are now rare in California waters (Barlow 1995; Dohl *et al.* 1983; Forney *et al.* 1995; Mangels and Gerrodette 1994), but were the fourth most common whale taken by California coastal whalers in the 1950s-1960s (Rice 1974). They are extremely rare south of California (Lee 1993; Wade and Gerrodette 1993). There are no data on the abundance of sei whales in the eastern North Pacific. There have been no reported interactions between sei whales and the Hawaii-based longline fishery or with any other western Pacific regional fisheries.

North Pacific right whale

The North Pacific right whale (*Eubalaena japonica*) is a large baleen whale which is often found near coastal waters in the Gulf of Alaska and the Aleutian Islands. The whales are known to leave these feeding grounds during the winter months and migrate south, but the extent of their southern range is unknown. To date, no sightings of the North Pacific right whale exist in the region where the Hawaii longline fishery operates.

The adults are generally between 45 and 55 feet in length and can weigh up to 70 tons. The animal's girth is often close to its length, giving the whale a stout appearance with the head making up almost a fourth of the body's length. Females are larger than males. Overall, very little is known about the north Pacific right whale, except that it was hunted to near extinction by the whaling industry over the last eight centuries. Currently, the population is estimated to have fewer than 100 animals and the whale is considered one of the whale species most in danger of becoming extinct in the near future.

Right whales were first protected by the League of Nations in 1935, and later by the International Whaling Commission (IWC) in 1946. The whale was first listed under the Endangered Species Conservation Act in June 1970, and later listed as endangered under ESA in 1973. Collisions with ships, entanglements in fishing gear, degradation of habitat, and disturbances with natural behavior are threats that impede the recovery of the North Pacific right whale.

Non-Endangered Marine Mammals

Species of marine mammals that are protected under the Marine Mammal Protection Act (MMPA), but are not listed as threatened or endangered, and could occur in the areas where coral reef ecosystem fisheries operate are as follows:

- Pacific white-sided dolphin (*Lagenorhynchus obliquidens*)
- Rough-toothed dolphin (*Steno bredanensis*)
- Risso's dolphin (*Grampus griseus*)

- Spotted dolphin (*Stenella attenuata*)
- Spinner dolphin (*Stenella longirostris*)
- Striped dolphin (*Stenella coeruleoalba*)
- Bottlenose dolphin (*Tursiops truncatus*)
- Melon-headed whale (*Peponocephala electra*)
- Pygmy killer whale (*Feresa attenuata*)
- False killer whale (*Pseudorca crassidens*)
- Killer whale (*Orcinus orca*)
- Blainsville's beaked whale (*Mesoplodon densirostris*)
- Cuvier's beaked whale (*Ziphius cavirostris*)
- Pygmy sperm whale (*Kogia breviceps*)
- Dwarf sperm whale (*Kogia simus*)
- Bryde's whale (*Balaenoptera edeni*)

Only the Pacific bottlenose dolphin (*Tursiops truncatus*) was observed to interact with vessels targeting bottomfish management unit species in the NWHI (Nitta 1999). Fish theft by bottlenose dolphins occurred at about 5-10 fm from the surface during the handline retrieval, and the dolphins would often play with the fish for a few minutes before consuming them. Observers only sighted about 40 Spinner dolphins but these dolphins did not interact with the fishing vessels (Nitta 1999).

Sea Turtles

All sea turtles are designated under the Endangered Species Act as either threatened or endangered. The breeding populations of Mexico olive ridley turtles (*Lepidochelys olivacea*) are currently listed as endangered, as are leatherback turtles (*Dermochelys coriacea*) and hawksbill turtles (*Eretmochelys imbricata*). Loggerhead turtles (*Caretta caretta*) and green turtles (*Chelonia mydas*) are listed as threatened (note the green turtle is listed as threatened under the ESA throughout its Pacific range, except for the endangered population nesting on the Pacific coast of Mexico). These five species of sea turtles are highly migratory, or have a highly migratory phase in their life history, and therefore, are susceptible to being incidentally caught by fisheries operating in the Pacific Ocean. The Hawaii longline fleet is known to interact with all species, except the Hawksbill turtle. Recent regulations to protect turtles are found in section 3.3.2. "Pelagic Fisheries." Interactions with other Western Pacific pelagic FMP fisheries are unknown but believed to be quite rare. There have been no observed interactions between sea turtles and the bottomfish fishery.

Most sea turtle population estimates are generated from counts of nesting females. Sea turtles require between 14 (the assumed maturation time for the Mexican leatherback turtle) and 25 years to reach reproductive age, suggesting that there are an unknown number of juvenile and subadult turtles foraging the Pacific Ocean. Compounding the difficulties in estimating sea turtle populations is the fact that several life history characteristics and parameters—such as sex ratios, age-specific survival rates, and recruitment into the breeding populations—are also unknown.

For these reasons, turtle researchers can only submit estimates regarding the total population sizes figures for sea turtle species.

Population declines have occurred in several turtle species in the Pacific Islands as the result of nesting habitat loss and excessive and widespread harvesting for commercial and subsistence purposes (Eckert 1993). There are only two populations of loggerhead turtles in the Pacific, one originating in Australia where serious declines are occurring, and the other in southern Japan (Eckert 1993). Leatherback turtles inhabiting the Pacific mainly originate from nesting beaches in Mexico and Costa Rica where significant declines have been documented; from Indonesia where their status is uncertain but possibly stable; and from Malaysia where the nesting colony is nearly extinct despite 30 years of conservation measures (Eckert 1993).

Impacts to sea turtles in the western Pacific include: (1) legal harvest and illegal poaching of adults and their eggs; (2) incidental capture in fisheries (coastal and high-seas); (3) loss and degradation of nesting and foraging habitat as a result of coastal development, including predation by domestic dogs and pigs foraging on nesting beaches; (4) increased environmental contaminants (i.e., sewage); and, (5) entanglement or ingestion of marine debris.

Green Turtles

Green turtles (*Chelonia mydas*) are found throughout the western Pacific region. The genus *Chelonia* is composed of two taxonomic units at the population level, the eastern Pacific green turtle (or black turtle, *C. mydas agassizii*), which ranges from Baja California south to Peru and west to the Galapagos Islands, and the *C. mydas* in the remaining range (i.e., insular tropical Pacific, including Hawaii). The green turtle was listed under the ESA in 1978, due to its declining numbers associated with overexploitation for commercial and other purposes, habitat loss and degradation. Populations of green turtles in the Pacific region continued to be threatened by directed harvest (both legal and illegal) and negative impacts on essential habitats. The spread of fibropapilloma has also slowed the recovery of the green turtle population.

In the Hawaiian Archipelago, their distribution has been reduced in recent historical times, with breeding aggregations being eliminated and certain foraging areas no longer utilized in the main Hawaiian Islands. It is estimated that more than 90% of the Hawaiian population of the green turtle nests at French Frigate Shoals. Satellite tagging of these animals shows that most of them migrate to the MHI to feed and then return to French Frigate Shoals to breed.

The principal food sources for the green turtle are benthic marine algae of several genera. These algae are restricted to shallow depths where sunlight, substrate, and nutrients are conducive to plant growth. As a consequence, the feeding pastures used by green turtles are usually less than 10 m deep and frequently not more than 3 m deep, often right up to the shoreline (Balazs *et al.* 1987). The underwater resting sites include coral recesses, the undersides of ledges, and sand bottom areas that are relatively free of strong currents and disturbance from natural predators and humans. In the MHI, these foraging and resting areas for adults usually occur at depths greater than 10 m, but probably not normally exceeding 40 m. Available information suggests that the resting areas are in proximity to the feeding pastures.

An issue of concern with the Hawaiian green turtle is the increased interactions between the sea turtles and monofilament fishing line, believed to come from the recreational fisheries. Most of the sea turtles become entangled in the line with their front flipper, which severely strangulates the flipper and usually results in amputation.

Hawksbill Turtles

Hawksbill turtles (*Eretmochelys imbricata*) are circumtropical in distribution, generally occurring from 30° N to 30° S latitudes within the Atlantic, Pacific and Indian Oceans and associated bodies of water. The hawksbill turtle was listed as an endangered species on June 2, 1970, and in the Pacific, this species is rapidly approaching extinction primarily due to the harvesting of the species for its meat, eggs and shell, as well as the destruction of nesting habitat by human occupation and disruption.

Along the far western and southeastern Pacific, hawksbill turtles nest on the islands and mainland of southeast Asia, from China to Japan, and throughout the Philippines, Malaysia, Indonesia, to Papua New Guinea, the Solomon Islands (McKeown 1977) and Australia (Limpus 1992). Along the eastern Pacific rim, hawksbill turtles were common to abundant in the 1930s (Cliffton *et al.* 1982). By the 1990s, the hawksbill turtle was rare to nonexistent in most localities where it was once abundant, and there are no known nesting beaches remaining on the Pacific coast of Mexico or along the Pacific coast of Central America (Cliffton *et al.* 1982; Cornelius 1982). There are no population estimates for hawksbill turtles in Guam or CNMI, although it is known that the species nests on Rota, Saipan and Guam.

Within the State of Hawaii, hawksbill turtles are known to nest on the Hawaiian Islands of Maui, Molokai and Hawaii. Two nesting sites are located in the Hawaii Volcanoes National Park (NMFS 1992; Katahira *et al.* 1994). The peak nesting occurs from late July to early September (Katahira *et al.* 1994). There are no records of nesting hawksbill turtles or reported observations of their occurrence near the NWHI, although they may have occupied the region in the past. Hawksbill turtles appear to prefer nesting sites with steep beaches and coarse sand, and this may explain, in part, their presence in the MHI.

As a hawksbill turtle grows from a juvenile to an adult, data suggest that the turtle switches foraging behaviors from pelagic surface feeding to benthic reef feeding (Limpus 1992). The maturing turtle establishes foraging territory and will remain in this territory until it is displaced (Limpus 1992). As the life history of the hawksbill turtle suggests that the adult turtles tend to forage primarily in nearshore waters, this might offer an explanation as to why there are no reports of hawksbill turtles having been incidentally caught by the Hawaii-based longline fishery.

Leatherback Turtle

The leatherback turtle (*Dermochelys coriacea*) is the largest and most pelagic of the marine turtles and is listed as endangered throughout its range. In the Pacific, leatherback turtle populations are in severe decline. Primary threats to the species are the killing of nesting females and collection of eggs at the nesting beaches as well as incidental take in coastal and pelagic fisheries. There are no nesting populations of the leatherback turtle in areas under U.S. jurisdiction in the Pacific; however, there are important foraging areas off the west coast of the continental U.S. and on the high seas near the Hawaiian Islands.

Leatherback turtles nest on exposed tropical beaches, and forage widely in temperate waters. Adult leatherback turtles are reported in the Pacific as far north as Alaska and the Bering Sea, and as far south as Chile and New Zealand. The largest known breeding populations of leatherback turtles occur on the Pacific coast of Mexico, notably in the states of Michoacan, Guerrero and Oaxaca. Other breeding sites are located on the shores of the Solomon Islands, Vanuatu, Fiji, China, Indonesia and Australia.

Reproduction is seasonal with females returning to breeding grounds every two or three years. Leatherback turtles reach maturity in about 13-14 years (Zug and Parham 1996). In Mexico, the nesting season extends from November to February, although some females arrive as early as August (Sarti *et al.* 1989). In the western Pacific, nesting peaks in May and June (Chu-Chien 1982), in peninsular Malaysia in June and July (Chan and Liew 1989) and in Queensland, Australia in December and January (Limpus 1984).

The diet of the leatherback turtle generally consists of cnidarians (i.e., medusae and siphonophores) in the pelagic environment (Bleakney 1965; Brongersma 1969; Davenport and Balazs 1991; Hartog and Nierop 1984). Hawaii fishermen in offshore waters commonly see leatherback turtles, generally beyond the 100-fathom curve but within sight of land. Two areas where sightings often take place are off the north coast of Oahu and the west coast of the Island of Hawaii.

On a few occasions leatherback turtles have been accidentally caught or entangled in fishing gear. Hawaii-based longline fishermen are known to incidentally catch leatherback turtles. Based on genetic analysis of mitochondrial DNA (mtDNA) leatherback stocks encountered in the Hawaii longline fishery are derived from two Pacific stocks: (1) the eastern Pacific region, which includes Mexico and Costa Rica originating leatherback stocks; and, (2) the western Pacific stock, which includes leatherback turtles which originate from nesting beaches in Malaysia, Indonesia and the Solomon Islands. There have been no reports of any interactions between the bottomfish fisheries and leatherback turtles in the region, although one leatherback turtle was entangled by a recreational fishing vessel off the island of Guam. In October of 1980, a leatherback turtle was found alive entangled in a lobster trap line near Kure Atoll. The turtle was released alive (NMFS 1996).

Loggerhead Turtles

The loggerhead turtle (*Caretta caretta*) is listed as a threatened species throughout its range. Major nesting grounds are generally located in warm temperate and subtropical regions, with some scattered nesting in the tropics. Nesting in the Pacific basin is restricted to the western region, primarily in Japan and Australia. There are very few records of loggerheads nesting on any of the many islands of the central Pacific, and the species is considered rare or vagrant on islands in this region (NMFS and USFWS 1998).

Tagging programs to study migration and movement of sea turtles provide evidence that the loggerhead turtles are highly migratory and capable of transpacific movement. Satellite telemetry studies show that loggerhead turtles tend to follow 17° C and 20° C sea surface isotherms north of the Hawaiian Islands (Polovina *et al.* 2000). Relationships between other turtle species and sea surface temperatures are likely but have not been documented.

Adult loggerheads nesting in Queensland, Australia, are primarily benthic feeders, preferring benthic invertebrates like gastropods, cephalopods, pelycepods, decapods, echinoderms and the occasional fish (Dodd 1988). Foraging also has been reported at sea off the west coast of Baja California, Mexico, where young juveniles were seen foraging on dense concentrations of a pelagic crab (*Pleuroncodes planipes*) (Bartlett 1989).

Based on genetic analysis of mitochondrial DNA (mtDNA) of loggerhead turtles encountered in the Hawaii longline fishery, the majority are derived from Japanese nesting populations. The loggerhead nests in the southern part of Japan, and the population is estimated at between 2,000 and 3,000. The data suggest the remainder of loggerheads encountered in the longline fishery are from the Australian stock. There have been no reported interactions of the bottomfish and crustacean fisheries with Loggerhead turtles.

Olive Ridley Turtles

The olive ridley (*Lepidochelys olivacea*) is one of the smallest living sea turtles (carapace length usually between 60 and 70 cm) and is regarded as the most abundant sea turtle in the world. The olive ridley turtle is listed as threatened in the Pacific, except for the Mexican nesting population, which is listed as endangered, primarily because of over-harvesting of females and eggs. Throughout the Pacific, this species has been exploited for food, bait, bone meal, fertilizer, oil and leather. Although the meat of the olive ridley turtle is palatable, its eggs are considered a delicacy.

The preferred nesting areas for the olive ridley occur in the Indian Ocean along the northeast coast of India (Mrosovsky 1993), and in the Pacific Ocean along the west coast of Mexico and Central America (Eckert 1993). In the eastern Pacific, the largest nesting concentrations occur in southern Mexico and northern Costa Rica, with very few turtles nesting as far north as southern Baja California (Fritts *et al.* 1982) or as far south as Peru (Brown and Brown 1982).

The olive ridley turtle is omnivorous and prey include a variety of benthic and pelagic prey items such as shrimp, jellyfish, crabs, snails, and fish, as well as algae and sea grass (Marquez 1990). It is also not unusual for olive ridley turtles in reasonably good health to be found entangled in scraps of net or other floating synthetic debris. Small crabs, barnacles and other marine life often reside on debris and likely attract the turtles. Olive ridley turtles also forage at great depths, as a turtle was sighted foraging for crabs at a depth of 300 m (Landis 1965). There have been no reported interactions between the bottomfish and crustacean fisheries and Olive Ridley turtles.

Seabirds

Although there are several seabird colonies in the MHI, the NWHI colonies harbor more than 90% of the total Hawaiian Archipelago seabird population. The NWHI provide most of the nesting habitat for more than 14 million Pacific seabirds. More than 99% of the world's Laysan albatross (*Phoebastria immutabilis*) and 98% of the world's black-footed albatross (*P. nigripes*) return to the NWHI to reproduce. Of the 18 species of seabirds recorded in the NWHI, only the short-tailed albatross (*P. albatrus*) and the Newell's shearwater (*Puffinus auricularis newelli*) are listed as endangered under the ESA, and there have been no reports of interactions between these species and Hawaii-based fishery operations. The short-tailed albatross population is the smallest of any of the albatross species occurring in the North Pacific with between 1,200-1,400 individuals. According to land-based sighting records, 15 short-tailed albatrosses have visited the NWHI over the past 60 years. Five of these visits were between 1994 and 1999 (NMFS 1999).

The black-footed and Laysan albatrosses that nest in the NWHI have occasionally been hooked by Hawaii pelagic longline fishing vessels. There are no reports of interactions between the fishery and the short-tailed albatross. Albatrosses are surface feeders and they tend to follow longline vessels and dive on the baited longline hooks as the vessels deploy or haul their fishing lines. To mitigate the harmful effects of fishing by Hawaii-based longline vessels on Laysan and black-footed albatrosses, the Council conducted a seabird mitigation study and an albatross population workshop in 1998. The Council also held several educational seminars with the fishermen to alert them to the issue. Several mitigation strategies to deter seabirds from fishing operations resulted from the mitigation study including dying squid blue, towing a buoy or tori line, and retaining offal. Longline fishermen can also reduce seabird interactions by setting at night or adding weight to their lines so they sink fast. Presently, the National Plan of Action for Seabirds (NPOA-s) provides guidance to the Councils, NMFS and the USFWS in reducing interactions between longline vessels and seabirds. The USFWS is the lead federal agency for the conservation of federally listed seabirds and consultation under section 7 of the ESA.

Only one seabird hooking event was observed on a bottomfish vessel when the vessel was trolling (Nitta 1999). A Laysan albatross dove on the trolling lure and became hooked. The bird was safely released alive. There have been no reports of the fishery interacting with either a short-tailed albatross or a Newell's shearwater. There have been no reported interactions between the crustacean fishery with either a short-tailed albatross or a Newell's shearwater.

In 1999, the Midway sport fishery reported nine interactions with Laysan albatrosses. Eight of the birds were entangled in fishing line and one bird was hooked by a recreational lure. All birds were released alive and no mortality was associated with the interactions. Even though the Midway sport fishery is small (five vessels in operation), there remains a possibility that the sportfishing vessels could incidentally capture an endangered short-tailed albatross, because the endangered seabird is known to frequent Midway Atoll. These recreational fishing vessels operate close to known seabird breeding colonies, and at times the seabird density surrounding their vessels may be great. Bottomfish vessels may also enter into areas of high seabird densities. At these times, and especially during trolling operations, all fishing vessels operating in these areas could reduce potential seabird interactions by towing seabird deterrent lines.

Threats to seabirds other than from fishing operations are introductions of invasive plants and animals, entanglement or ingestion of marine debris, collisions with aircraft and other human structures, lights, disease, human disturbance and urbanization.

Short-tailed Albatross

The short-tailed albatross (*Phoebastria immutabilis*) is the largest seabird in the North Pacific with a wingspan of more than 3 m (9 ft) in length. It is characterized by a bright pink bill with a light blue tip and defining black line extending around the base. The plumage of a young fledgling (i.e., a chick that has successfully flown from the colony for the first time) is brown and at this stage, except for the bird's pink bill and feet, the seabird can easily be mistaken for a black-footed albatross. As the juvenile short-tailed albatross matures, the face and underbody become white and the seabird begins to resemble a Laysan albatross. In flight, however, the short-tailed albatross is distinguished from the Laysan albatross by a white back and by white patches on the wings. As the short-tailed albatross continues to mature, the white plumage on the crown and nape changes to a golden-yellow.

Before the 1880s, the short-tailed albatross population was estimated to be in the millions and it was considered the most common albatross species ranging over the continental shelf of the United States (DeGange 1981). Between 1885 and 1903, an estimated five million short-tailed albatrosses were harvested from the Japanese breeding colonies for the feather, fertilizer, and egg trade, and by 1949 the species was thought to be extinct (Austin 1949). In 1950, ten short-tailed albatrosses were observed nesting on Torishima (Tickell 1973).

The short-tailed albatross is known to breed only in the western North Pacific Ocean, south of the main islands of Japan. Although at one time there may have been more than ten breeding locations (Hasegawa 1979), today there are only two known active breeding colonies, Minami Tori Shima Island and Minami-Kojima Island. On December 14, 2000, one short-tailed albatross was discovered incubating an egg on Yomejima Island of the Ogasawara Islands (southernmost island among the Mukojima Islands). A few short-tailed albatrosses have also been observed attempting to breed, although unsuccessful, at Midway Atoll in the NWHI.

Historically, the short-tailed albatross ranged along the coasts of the entire North Pacific Ocean from China, including the Japan Sea and the Okhotsk Sea (Sherburne 1993) to the west coast of North America. Prior to the harvesting of the short-tailed albatross at their breeding colonies by Japanese feather hunters, this albatross was considered common year-round off the western coast of North America (Robertson 1980).

In 1999, the breeding population of the short-tailed albatross was estimated at approximately 600 breeding age birds: 212 pairs on Torishima and 60 pairs on Minami-Kojima (65 FR 46643, July 31, 2000). Currently, short-tailed albatross have an annual survival rate of 96% and population growth rate of 7.8% (65 FR 46643, July 31, 2000). Because of the robust growth of the population at Torishima, and the fact that short-tailed albatrosses do not return to the colony until three or four years of age, a large number of these birds are dispersed at sea. Furthermore, at least 25% of the reproducing adults also remain at sea during each breeding season. As a consequence, the exact number of individuals in the population is difficult to assess and at this time is estimated to be between 1,200-1,400 individuals.

The short-tailed albatross was first listed under the Endangered Foreign Wildlife Act in June 1970. On July 31, 2000, the USFWS extended the endangered status of the short-tailed albatross to include the species' range in the United States. The primary threats to the species are destruction of breeding habitat by volcanic eruption or mud and land slides, reduced genetic variability, limited breeding distribution, plastics ingestion, contaminants, airplane strikes, and incidental capture in longline fisheries.

Newell's Shearwater

The Newell's shearwater (*Puffinus auricularis newelli*) is listed as "threatened" under the ESA. and is considered to be in great jeopardy by the IUCN. Generally, the at-sea distribution of the Newell's shearwater is restricted to the waters surrounding the Hawaiian Archipelago, with preference given to the area east and south of the main Hawaiian Islands. The Newell's shearwater has been given this conservation status because of its small population size, approximately 14,600 breeding pairs, its isolated breeding colonies and the numerous hazards affecting them at their breeding colonies (Ainley *et al.* 1997). The Newell's shearwater breeds only in colonies on the main Hawaiian Islands (Ainley *et al.* 1997), where it is threatened by urban development and introduced predators like rats, cats, dogs, and mongooses. (Ainley *et al.* 1997).

Shearwaters are most active in the day and skim the ocean surface while foraging. During the breeding season, shearwaters tend to forage within 50-62 miles (80-100 km) from their nesting burrows (Harrison 1990). Shearwaters also tend to be gregarious at sea and only the Newell's shearwater is known to occasionally follow ships (Harrison 1990. Shearwaters feed by surface-seizing and pursuit-plunging (Warham 1990). Often shearwaters will dip their heads under the water to sight their prey before submerging (Warham 1990).

Shearwaters are extremely difficult to identify at sea, as the species is characterized by mostly dark plumage, long and thin wings, a slender bill with a pair of flat and wide nasal tubes at the base, and dark legs and feet. Like the albatross, the nasal tubes at the base of the bill enhances the bird's sense of smell, assisting them to locate food while foraging. The wedge-tailed shearwater may be more distinctive from the other species of shearwaters as it is slightly larger with flesh-colored legs and feet and has a long wedge-shaped tail (Harrison 1990). In addition, the wedge-tailed shearwater is also polymorphic, meaning that there are dark, light and intermediate plumage forms (Ainley *et al.* 1997).

Terrestrial-based Birds

Five terrestrial birds are species of particular concern: the Laysan duck (*Anas platyrhynchos laysanensis*), Laysan finch (*Telespyza cantans*), Nihoa millerbird (*Acrocephalus familiaris kingi*), Nihoa finch (*Telespyza ultima*), and the Micronesian megapode (*Megapodius laperouse*

laperouse). Although these land-based birds do not exist or depend upon the coral reef environment, per se, vessels transiting waters in the coral reef environment have the potential to introduce invasive species taxa like snakes, rats, rabbits, ants or other nuisance through the discard of floating debris or in the event of a vessel grounding.

Both snakes and rats (*Rattus spp.*) are known predators of birds, and rats can consume seeds or plants that the birds are dependent upon for food. The brown tree snake (*Boiga irregularis*) is present in Guam and has been sighted on Saipan. Laysan millerbirds (*Acrocephalus familiaris*), Laysan rails (*Porzanula palmeri*), and the Laysan honeycreeper (*Himotione sanuinea freethi*) became extinct sometime between 1915 and 1923 because of the introduction of rabbits to the island. Laysan millerbirds were also transplanted to Midway Atoll but were eliminated in 1944 when rats where introduced. Since then rats have been eradicated from Midway, and no rats are present on any of the NWHI. If rats were to become established in the NWHI, they would pose an enormous threat to the birds by preying on eggs and chicks, and by destroying vegetation. However, rats and mice (*Mus musculus*) are present on islands at other Pacific remote areas including Guam, the Mariana Archipelago, and American Samoa. There have been no reported interactions between the bottomfish and crustacean fisheries with any terrestrial-based birds or plants.

Laysan Duck

The Laysan duck (*Anas platyrhynchos laysanensis*) is also known as the Laysan teal because of its small size. It has a mallard origin, and is dark brown with a bright purple-green speculum (plumage surrounding the eye) bordered with white. The feet and legs are orange in both sexes, but the coloration is deeper in the males. Male Laysan ducks have a blue-green bill with black spots along the top. The females have a dull, brownish yellow bill with black spots along the outer boarders of the upper bill.

The Laysan duck is primarily insectivorous feeding on brine flies (*Neoscatella sexmaculata*) and brine shrimp (*Artemia* sp.). The species also search the sand for larvae and pupae of flies and beetles near seabird carcasses, and some feed on crustaceans and other littoral forms from the tidal pools.

Populations of Laysan ducks fluctuate naturally from 500-600 to less than 100 individuals (USFWS 1982). Between 1958 and 1972, a total of 545 Laysan ducks were banded: 36 were taken to the Honolulu Zoo; of the 388 adult Laysan ducks banded, 228 were males and 160 were females (USFWS 1982). Several banded ducks have been retrapped 10-12 years later but no band recoveries have been reported off of Laysan Island.

The Laysan duck was listed under ESA in 1964, due to the vulnerability of the species and its habitat to human disturbances, and to severe storms and possible introductions of rats. Because of the limited habitat of the island, and the vulnerability to natural and anthropogenic (human-caused) catastrophes, the Laysan duck will most likely always be considered a threatened species (USFWS 1982).

Laysan Finch

The Laysan finch (*Telespyza cantans*) has a distinctive, heavy conical bill which is blue to gray in color. The male adults of the species have a bright yellow head, throat and breast, with dark green to black streaking on the upper back blending to gray on the lower back. Females are brownish streaked all over with more black above and a faint wash of greenish-yellow on their breast. The Laysan finch was listed under the ESA on March 11, 1967.

By 1936, there were an estimated 1,000 Laysan finches on the island and by 1950, the population consisted of an estimated 5,000 birds (Brock 1951; Ely and Clapp 1973). In 1983, the population reached about 10,000 birds (USFWS 1984) and has remained relatively stable.

The Laysan finches are seed eaters, although they will forage on a variety of plant and animal material (USFWS 1984). They have been known to forage on seabird eggs and on dead seabird carcases for emerging fly larvae or for other invertebrates. The birds lay 2-4 eggs from late April to early June, with most chicks fledging by late July or early August.

In the past, the introduction of rabbits (*Oryctolagus cuniculus*) to Laysan Island caused the extinction of the Laysan rail (*Porzana palmeri*), Laysan millerbird (*Acrocephalus familiaris familiaris*), and the Laysan honeycreeper (*Himatione sanguinea freethi*). The rabbits were eradicated from Laysan in 1924 – but not until they had defoliated the island.

Nihoa Millerbird

The Nihoa millerbird (*Acrocephalus familiaris kingi*) is endemic to Nihoa Island and has never been transplanted to any other area. It is a relative of the Muscicapidae (thrushes), and has a thin dark-colored bill. The bird is small with dark gray-brown plumage on the back and buffy-white plumage on the breast. It was listed under ESA in 1967.

Compared to the Nihoa finches, the millerbirds are relatively secretive and encountered in dense, low shrubs (*Sida* and *Chenopodium*). They tend to hop, run, or fly about in the underbrush and scarcely ever leave cover.

The Nihoa millerbirds strictly eat terrestrial arthropods, and earned their name by eating the endemic "miller" moth (*Helicoverpa pallida hihoaensis*). The Nihoa millerbird nesting is linked to availability of terrestrial arthropods and consequently, variation in the weather can shift nesting periods by several weeks from year-to-year. Generally, the birds begin nesting between January and May, and the average clutch size is two eggs.

Due to their seemingly secretive behavior, the birds have been difficult to survey. From the late 1960s to the mid 1970s, the USFWS conducted line transect censuses for both the Nihoa finch and millerbird. These surveys demonstrated that about 200-600 millerbirds existed on Nihoa.

Nihoa Finch

The Nihoa finch (*Telespyza ultima*) is endemic to Nihoa Island and resembles the Laysan finch in many ways. The plumages of the two species are similar but the Nihoa finch is smaller overall than the Laysan finch.

The Nihoa finch was listed under ESA in 1967, and estimates from 1964 through to 1975 suggest that a population of 3,000-5,000 birds existed. The population estimate for the early 1980s was about 1,600 birds. However, the range of the population tends to change from year-to-year possibly due to changes in the carrying capacity of the habitat for Nihoa finches (USFWS 1984).

Nihoa finches are widespread over the island and are often seen near rocky outcroppings where they nest in holes in the rock. The birds prefer open and vegetated habitat, eating a wide variety of plant material (Conant 1983). Like the Laysan finch, the Nihoa finch are omnivorous and will forage on abandoned or unattended seabird eggs, and will congregate near the few seeps or freshwater pools on the island. Nesting may extend from early February to early July, with fledging occurring into August.

Micronesian Megapode

The Micronesian Megapode (*Megapodius laperouse laperouse*), commonly known as the *sasangat* (Chamorro) or *sasangal* (Carolinian), is a pigeon-sized bird that defends year-round territories to secure adequate foraging areas. A minimum territory size is about one hectare (2.47 acres) (Glass and Aldan 1988). The Micronesian megapode is present on 12 islands in the Mariana Archipelago. Small remnant populations exist on the southern Mariana Islands of Aguiguan, Tinian, Saipan, and Farallon de Medinilla while larger populations are present on the northern uninhabited Mariana Islands of Anatahan, Guguan, Sarigan, Alamagan, Pagan, Ascuncion, Maug, and possibly Agrihan (USFWS 1998a). The total number of individuals throughout the Mariana Archipelago is estimated to be between 1,400 and 1,975 birds (USFWS 1998a).

Megapodes are sometimes called incubator birds because they rely on alternative heat sources to incubate their eggs (Clark 1964). They tend to select nest sites in sun-warmed cinder fields or areas warmed by geothermal heat. Alternative nest sites include roots of rotting trees, logs, and in patches of rotting grasses. The birds lay a single large egg and may lay additional eggs during a five or six day period (Glass and Aldan 1988).
Megapodes are capable of flying over water for considerable distances, such that they could fly the 2.9 miles (4.6 km) between Saipan and Tinian, and the 5.5 miles (8.9 km) between Tinian and Aguiguan, but they would find the 18-37 miles (30-60 km) between adjacent northern islands difficult.

The megapode was listed as an endangered species on June 2, 1970, and the USFWS believes that the level of threat to the bird is moderate and that there is a high rate of recovery (USFWS 1998a). Current threats to the megapode include habitat degradation by feral ungulates and urbanization, competition with introduced galliformes, military training activities, and predation by introduced monitor lizards, cats, rats, pigs, and dogs. The Micronesian megapode is also threatened by potential drought, typhoons, and volcanic activity. The greatest potential threat to the megapode is the establishment of brown tree snakes on the islands north of Guam.

Terrestrial Plants

Five land-based plants, four species on Nihoa Island and one on Laysan Island, are species of particular concern under ESA. It is suggested that vessels transiting waters in the coral reef environment have the potential to introduce invasive species taxa like snakes, rats, ants, or nuisance plants through the discard of floating debris or in the event of a vessel grounding. Currently, no rats are present on any of the NWHI, but rats (*Rattus spp.*) and mice (*Mus musculus*) are present on islands at other Pacific remote islands including Guam, the islands of CNMI, and American Samoa.

All of the plants of particular concern are located in the NWHI. *Sesbania tomentosa* (legume), *Schiedea verticillata* (fleshy root herb), *Pritchardia remota* (palm), *and Amaranthus brownii* (weedy herb) are plants of concern located on Nihoa Island. *Mariscus pennatiformes* (sedge) is a plant of particular concern on Laysan Island, as well as *Cenchrus agriminioides* (*kamanomano*), but the latter is now thought to be extinct (Morin and Conant 1998). Competition with alien plants like pigweed (*Portulaca oleracea*) are threatening *Amaranthus brownii* and *Schiedea verticillata* on Nihoa. Rabbits had totally defoliated Laysan Island by 1924, causing the extinction of three plants, five arthropods, and three bird species. *Mariscus pennatiformes* managed to return after the defoliation but is now threatened by alien plants like *Cenchrus echinatus* (weedy sand burr), *Pluchea indica* (woody plant), and *Conyza bonariensis* (weedy composite).

Sesbania tomentosa

Sesbania tomentosa is a perennial legume (Papilionoideae) endemic to the Hawaiian Islands. While generally recognized as a single species (Wagner *et al.* 1990), one author (Char 1983) split the taxon into seven distinct species with an additional two subspecies. Growth forms of the plant range from being low and sprawling to somewhat arborescent, reaching heights of up to 6 m. Flowers range from light yellow to deep scarlet and are lightly fragrant, emitting a "fruity" odor. While some flowers may be found within a population throughout the year, flowering peaks after winter rains (February-March) and declines throughout the summer and fall months with the onset of the dry season (Char 1983; D. Hopper, pers. comm.).

Sesbania tomentosa is most commonly associated with dry, coastal habitats, but can be found at elevations greater than 600 m. The species has declined throughout its range and the small scattered populations and individuals now present are relicts of what was once a widespread endemic species (Wagner *et al.* 1990).

Populations of *S. tomentosa* have declined throughout the state and this is exemplified on the most populated island, Oahu, which was recorded as having four known populations in the 1930s, but only a single population by 1990 (TNC (The Nature Conservancy of Hawaii) 1998). Frequently cited reasons for the decline of *S. tomentosa* include herbivory by introduced ungulates and arthropods (Howarth 1985; Wagner *et al.* 1990), encroachment by alien plants, damage from off-road vehicles, fire, and other sources of habitat destruction (Athens 1997). In 1994, *S. tomentosa* was listed by the federal government as endangered.

Schiedea verticillata

Schiedea verticillata is a member of the pink family (Caryophyllaceae), a short-lived perennial herb which dies back to an enlarged fleshy root, especially during the dry seasons. The species' stems are about 0.4 -0.6 m (1.3 -2 ft) in length which are upright or sometimes hanging. *Schiedea verticillata* was listed under ESA in 1996.

Schiedea verticillata typically grows in soil pockets and cracks on coastal cliff faces at elevations between 30 and 242 m (100-800 ft). In 1983, there were six populations containing a total of 385 - 414 individuals (Conant 1985). In 1992, only 170-190 plants remained in these six populations. However, in 1997 there were a total of 359 plants in ten populations (Rowland 1997).

Although the population numbers appear stable, this plant is particularly susceptible to landslides and rock slides (USFWS 1998b). It is unknown if alien plants and insects are posing a threat to the species, but fire and other human disturbance are potential threats. In addition, it is thought that this plant may be at greater risk of extinction if rats were introduced to Nihoa because of their fleshy root, a rich food source for rodents.

Pritchardia remota

Pritchardia remota or *loulu*, is a member of the palm family (Arecaceae), and stands up to 5 m (16 ft) in height with a ringed, wavy trunk about 15 cm (5.9 inches) in diameter. It is a long lived perennial and the populations on Nihoa have remained stable for several years (USFWS 1998a). The plant was first listed under ESA on August 21, 1996.

Most of the populations of *Pritchardia remota* are located in scattered small groves in two valleys. The means of pollination are unknown, but a variety of insects have been observed visiting the flowers (D. Hopper, pers. comm., as cited in USFWS (US Fish and Wildlife Service) 1998b). *Pritchardia remota* provides nesting and other habitat for red-footed boobies, and perching space for brown noddies (Conant 1985).

Due to the small numbers of populations and individuals, and its limited distribution, this species is threatened by stochastic extinction and/or reduced reproductive vigor (USFWS 1998b). Alien plant and insect species on the island may be posing threats. Rodent predation as well as flash floods, fire, and human disturbances are other threats (USFWS 1998b).

Amaranthus brownii

Amaranthus brownii is a member of the amaranth family (Amaranthaceae) and is endemic to Nihoa Island. It is an annual herb with leafy upright or ascending stems, 30-90 cm (1-3 ft) long. This species can be distinguished from other Hawaiian members of the genus by its spineless leaf axils, its linear leaves, and its fruit which does not split open when mature (Wagner *et al.* 1990). It is believed that fewer than 40 individuals exist (USFWS 1998b).

The plant typically grows in shallow soil on rocky outcrops and is found in fully exposed locations at elevations between 30 and 242 m (100-800 ft). It is easiest to find and identify in the winter and its growing season extends between December and June or July (Conant 1985). The means of pollination are unknown. In 1983, the two known colonies of *A. brownii* contained about 25 plants: one colony of about 23 plants near Miller's Peak and about 12 plants in three small colonies in Middle Valley. Although there have been annual surveys since 1983, no plants have been seen in either location since 1998. Even though seeds were collected before its disappearance, the resulting germination and survival rates of seedlings were very low, suggesting a reduction in the reproductive vigor of the species (Wagner *et al.* 1985; 1986; 1990). The plant may have disappeared in the known colonies due to the introduction of pigweed, an alien species that grows well in habitat similar to *A. brownii.*

Amaranthus brownii was listed as an endangered species on August 21, 1996. Currently, the USFWS plans to conduct winter surveys to get an accurate population count and to collect seeds and cuttings to establish *ex situ* populations (USFWS 1998b).

Mariscus pennatiformes

Mariscus pennatiformes (subspecies *bryanii*) is a very rare sedge endemic to Laysan Island. Since the defoliation of Laysan Island by rabbits in the early 1900s, the plant has had only small populations. Only 12 individual plants existed in 1980, and now there are about 100 plants (M. Bruegmann, pers. comm.). The plant was listed as endangered under ESA in 1994.

M. pennatiformes tends to prefer moist soil and so now it is confined to the south end of the lagoon (Morin and Conant 1998). It once was widely distributed across the island (Schauinsland 1899); and it may have been important habitat for the now extinct Laysan millerbird and the Laysan honeycreeper, and perhaps the Laysan finch (Morin and Conant 1998). The Laysan finches eat seeds from almost all species that occur on the island, and so the seeds of *M. pennatiformes* should be considered a food source for the Laysan finch (Morin and Conant 1998).

Due to the small numbers of populations and individuals, and its limited distribution, this species could be threatened by stochastic extinction and may have reduced reproductive vigor. The plant is also threatened by burrowing birds, and/or Laysan finches that feed on seedlings and young shoots (Morin and Conant 1998). The plant could also be threatened by the introduction of rodents or other alien plant species.

The USFWS recovery efforts include propagation of *M. pennatiformes* on-site in temporary greenhouses, and out-plant only after reaching a relatively bird-resistant size (Morin and Conant 1998). In addition, the Laysan Island Ecosystem Restoration Plan outlines a 20-year plan to eradicate at least 12 of the 13 nonnative plants on Laysan Island, replacing alien vegetation with appropriate native species (Morin and Conant 1998).

Invasive Species

Executive Order 11987 issued in 1977, directs federal agencies to restrict the introduction of exotic species into natural ecosystems under their jurisdiction and to encourage states to do the same. Executive Order 13112 issued February 1999, directs federal agencies to prevent the introduction of invasive species and provide for their control. It also established the Invasive Species Council and directed them to write an invasive species management plan within 18 months. In addition, the National Invasive Species Act of 1996 (NISA) directed the U.S. Coast Guard to promulgate voluntary guidelines for ballast water management and other ship's operations to reduce the number of alien species introduced to the waters of the US.

In general, alien species can be introduced to island ecosystems from fishing and non-fishing vessels in the Pacific region by: (1) ship wreck; (2) accidental discard of floating materials harboring alien species; (3) hull fouling; (4) live holding and bait wells; and (5) exchanging ballast water. A report by the Environmental Defense Fund shows that about 400 of the 1,177 species listed as threatened or endangered are at risk from invasive species. It is estimated that invasive species cost the U.S. $122 billion annually. Vessel ballast water is the most common pathway for marine species transfer throughout the world. It is estimated that 21 billion gallons of ballast water is dumped into U.S. ports each year, and this water can transport a wide variety of healthy species, including viruses, bacteria, protists, fungi and molds, plants and animals and their various life stages. Consequently, the U.S. and other nations around the world are requiring vessels to practice proper ballast water management measures when transiting from one region to another.

International attention has also been given to invasive species issues. On November 27, 1997, the International Maritime Organization developed guidelines which outline techniques for minimizing introductions from cargo ship ballast discharge. These guidelines are expected to become part of the International Convention for the Prevention of Pollution from Ships (MARPOL). This would require the U.S. Congress to enact legislation detailed in the guidelines.

Endemic plants and insects on small islands and atolls, and the predators they support, are known to be especially vulnerable to the introduction of competing or consuming species (Elton 1958). This primarily is due to their isolation, with some island ecosystems in extreme isolation like the NWHI. On-island ecosystems' niches usually occupied by species present on continents often are vacant, leaving ample opportunity for an opportunistic invader to become quickly established. Invasive species of special concern in the Pacific region are snakes, rodents, ants, and plant species. Interestingly, a study by Chown *et al.* (1998) shows that there is a clear relationship between the number of humans visiting an island and the number of alien species present.

Brown Tree Snake

The brown tree snake (*Boiga irregularis*) was accidentally introduced in the 1950s to the island of Guam from the Admiralty Islands in the South Pacific. The brown tree snake is native to the Solomon Islands, Papua New Guinea, and northern Australia. This nocturnal, mildly venomous snake quickly spread throughout Guam and decimated the island's bird, lizard and mammalian populations. By the 1980s, the brown tree snake had caused a decline in native fauna, and 11 of Guam's 13 native forest birds had disappeared (Mac *et al.* 1998).

Although regulations governing the prevention of brown tree snake infestation have been promulgated by the CNMI legislature, a high risk remains that the snake will be introduced to other areas because: (1) the high abundance of snakes on Guam; (2) the tendency of snakes to hide in all sorts of artificial objects including vehicles, cargo containers and buildings; and, (3) the large volume of ship and air traffic from Guam to other parts of the world. Brown tree snakes have been found in and near transportation facilities on three other islands in the Mariana Archipelago, elsewhere in the Federated States of Micronesia, the Republic of the Marshall Islands, Okinawa, Diego Garcia, the State of Hawaii, and Corpus Christi, Texas (Fritts and Rodda 1998). The brown tree snake has already successfully colonized the island of Saipan in the CNMI. Current prevention efforts include maintaining trap lines at the ports, conducting night searches, and investigating snake reports. A sniffer dog program was established in the CNMI in 1998, and the program still checks cargo at the ports (USFWS 1998a). The Guam Department of Agriculture is setting snake traps around the Guam airport for similar reasons.

Rodents

Dispersed by human commerce, omnivorous rodents like the rat (*Rattus* sp.) and the mouse (*Mus musculus*) have become widely established on many Pacific islands, where their presence has resulted in extinctions and reductions in populations of numerous native species. In the Western Pacific Region, rodents are present in all island areas except the NWHI, where they have been recently extirpated from Kure Atoll and Midway Islands due to efforts by the USFWS and the State of Hawaii. Rats must be prevented from spreading from the main Hawaiian Islands to the NWHI, and efforts must be taken to control or exterminate rats in other island regions where they now exist. DeGange *et al.* (1995) state that rats are usually spread to additional islands around the world through moored vessels and shipwrecks. The USFWS representatives in the State of Alaska consider invasive rats as the greatest threat to the Aleutian Islands and have mounted an extensive rat eradication and invasive rat prevention program.

Ants

The introduction of alien insects, especially ants, to island ecosystems often results in a dramatic loss of native invertebrate species (Cole *et al.* 1992). Ants are especially lacking in much of the insular regions of the Pacific when compared to the rest of the tropics (Jourdan 1997). In addition to potentially damaging native plants and seeds, introduced insect species like ants may reduce or eliminate native insects that serve as pollinators. There is no successful form of biological control for invasive ants (Man 1994).

Some of the invasive ant species of particular concern are the fire ants (*Solenopsis* sp.), the little fire ant (*Wasmannia auropunctata*), the Argentine ant (*Iridomyrmix humilis*), and the big-headed ant (*Pheidole megacephala*). Another ant, *Anoplolepis gracilipes*, has invaded Christmas Island in the Indian Ocean. In 1999, theses ants were reported to have killed and eaten three million crabs (*Gecarcoidea natalis*) in 18 months.

Plants

Alien plants can change the large-scale functioning of a native island ecosystem and alter the population dynamics and community structure of native species (Vitousek 1992). One of the primary modes of transportation of invasive plant species is by the spread of seeds in mud on people's shoes.

Among the most destructive invading plants are various grasses like beardgrass *(Schizachyrium condensatum*), buffelgrass (*Cenchrus ciliaris*), fountain grass (*Pennisetum setaceum*), and molasses grass (*Melinis minutiflora*), as well as broomsedge (*Andropogon glomeratus*). Some of the harmful plant species of high concern for the USFWS in the NWHI are the *Verbesina encelioides* (golden crownbread), *Cenchrus echinatus* (weedy sand burr), and *Setaria verticillata*. *Clidemia* is also an aggressive invading plant in parts of India, Southeast Asia, and the Pacific Islands, including the Hawaiian islands, where it was introduced about 1940 (Mac *et al.* 1998).

Measures to Reduce Introductions of Invasive Species in Island Ecosystems

Increased awareness to the potential harm invasive species pose to fragile island ecosystems is the first and foremost step to developing measures to help reduce any future potential introductions by fishing vessels. Since all vessels have the right to passage in the Pacific EEZ, including foreign vessels, it may be more efficient to develop a set of universal measures for all vessels fishing or transiting the region. Some of these measures could include:

1. Education and outreach with posters and brochures being developed for distribution;
2. All vessel supplies and clothing should be packed in plastic buckets with fitted lids or other sealable metal or plastic containers;
3. No cardboard boxes;
4. Wooden boxes should be treated, and the inside and outside surfaces painted or varnished to provide a smooth, cleanable finish that seals all holes;
5. Everyone changes footwear at dockside (i.e., practice vessel shoes and "street shoes");
6. All equipment should be kept thoroughly clean;
7. Cooking items should be cleaned and food items frozen, if freezable;
8. Have annual vessel risk assessments for possible invasive species introductions; and,
9. Employ brown tree snake sniffer dogs checks for vessels departing Guam and Saipan.

It is noted that the FMP will contain broad frameworking procedures to facilitate rapid rule-making if necessary to deal with problems identified after the plan is in effect. This could include additional measures to protect listed/protected species from any potential direct or indirect effects from fishing activities.

Currently, fishermen are prohibited from landing on any of the NWHI unless they have obtained a Special Use Permit from the USFWS and the permission from the Refuge manager. Fishermen are permitted, however, to transit through areas (right-of-passage), as are pleasure craft and foreign vessels.

U.S. Coast Guard Ballast Water Measures

The U.S. Coast Guard interim rule on ballast water management was published on May 17, 1999. These measures are intended to limit the introduction and spread of aquatic nuisance species into the waters of the United States. The new U.S. Coast Guard rule establishes voluntary ballast water management guidelines for all waters (except the Great lakes and sections of the Hudson River) of the U.S. and establishes mandatory reporting and sampling procedures for nearly all vessels entering U.S. waters. Ballast water exchange should occur only in water beyond the EEZ or where the water depth exceeds 2,000 m. Otherwise, vessel owners are encouraged to retain the ballast water on board. If the U.S. Coast Guard determines that the voluntary program is ineffective at controlling the introduction or spread of invasive species, the guidelines will become mandatory and carry civil and criminal penalties.

U.S. Fish and Wildlife Service, Pacific Remote Islands NWR Complex NWHI Special Use Permit

Anyone wishing to obtain access within refuge boundaries must contact the USFWS for a detailed explanation of the required permits and regualtions. This includes permission from the Refuge manager and an appropriate Special Use Permit (USFWS 2000). Kure Atoll and Midway Atoll are exempt from these requirements.

With the exception of Tern Island, French Frigate Shoals, the following rules apply:

- Clothing and Soft gear: any person landing boats at any island should have clean clothes[3] and shoes.
- Any personnel going ashore at any island and moving inshore from the immediate area in which waves are breaking at the time of landing must have new footwear[4], new or island specific clothes and new or island specific soft gear[5] all frozen for at least 48 hours.

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[3] *Clothing* means all apparel, shoes, socks, over and under garments.

[4] *New footwear* means never used and clean off the distributor shelf.

[5] *Soft gear* means all gear such as day packs, fanny packs, camera bags, and all contents within.

- At the discretion of the local USFWS representative, personnel from the NOAA ship R/V *Townsend Cromwell*, or any other vessel servicing the Refuge, may be allowed on shore to visit predesignated areas for guided tours. For such tours, personnel must have new footwear, clean clothes, and clean soft gear all frozen for at least 48 hours.
- Otherwise, any personnel entering any vegetated area, regardless of how sparse the vegetation, must have new footwear, new clothes and new soft gear all frozen for at least 48 hours.

If there is clothing or gear coming off Kure Atoll and Midway Atoll, the clothing and gear should never be offloaded to any of the other islands in the NWHI. This also means that special care needs to be taken to avoid contaminating gear storage areas and quarters aboard transporting vessels. The primary goal is to avoid contaminating supplies with seeds or insects from other islands. Soil cannot be transported to or between islands.

Tern Island has less stringent rules because it already has a number of established alien species. Equipment and supplies are not required to be previously frozen or fumigated, and can be offloaded at Tern Island in cardboard boxes or wooden containers.

Food items like tomatoes, ray sunflower seeds, alfalfa, and mustard seeds cannot be brought onto any of the NWHI, but other items—like mung beans, soy beans, and radishes—would not likely survive on the islands and are allowed for fresh greens. Bulk dried fruits are allowed but should be frozen solid for at least one day to kill any insects.

There are also additional special requirements for anyone wanting to land on Nihoa Island. First, access to Nihoa by permittees will only be allowed under the accompaniment and supervision of a Refuge Representative, who has authority to disallow access to the island, or order an immediate departure if conditions are violated in some way. In addition, all field equipment made of wood or fabric must be new and never used before, and previously used equipment must be either frozen or fumigated. And last, all clothing and personal effects must be cleaned and thoroughly inspected and all footwear must be new.

A Strategic Plan to Protect Island Ecosystems in Alaska from the Introduction of Rodents, U.S. Fish and Wildlife Service, Region 7, Alaska

In response to the increased threat of Norway rats (*Rattus norvegicus*) to seabirds in Alaska, the USFWS launched an effort to prevent further introductions and began to eradicate rats from infested islands. Part of this effort was directed by a Strategic Plan developed by DeGange *et al.* (1995) to Protect Island Ecosystems in Alaska from the Introduction of Rodents. The strategic plan discussed establishing education and outreach programs, as well as a cross-program Service team (rat pack) to prevent rats from being introduced to additional islands in Alaska.

To achieve these goals, the Alaska Maritime National Wildlife Refuge staff have joined with the people of the Pribilof Islands and the fishing industry to conduct training and inspection of vessels and commercial facilities. The USFWS is also developing a training video to show how to inspect ships for rodents, and how to set up a prevention program, and brochures and posters.

Because local residents were not aware of the threats rats pose to island faunas, continued media support was recommended as an essential part of the education process. The plan also recommended that the Refuge and other USFWS staff develop a school curriculum on seabirds which includes the rat issue.

DeGange *et al.* (1995) also discuss the necessity to develop a plan that outlines how the government should respond in the event of a shipwreck on an important seabird nesting island. The plan called for a mechanism for observers to report on the status of rodent infestations on individual ships. The rodent surveys are to assist officials with vessel risk analyses in the event of a shipwreck. Since the State of Alaska requires individuals to be certified to use rodenticides, the plan suggests that a corps of trained individuals be located in coastal Alaska to respond to shipwrecks in their area.

As the USFWS may have to rely on the U.S. Coast Guard for transportation and access to shipwreck sites, the plan suggests that a Memorandum of Agreement be developed defining the roles of each agency in responding to shipwrecks. The USFWS also plans to conduct research on the life history of rats, and compile data on their biology and distribution in Alaska, as well as investigate other methods to control or eradicate rats.

3.3 The Fishery Context

3.3.1 Ex-vessel Value of Coral Reef Resources

Tables 3.2 and 3.3a-3.3f summarize the recent approximate total annual ex-vessel value for each of the domestic marine fisheries of the Western Pacific Region's island groups. They focus on fisheries for coral reef resources, but rough estimates of the crustacean and precious corals fisheries (categorized as deep-bottom), and pelagic fisheries, also appear. This allows these fisheries to be compared to coral reef fisheries. It also highlights the potential follow-on effects of the management measures in this FMP. Table 3.2 is a regional summary, while tables 3.3a-

3.3f break down the information by island area. Monetary value is expressed in 1999 dollars. Ex-vessel values are the estimated total annual gross value of landings from each fishery, whether sold or not. The ex-vessel values for the sport sector represent charter fees. The landings value for these fisheries are included in the food sector. It should be noted that there is a variable, and in some cases quite high, level of uncertainty as to the accuracy of values in Tables 3.3a-3.3f.

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

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

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

Table 3.2: Summary of annual ex-vessel value for Western Pacific Region fisheries ($,1,000/year).

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

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

Table 3.3a: American Samoa fisheries by area, annual volume, and ex-vessel value.

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

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

Table 3.3b: Northern Mariana Islands fisheries by area, annual volume and ex-vessel value.

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

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

Table 3.3c: Guam fisheries by area, annual volume and ex-vessel value.

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

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

Table 3.3d: Main Hawaiian Islands fisheries by area, annual volume and ex-vessel value.

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

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

Table 3.3e: Northwestern Hawaiian Islands fisheries by area, volume and ex-vessel value.

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

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

Table 3.3f: Other islands fisheries by area, annual volume and ex-vessel value.

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

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

3.3.2. Summary of Existing FMPs in the Western Pacific Region

This section describes the fisheries managed under the Council's four already-implemented FMPs.

Northwestern Hawaiian Islands Bottomfish and Seamount Groundfish Fisheries

Before the implementation of the Bottomfish and Seamount Groundfish Fishery Management Plan, annual commercial bottomfish landings in the MHI and NWHI were estimated at 1.4 million pounds. During the 1960s, bottomfish landings decreased to 400,000 lbs. annually, but consequently rose back to over one million pounds in the 1970s, due to expanded local market and strong interest in the NWHI stocks. As a result of this expanding fishery, the Council implemented the Bottomfish FMP for bottomfish and seamount groundfish fisheries in the Western Pacific Region in 1986 and has amended this plan six times. Currently, in the NWHI, a maximum of 17 permits are assigned in two limited entry zones, the Ho`omalu Zone, with seven permits, and the Mau Zone, with 10 permits, two of which are designated for a Community Development Program. These 17 vessels fish an area approximately a quarter the size of the mainland U.S. and provide the State of Hawaii with more than one-half of its fresh premium-quality bottomfish. The fishery currently harvests less than 55% of the maximum sustainable yield and is valued at approximately $1 million per year. Bottomfishing occurs year-round and each Ho`omalu Zone permit holder must make a minimum of three trips and land 2,500 lbs. of fish (half bottomfish) to retain the permit. The most productive bottomfishing grounds include Brooks Banks, Laysan Island, Maro Reef, and Necker Island, respectively. However, productivity varies at banks by year. The most productive bottomfish depths are generally found between 50 and 100 fm and between 50% and 90% of the total bottomfish in the NWHI are caught at these depths. In certain years up to 20% of the total bottomfish landings is comprised of uku (Aprion virescens), a bottomfish management unit species in the shallow-water species complex.

There are no known mortalities of Hawaiian monk seals attributed to the NWHI bottomfish fishery. Furthermore, data from a NMFS observer program in the early 1990s concluded that the NWHI bottomfish fishery is generally not taking fish that are considered prey for monk seals and that the bottomfish management unit species are healthy, with none being overfished.

In the main areas where the fishery occurs in the NWHI, interactions with coral reef resources and habitats are very minimal. Bottomfish fishing for the deep-water species complex (i.e., *onaga*, *opakapaka*) primarily occurs between 50 and 100 fm, while coral reef substrate is defined to 50 fm. There may be some anchor damage in waters less than 50 fm where there are steep drop-offs.

Summary of Regulations and Reporting

- The owner of any vessel used to fish for bottomfish management unit species in the NWHI must possess either a Mau Zone permit, or a Ho`omalu zone permit. A single vessel may not be registered in both zones concurrently.
- Possession and use of bottom trawls and bottom set gillnets is prohibited.
- Permits are non-transferrable.
- Establishes limited-entry into Hoomalu and Mau Zones based on prior qualified landings of bottomfish MUS.
- Implements a use-it-or-lose-it requirement for permit renewal of vessels.
- The possession and use of any poisons, explosives, or intoxicating substances for the purpose of harvesting bottomfish managed unit species is prohibited.
- The fishery is subject to mandatory logbook reporting using the State of Hawaii NWHI bottomfish forms.
- Permitted vessels may not exceed 60 ft in length, unless approved by the Regional Administrator in consultation with the Council.
- Each permit holder must attend a NMFS protected species workshop.
- Each permit holder must notify the Regional Director before fishing within any protected species study zone in the NWHI.

In addition to those regulations stated above, participants in the NWHI fishery are required to complete the State of Hawaii Daily Bottomfish Catch Report. This form includes space for recording the number of bottomfish MUS and other animals kept and discarded. This form includes the areas fished, weather conditions and the date and time the gear was deployed. There is also space for recording the numbers of Hawaiian monk seals, sea turtles, and other protected species observed in the area.

Habitat Impacts

Bottomfish gear has very limited impacts on habitat. Habitat damage may occur from deployment of anchors during deep water fishing activities. However, damage is highly localized because the total targeted fishing habitat is limited to the 100 fm contour in areas with high relief. Anchoring during fishing operations is generally conducted at depths from 40-60 fm, with depths ranging from 30 to 175 fm. Reef-building corals are generally not found below 50 fm, the lower extent of light attenuation. It is estimated that suitable bottomfish habitat where vessel anchoring might occur represents approximately 1% of the total bank habitat. Shallow-water bottomfishing activities are conducted while drifting or trolling therefore minimizing the potential for anchor damage. Submersible studies done in 2001 on bottomfishing banks in the NWHI have reported minimal evidence of fishing impacts to habitat (C. Kelley pers comm 2001).

Target Resources

The domestic bottomfish fishery in the Western Pacific Region primarily targets deep-sea snappers and groupers. Generally, the following deep-water snapper and grouper species are sought after because of their high market values: *kalekale (Prisipomoides seiboldi), opakapaka (P. Coruscanus), gindai (P. Zonatus), ehu* or red snapper (*Etelis carbunculus),* and sea bass (*Epinephelus quernus).* The fishery also targets a shallow-water bottomfish species, *uku (Aprion virescens)*, which is caught bottomfishing and trolling in waters between 15-30 fathoms.

Gear Description and Use

The standard bottomfish gear is a hydraulic or electric handline hauler with a 130-lb. test mainline and terminal rigs, to which the hooks and lead weight are attached. Generally, the terminal line consists of about twelve hooks spaced at 7-8 ft intervals with a 2- to 6-lb. lead weight attached at the end of the line. A chum bag is attached just above the last hook and filled with finely chopped fish. Each hook is baited with fish or squid, and the gear is lowered into the water.

Depending on species targeted, the gear is lowered at depths ranging from 50-150 fm. Using years of acquired knowledge and advanced electronic equipment, such as sonar fish finders and geographic positioning systems, target species are easily located and the gear can be accurately placed within a few meters above those substrates. Ideally, the gear is placed one fathom above the bottom in order to effectively attract target species. If the gear is set on the bottom, target species may not be enticed to take the bait. If set too high in the water column, it may deter target species wary of predation by larger predators. Once the gear is placed in its ideal location, it is jerked sharply to release the contents of the chum bag. The mainline is then hauled either by hand, hydraulic gurdy or electric reel. Vessels drift or anchor during gear deployment, depending on weather conditions, ocean currents, species targeted, and other variables. Because most of the target species are found in areas with a steep slope, vessels usually deploy gear close to the minimum depth contour and drift out to deeper water.

Incidental Catch and Bycatch

Being a hook-and-line rig, this gear is relatively selective, with the ability to successfully target particular species groups, depending on the skill of the fisher. Experienced vessel crews have the ability to catch the desired species with very little bycatch. Gear is deployed at specific depths and in areas of certain habitat characteristics (e.g., high relief). It is, however, impossible to completely avoid non-target species.

Logbook data and research programs conducted by the State of Hawaii and NMFS reveal that bycatch accounts for approximately 8-19% of the total catch in bottomfish fisheries in the Hawaiian archipelago. Sharks, oilfish, snake mackerel, pufferfish, and moray eels are the most numerous discard species; they are not kept by vessels because of their unpalatability. Some carangids (large jacks and amberjacks) are also discarded because of concerns about ciguatera poisoning. It should be noted that a large percentage of the snappers and the groupers are included as bycatch because of damage from sharks.

Northwestern Hawaiian Islands Lobster Fishery

The Crustaceans FMP establishes management measures for the spiny and slipper lobster fishery in the NWHI, and is considered one of the most tightly regulated and conservative management plans for lobsters. The principal species targeted by this fishery are the spiny lobster, Panulirus marginatus, and the common slipper lobster, Scyllarides squammosus. Other management unit species include Panulirus penicillatus, another spiny lobster species; other slipper lobster species in the family Scyllaridae; and Kona crab, Ranina ranina. It was not until the late 1970s that development of the lobster fishery in the NWHI was fully realized, following surveys by NMFS that suggested its commercial potential. The FMP for the lobster fishery was adopted in 1983. Landings reached a record high by 1988. However, in the early 1990s lobster catches fell dramatically, but not due to overfishing. A long-term cyclic change in abundance resulted from a broad climate-induced reduction in overall oceanic productivity, which resulted in lower abundance of resources throughout the food web of the NWHI. The FMP was amended accordingly by limiting entry and imposing a fleet-wide seasonal harvest quota among other measures. Highlights of the NWHI lobster fishery include the following:

- The NWHI lobster fishery is a million-dollar industry in which commercial fishing vessels target red spiny and slipper lobsters.
- NWHI banks most important to the fishery include Necker, Maro, Gardner, Pearl and Hermes, Kure, Lisianski and Nihoa at depths between 10 and 35 fm.
- The fishery uses a "retain-all" strategy (where all lobsters caught are counted against the quota) since research suggested that more than 60% of lobsters that are released from the vessels die from predation or exposure.
- The annual harvest guideline for the NWHI fishery is determined based on 13% of the estimated exploitable lobster population (i.e., those lobsters taken in traps). This allows no more than a 10% risk of overfishing.
- Lobster populations in the NWHI are considered healthy. MSY for the NWHI is estimated to be about 220 mt (300,000 lobsters). The harvest guideline in recent years has been substantially less.

In 2000, NMFS closed the fishery due to uncertainties in their population assessment model. A recent NMFS declaration proposes to keep the fishery closed for up to two years more, while allowing research at the major banks.

Summary of Regulations

- Lobsters may only be taken by lobster trap or by hand. (Use of nets, chemicals, explosives, hooks or spears is prohibited.)
- Escape panels with a specified minimum opening size are required in traps.
- Assembled traps are limited to 1,100 per vessel (1,200 total traps).
- Traps may not be left unattended in the water except in the event of an emergency.
- Closed areas include a 20-nm protected species zone around Laysan Island and all federal waters shallower than 10 fm. (Federal waters 0-50 fm around French Frigate Shoals and the northern half of Midway would also be closed under the Coral Reef Ecosystem FMP.)
- The NWHI fishery is closed from January to June, but it typically only lasts one to a few months a year.
- Logbooks are mandatory and data collectors or observers can be required, if requested by NMFS.
- The limited entry program allows at most 15 permits, of which only about half are active in a given year.
- A retain-all fishery is required, due to low survival of released lobsters.
- Fleet-wide harvest guidelines, with bank-specific quotas for Necker, Maro, Gardner and all other NWHI areas (known as Area 4), apply.
- Harvest quotas are recalculated based on a constant harvest rate and risk to overfishing in order to lower risk.
- Lobster permitted vessels are required to have VMS to transit through NWHI lobster grounds during closed season. (Voluntary VMS also facilitates enforcement.)

Habitat Impacts

Typically, traps are set in areas of relatively low structural relief, away from coral reef habitat. If traps are set too close to coral reef and other high relief habitats, lobsters cannot be enticed to enter the traps. Interactions of the lobster fishery with coral reef resources and habitats are limited and poorly known. Anecdotal reports suggest that some coral pieces have been observed in trap-hauls, but this remains unquantified and additional research is needed. Members of the Council's Crustacean Plan Team and Advisory Panel report that this may be attributed to lobster vessels being forced to fish in exploratory banks, and it may have been exacerbated by the inexperience of one vessel's captain. Vessel groundings are another potential habitat impact of the NWHI fishery, but in the past two decades only one permitted lobster vessel has run aground. A survey two years later found only limited damage. The FMP's existing management measures (e.g., gear restrictions, closed areas) help mitigate potential adverse impacts to essential fish habitat.

Gear Description and Use

All vessels participating in the NWHI lobster fishery use traps manufactured by Fathoms Plus. The trap is dome-shaped and molded from black polyethylene. Their dimensions are approximately 2.5' x 3.2' x 1'. To ensure that they deploy upright on the bottom, lead weights are secured inside the trap. Each trap has two entrance cones located on opposite sides of the trap. They also have two escape vents composed of four circular holes at least 2½ inches in diameter; these allow undersized lobsters and other incidental catch, such as octopus, to escape. This gear restriction has resulted in significant reduction in the incidental take of non-target species. Trap opening sizes are specified by regulation. Traps are set in strings of several hundred (typically about 800 per day) and baited with chopped mackerel.

Incidental Catch and Bycatch

Bycatch, as determined by experimental traps without escape vents includes (in decreasing order of abundance) hermit crabs, reef fish, other crabs, moray eels, other lobsters, molluscs, and small sharks. The amount of bycatch is much less in commercial traps with mandatory escape vents. Some lobster traps are lost each year. A 1992 NMFS report found that while lobsters may enter these traps, they were also able to exit and there was no observed mortality associated with ghost fishing. The study concluded that lobsters may use the traps as shelter.

Reporting

Participants in the NWHI fishery are required to complete the NMFS Daily Lobster Catch Report after each set. The form includes space for recording the number of spiny lobsters, slipper lobsters, Kona crab, octopus, and other animals kept, and the number discarded. There is also space for recording the number of Hawaiian monk seals, sea turtles, and other protected species observed in the area. While lobster have been recorded in the diet of the endangered Hawaiian monk seal, no conclusive evidence exists about the importance of lobsters to seals. The areas fished, weather conditions, and date and time of gear set and haul are also recorded. A Hawaii Division of Aquatic Resources Crustaceans Trip Report is also required, which summarizes the number and weight of lobsters caught and weight sold.

Precious Corals Fishery

Before Congress passed the Magnuson Act in 1976, precious corals had been fished in the U.S. EEZ of the western Pacific region by foreign vessels. In 1975, Japanese vessels reportedly harvested about 100 mt of precious corals within 200 nm of Midway, Wake, Yap, and Saipan Islands. In 1977, a Taiwanese precious coral vessel entered Midway Island and reported that 30 vessels would dredge around Milwaukee bank, outside the U.S. EEZ.

The Precious Corals FMP was implemented in 1983, and has been amended four times. In the FMP, precious coral beds are treated as distinct management units because of their widely separated and patchy distribution and the sessile nature of individual colonies. Beds are classified as Established, Conditional, Refugia, or Exploratory. Established and Conditional Beds have specific harvest quotas. Refugia Beds are areas set aside for baseline studies and possible reproductive reserves, with no commercial harvesting allowed. Exploratory areas make up the remainder of the EEZ, where precious corals may exist but have not been discovered. Each island area—Hawaii, American Samoa, Guam, and the PRIAs—have individual Exploratory areas with a 1,000 kg annual quota. An amendment has been drafted to include the CNMI under this same regime. The Hawaiian Exploratory area contains many times more precious coral habitat than the other Exploratory areas. Of the potential habitat in the Hawaiian EEZ, 99.7% is unexplored, with most of it in the NWHI. The major potential banks are off Brooks Banks and the area around Midway Atoll.

Interaction between fisheries managed under the Precious Corals FMP and coral reef resources and habitats are non-existent for pink, red, gold, and bamboo coral, because these fisheries occur much deeper than 50 fm. However, black coral is harvested from 30-50 fm in the main Hawaiian Islands. Harvesting black coral removes habitat itself, but it is unknown if this is a significant ecosystem effect, if harvested at sustainable levels. Bottomfish abundance has been shown to correlate with black coral habitat, but this correlation may be obscured by the long-term effects of fishing on the stocks. More research is needed.

Target Resources

The precious corals fishery in the Western Pacific Region has only occurred in the EEZ and state waters surrounding Hawaii. Much of the black coral (*Antipathes dichotoma, A. grandis, and A. ulex*) is harvested in state waters. Most of the pink and red coral (*Corallium secundum, C. regale,* and *C. laauense)* and gold coral (*Gerardia* spp., *Narella* spp., and *Calyptrophora* spp.) are harvested in deep waters (175-250 fm) of the EEZ. Bamboo coral (*Lepidisis olapa* and *Acanella* spp.) is also found at these depths, but is not currently exploited.

Gear Description and Use

Black coral harvesters use scuba and mixed gas to achieve greater depths, hatchets or sledges to harvest colonies, and float bags to send colonies to the surface for retrieval. Red, pink, and gold coral harvesters use one-man submersibles certified to dive 2,000 ft (333 fm) equipped with manipulator arms and collecting baskets, on-board GIS, streaming video cameras, and computers with graphical software. Black coral harvesters scuba dive from a small vessel located directly above the bed, while deeper coral harvesters employ a mothership and two submersibles.

Incidental Catch and Bycatch

Only organisms growing directly on the coral are potential bycatch. These include sponges, polychaetes, and other lower invertebrates. Free-swimming fauna inhabiting the corals, such as eels and bottomfish, would invariably abandon their shelter as it is harvested.

Habitat Impacts

Selective harvest minimizes potential impacts on habitat. Precious corals are habitats for some species of animals, including juvenile bottomfish and arrowtooth eels. Hawaiian monk seals are believed to forage for bottomfish and arrowtooth eels. Minimum size restrictions and a quota of 5% of the standing stock protect the habitat. While the largest colonies will be harvested, a twenty-year age distribution will remain for all beds.

Reporting Requirements

Harvesters submit daily harvest reports by radio; these include weight by species and position of the mothership. Harvesters fill out a NMFS daily precious coral harvest logbook, which must be submitted within 72 hours of landing at port. Logbook requirements include harvest method, hours fished, depth, and area fished, and weight of coral by species. Additional data reporting has been proposed.

Current Regulations

- The five defined beds and the four Exploratory areas have area-specific permits.
- No vessel can have more than one permit valid at any one time.
- Permits are issued for one year, except for the Makapuu bed, which has a two-year time span.
- Each bed has a specific quota for each species; quotas apply only to live coral.
- Exploratory areas have a 1,000 kg per year quota for all species combined.
- There is a 10" minimum size restriction to harvest pink coral.
- Non-selective gear is prohibited in the MHI, but allowed in all other areas of the EEZ.

Proposed Regulations

As this fishery has recently emerged from a 20-year hiatus, many proposed measures are being considered to adapt to new technology and other management concerns.

- Only selective gear would be allowed in all permit areas.
- Size restrictions for pink corals would apply to all permit areas. There would be a 48" minimum height and 1" minimum base size for black coral.
- Harvest of gold coral would be suspended at Makapuu bed, and throughout the entire NWHI.
- New reporting requirements would include the submission of video tape logs. Specific locations of all dives, including dives where no harvest occurred, and damaged but not harvested coral would also have to be reported.

- There would be no quota for the Hawaiian Exploratory area. However, fishing there would be subject to the following restrictions: (1) a maximum of 1,000 kg harvested at any given site; and, (2) gold coral could not be taken in the NWHI.
- A precious coral mega-reserve would be established in the NWHI. It would encompass precious coral habitat to a depth of 750 fm, including the existing Wespac Refugia and stretching approximately 250 miles to the southeastern edge of Brooks Banks. Within this area, the harvest of gold, pink, and red corals would be prohibited.

Pacific Pelagic Fisheries

The original Pelagics FMP became effective on March 23, 1987. The plan addressed several immediate issues, such as the regulation of foreign fishing vessels in U.S. Pacific insular EEZ waters through fishing permits and area closures, the prohibition of drift gill net fishing except for experimental purposes, observer requirements, catch reporting and definition of pelagic management unit species.

The plan also created a framework for the future management of pelagic fisheries within the EEZ of the Western Pacific Region. The Pelagics FMP has been amended eight times and the following is a summary of each of the FMP amendments and related Council activity.

Amendment 1 to the Pelagics FMP was implemented by regulation published in the Federal Register on March 7, 1991. It was drafted in response to the Secretary of Commerce's Guidelines for the MSFCMA National Standards requiring a measurable definition of recruitment overfishing for each species or species complex in a FMP. The overfishing index expressed the current spawning population as a percentage of the original un-fished spawning population in the virgin stock, or spawning potential ratio (SPR). For pelagic teleost fish the SPR was set at 20% of the original un-fished spawning population. For sharks, however, the Council recognized that these species were on the whole less resilient to fishing pressure and established a higher SPR of 35%. The optimum yield (OY) for pelagic management unit species was also defined as the amount of fish that can be harvested by domestic and foreign vessels in the EEZ without causing local overfishing or economic overfishing.

Amendment 2 was implemented on May 31, 1991, and required domestic longline vessels to have federal permits and maintain federal fishing logbooks. It also authorized the placement of observers on those vessels wishing to fish within 50 nm of the NWHI. Amendment 2 also implemented the application of the Pelagics FMP to the Northern Mariana Islands.

Amendment 3 was implemented on October 18, 1991, and established a 50 nm longline exclusion zone around the NWHI to protect endangered Hawaiian monk seals. Amendment 3 abrogated Amendment 2 but contained framework provisions through which a mandatory observer program was implemented to collect information on sea turtle-longline interactions.

Amendment 4 came into effect on October 16, 1991. It established a three-year moratorium on new entries into the Hawaii-based domestic longline fishery. The moratorium expired on April 22, 1994. A provision to impose a mandatory VMS policy for domestic longline fisheries in the Western Pacific Region was implemented under the framework process of Amendment 4.

Amendment 5 was added on March 4, 1992, and established a longline exclusion zone around the MHI ranging from 50 to 75 nm and a similar 50 nm exclusion zone around Guam and its offshore banks. This zone was established to prevent gear conflicts and vessel safety issues arising from interactions between longliners and smaller fishing boats. A seasonal reduction in the size of the closure was implemented on October 6, 1992. Between the months of October and January, longline fishing is prohibited within 25 nm of the windward shores of all islands except Oahu, where longline fishing is prohibited within 50 nm from the shore.

Amendment 6 was implemented on October 27, 1992, and specified that all tuna species were now designated as fish under the United States management authority. Amendment 6 included tuna and related species of the genera *Allothunnus* spp., *Auxis* spp., *Euthynnus* spp., *Gymnosarda* spp., *Katsuwonus* spp., *Scomber* spp., and *Thunnus* species. It also proposed application of the longline exclusion zones of 50 nm around the island of Guam and associated seamounts, and the 50/75 nm zone around the MHI to foreign longliners, purse seiners, and baitboats. Before this amendment the foreign longline exclusion zones around Guam and the MHI/NWHI extended to 150 nm. The original foreign longline exclusion zones around American Samoa remained unchanged but applied equally to foreign purse seiners and baitboats.

Amendment 7 came into effect on May 25, 1994, and instituted a limited entry program for the Hawaii-based domestic longline fishery. It limits the number of vessels in the fishery to 164 longline boats and these must not exceed 94 ft in length, the size of the largest vessel in the fleet prior to the moratorium period specified under Amendment 4.

Amendment 8 was part of a collective document that, besides the Pelagics FMP, included amendments to other Council FMPs. It was drafted in 1998, but only partially approved on April 19, 1999. Parts of the amendment that were not approved included sections on pelagic bycatch and overfishing.

Proposed Amendment 9, would implement an annual fleet-wide precautionary harvest guideline for sharks in the Hawaii-based longline fishery. Initially the harvest guideline was set at 50,000 sharks, based on the average retained catch between 1996 and 1998. The proposed amendment will also contain a framework by which the harvest guideline can be rapidly adjusted from year-to-year, depending on blue shark stock assessments or other performance indices. However, these guidelines may be affected on the new laws regarding shark finning. The amendment will also ban demersal or bottom longline fishing that targets Pelagic Management Unit Species, and specifically sharks in the federal waters of the Hawaiian Islands.

3.4 The Social Context

This section contains two topic areas. The next section describes the economic setting and use of coral resources in each of the island jurisdictions in the Council's region. The second part of this section reviews the legal context of jurisdiction over marine resources in the region. In addition to jurisdiction by states, federal agencies have overlapping responsibilities in some areas.

3.4.1 Use of Coral Reef Resources

American Samoa

Socio-economic Overview

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

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

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

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

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

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

Historical and Present Coral Reef Uses

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

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

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

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

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

Coral reefs around American Samoa are recovering from a series of natural disturbances that occurred over the past two decades: a crown-of-thorns invasion (1978), three hurricanes (1986, 1990, 1991), and mass coral bleaching (1994), as well as chronic human-induced impacts along the populated coasts. Beaches, wetlands, and coral reefs have been extensively altered due to highway construction and urban expansion, particularly along the south shore of Tutuila. Coastal erosion is amplified by the removal of large quantities of beach sand and coral rubble from the shoreline for use around homes. Together, these shoreline alterations have largely eliminated the use of the central south coast by nesting sea turtles. Direct losses of coral reef habitats are related to dredging for harbors and filling to build the international airport runway.

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

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

Commonwealth of the Northern Mariana Islands

Socio-economic Overview

The Northern Mariana Islands was part of the former Trust Territory of the Pacific Islands, administered by the US, before becoming a commonwealth by plebiscite in 1998. It has a total land area of 176.5 square miles spread over 264,000 square miles of ocean and consists of three main islands, Saipan, Tinian, and Rota, and several small islands and atolls. The southernmost island, Rota, lies some 50 miles northeast of Guam and 430 miles south of CNMI's northernmost island, Uracus. The small islands of the northern part of the chain are lightly populated. In 1990, the population of the northern islands was 36, and was further reduced in 1992. The main islands are grouped together in the southern part of the chain. The Commonwealth's capital is Saipan, but no locality on that island is recognized specifically as the capital; several government offices are located on Capital Hill, but the legislature meets in Susupe. Ninety percent of its 79,429 residents live on the island of Saipan, and almost all the rest on Tinian and Rota. Chamorro is the most commonly spoken native language.

The Bureau of the Census estimates that the population of the Northern Mariana Islands grew by 25,179 persons between the 1990 census and 1999 to an estimated 69,216 persons. Of this increase, 59% (14,803 persons) resulted from migration to the islands, principally from Asian countries (Bureau of Census, International Data Base, 12/29/99). The Chamorro and Carolinan ethnic groups native to the islands represented some 27% of the CNMI's 1999 population.

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

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

The aboriginal people of the CNMI include the indigenous Chamorros, original inhabitants of the islands, and the Carolinians, who are Micronesians that resettled on Saipan during the 1840s. Carolinians are a small minority of the population, but they are known for their seafaring and fishing skill. Their fishing activity largely centered on the harvest of lagoon and reef species, but small paddling canoes were sometimes used to fish a short distance outside the reef (Amesbury *et al.* 1989). In the two decades since these islands achieved commonwealth status their demographic, economic, and social structure has changed dramatically. When the CNMI opened to foreign capital and labor, it was transformed from a small economy supported largely by subsistence and government to a large regional tourist destination and a garment-manufacturing haven. Although tourism has been CNMI's largest income source, the Asian financial crisis of the late 1990s caused visitor arrivals from Japan and Korea to drop by one-third. At present, garment production is CNMI's fastest growing industry and is credited with preventing an economic depression following the decline of the tourist industry.

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

Historical and Present Coral Reef Uses

Before World War II, the Japanese exploited sea cucumbers, trochus (topshell), precious corals and many other coral reef resources in the Japanese Mandated Islands, which included the present Commonwealth of the Northern Mariana Islands. Commercial fisheries for trochus and sea cucumbers were re-opened during the mid-1990s for the first time in recent history. Over an 18-month period in 1995-1996, 268,000 sea cucumbers were collected (Green 1997).

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

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

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

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

Guam

Socio-economic Overview

Guam and the Mariana Islands were first settled about 3,000 years ago, but their present social and demographic structure is largely the result of colonial experiences of the last 300 years. Guam's total population is estimated to have reached 163,000 in 1999, nearly doubling the 1970 total of 85,000. Of the total reported labor force of 72,700 (June 1999), 61,460 were employed and 11,060 were unemployed, for an official jobless rate of 15.2%. In September 1997, at the beginning of the current economic and employment downturn on Guam, the unemployment rate was only 9.2% (Bank of Hawaii 1997c).

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

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

Historical and Present Coral Reef Uses

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

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

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

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

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

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

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

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

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

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

Hawaii

Socio-economic Overview

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

In 1998, Hawaii's ethnic makeup was 22% Caucasian, 21% Hawaiian or part Hawaiian, 18% Japanese, 13% Filipino, 7.3% Hispanic (1990), 3% Chinese, and 1% African-American; other ethnicities made up the balance (DBEDT 1999). (However, Office of Hawaiian Affairs data reveals that a significant part of the population lists their ethnicity as "other/unknown.")

Hawaii's population has been growing at the rate of 7% during the past decade, and was estimated to be 1,193,001 in 1998.

By most statistical measures, people of Native Hawaiian ancestry have the lowest incomes and poorest health of any ethnic group in the State (OHA 1998). Federal, state, and private programs have been established to benefit Hawaiians. There is also an active cultural renaissance among Native Hawaiians, with efforts to restore the language, arts, and subsistence activities, including traditional fishing practices. As part of this renaissance, Native Hawaiians continue to assert their rights of access to oceanic resources. In Hawaii, all shoreline to the highwater mark and undeveloped areas *mauka* (inland, toward the mountains) are public areas that can be accessed for cultural and traditional practices, a holdover from the days of the kingdom (Mackenzie 1991). These Native Hawaiian gathering rights, including shoreline access, have been reaffirmed in court decisions.

The islands of the State of Hawaii were discovered and settled by Polynesians between the third and seventh centuries A.D. Captain James Cook, the first European to reach Hawaii, arrived in 1778. Europeans and Asians began to settle on the islands in the nineteenth century with the development of pineapple and sugar plantations. In 1898, the islands were ceded to the United States and Hawaii became the fiftieth state in 1959.

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

Historical and Present Coral Reef Uses

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

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

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

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

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

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

Historically, Penguin Bank has also been one of the most important bottomfish fishing grounds in the MHI, because it is the most extensive shallow shelf area in the MHI, and it is within easy reach of major population centers. Penguin Bank is particularly important for the MHI catch of *uku* (*Aprion virescens*, or gray snapper), one of the few bottomfish species available in substantial quantities to Hawaii consumers during summer months. Table 3.4 compares bottomfish landings at Penguin Bank during two periods as a percentage of total MHI commercial landings, for five major bottomfish species. It shows that the bank has increased in importance over the years.

For the period 1991 to 1995, 8% of the licensed commercial fishermen who participated in the MHI bottomfish fishery reported catches from Penguin Bank (WPRFMC 1996). Penguin Bank has long been known to support a productive bottom "handline" fishery for snappers and groupers. It is also a popular bottomfish fishing ground for recreational anglers. However, the magnitude and value of the recreational landings, while significant, are poorly documented (Friedlander 1996). However, Holland (1985 in Friedlander 1996) noted that the Kewalo Basin charter fishing fleet uses Penguin Bank as one of its major fishing areas. Offshore and inshore fishing gear are used on Penguin Bank in about equal importance. Table 3.5 lists, in decreasing order of catch, offshore gear and inshore gear. Table 3.6 lists the most common reef/inshore fish species reported in commercial landings from Penguin Bank over the past decade, by five-year periods. Catches for most species are generally comparable for both periods with slightly less taken in the last period (1995-2000). Sharks appear to have been under-reported in the earlier period (1991-1995).

Table 3.4: Mean annual catch (lb) of the most common reported inshore fish species from Penguin Bank (2-200 nm) based on reported DAR commercial fisheries catch statistics from 1991-1995 (modified from Friedlander 1996) and from 1996-2000 (D. Hamm, pers. comm).

Species/Taxa	1991-1995	1996-2000
Bigeye scad (Selar crumenophthalums)	537	474
Goatfish (Mulloidichthys vanicolensis)	264	165
Surgeonfish (Acanthurus xanthopterus)	204	65
Scad (Decapterus spp.)	152	41
Wrasse (Bodianus bilunulatus)	149	62
Barracuda (Sphyraena helleri)	111	56
Wrasse (Xyrichthys pavo)	111	176
Sharks (misc.)	65	3605
Other goatfish (Parupeneus spp.)	37	6
Big-eye-fish (Priacanthus spp.)	28	30
Parrotfish (Scarid spp.)	22	-
Trumpetfish (Aulustoma chinensis)	14	1
Soldierfish (Myripristis spp.)	12	31
Leatherback (Scomberoides lysan)	5	6
Surgeonfish (Acanthurus dussumieri)	4	1
Surgeonfish (A. olivaceus)	4	-
Goatfish (Parupeneus porphyreus)	2	1
Unicornfish (Naso spp.)	1	1
Threadfin (Polydactylus sexfilis)	1	-
Wrasse (Coris spp.)	1	3
Flyingfish (Exocoetus spp.)	-	1

Table 3.5: Mean actual catch (lbs) by gear type from Penguin Bank (2-200 nm), based on data from DAR reported commercial fishery catch statistics from 1991-1995 (modified from Friedlander 1996).

Gear Type	Catch (lbs/yr)
Offshore gear	
Aku pole & line	67,486
Trolling	26,607
Tuna handline	1,295
Subtotal	95,388
Inshore gear	
Deep handline	83,517
Net	14,191
Inshore handline	2485
Other	573
Trap	493
Diving	22
Subtotal	101,281
Total	**196,670**

Table 3.6: Average percentage of total MHI commercial catch and average commercial catch of major bottomfish species harvested from Penguin Bank. Sources: WPRFMC (1996); and unpublished data from HDAR.

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

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

An investigation of the deepwater macroalgal community, using a manned submersible, provides information on algae at Penguin Bank (Norris *et al.* 1995). The bank consists of a broad carbonate platform (~60m deep) covered with loose carbonate rubble and coarse sediments from the calcareous green alga, *Halimeda*. The algal community, comprising 54 species, is characterized by two deepwater species and many species that occur in shallow water. The deeper areas of the bank (182 m) are dominated by crustose coralline algae.

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

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

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

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

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

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

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

Currently, there are no other major fisheries in the NWHI. Commercial trolling for *ono* occurs seasonally in some areas of the NWHI. For a short time in 1999, experimental fishing for coastal sharks was permitted. Many of the shallow reefs in the NWHI are within waters of the State of Hawaii. Section 5.4 discusses documented and potential fisheries interactions with protected species in the NWHI. Occasional visitors, including federal government personnel and contract workers at Midway Atoll, fish recreationally in the NWHI. However, Midway is considered part of the PRIAs and recreational development is discussed in that section.

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

Pacific Remote Island Areas

Socio-economic Overview

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

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

The written historical record provides no evidence of prehistoric populations on Wake atoll, but Marshall Islanders occasionally visited Wake, giving it the name Enenkio. The island was annexed by the United States in 1899. Before the 1930s the only visitors were scientists and survivors of shipwrecks. The Navy received administrative control of Wake in 1934, and established an air base on the atoll in January 1941. Wake Island figured prominently in World War II. The U.S. re-occupied the atoll after the war, and administrative authority was held by the Federal Aviation Administration until 1962, when it was transferred to the Department of the Interior, which in turn assigned authority to the U.S. Air Force.

In 1858, both Hawaii and the U.S. claimed Johnston Atoll. Guano deposits found on the island were exploited for a short period in the nineteenth century. In 1926, President Calvin Coolidge, through Executive Order 4467, declared Johnston Atoll a breeding ground and refuge for seabirds. The atoll was later designated a national wildlife refuge where the U.S. Fish and Wildlife Service manage a recreational fishing program. Johnston Atoll is still controlled by the U.S. military. Starting in the late 1940s, Johnston Atoll played an important role in the U.S. nuclear testing program. In 1962, three rockets accidentally exploded on or above Johnston Island. Chemical munitions have been stockpiled on Johnston for storage and destruction by means of a specially designed chemical munitions incinerator.

A recently established eco-tourism operation in the Midway Atoll National Wildlife Refuge has improved public access to the NWHI. An agreement between Midway Phoenix Corporation and the USFWS allows up to 100 people to visit the atoll each week. These visitors normally get to Midway by air, on charter flights from Honolulu. Typical activities include charter fishing, diving, and wildlife observation. The company emphasizes this last activity in its promotional material, promoting wildlife tours that let visitors "gain first hand knowledge of the albatross, resident seabirds, migrant shorebirds, threatened green turtles and endangered Hawaiian monk seals." The Public Use Plan for the Refuge outlines other outdoor recreational activities—including shoreline fishing, lobstering, night diving, night fishing, kayaking tours, and glass-bottom boat excursions—that could be offered to visitors in the future (USFWS 1997). These activities should result in increased recreational use of NWHI marine resources.

Because of their location and history, no genuine community participation in coral reef fisheries can be identified for the PRIAs. The next section discusses coral reef resource use by part-time residents on these islands and atolls.

Historical and Present Coral Reef Uses

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

Fishing is light in most areas. Hawaii-based vessels have been reported to make sporadic commercial fishing trips to Palmyra and Kingman Reef for bottom fishing and harvesting coastal sharks for finning. The past extent of harvesting by passing yachts or poaching by foreign fishing vessels is unknown (Green 1997). Since May 2000, The Nature Conservancy has been conducting small scale experimental ecotourism activities, including, diving, snorkeling, kayaking, fishing, and wildlife photography. The Nature Conservancy has also proposed establishing an inshore/offshore sportfishing operation. It would include a catch-and-release program for pelagic species, bonefish (*Albula* spp.), and other reef fish, particularly the giant trevally (*Caranx ignoblis*). The proposal also includes monitoring of fish stocks, and conducting biological investigations on the migratory, reproductive, and recruitment patterns of those stocks. Data on catch and effort from the recreational fishing will also be recorded (Cook pers. comm.). In addition, pursuant to a license agreement with The Nature Conservancy, Palmyra Pacific Seafoods, LLC has established and is currently operating a commercial fishing operation on Palmyra Atoll. Palmyra Pacific Seafoods, LLC is operating under rights granted to it by the Fullard-Leo family, and its existing fishing areas and business interests include the resources in the vicinity of Kingman Reef (Frank Sorba pers. comm at 108th Council Meeting).

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

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

The original Johnston Atoll has been extensively modified by dredging and filling. An estimated four million square meters of coral were destroyed by construction, and an additional 25 million square meters were damaged by the resulting sedimentation. By 1964, dredge and fill operations had enlarged the original island by over tenfold and had added two man made islands.

Fishing regulations have changed at Johnston Atoll in recent years because of concerns that fish were being exported and that coral collecting had become excessive and was incompatible with the philosophy of the refuge (Green 1997). Current Department of the Interior (DOI) rules, with cooperation from the U.S. military, prohibit coral collecting and the export of any reef fish or invertebrates from the island. No recent fisheries statistics are available for the area.

National Wildlife Refuges have been established at Baker, Howland and Jarvis Islands, Johnston Atoll, Midway Atoll and most recently, Palmyra Atoll and Kingman Reef. Natural resources are managed by the USFWS and access is by special permit only.

3.4.2 Jurisdictional Issues

Introduction

This section reviews the complex issues surrounding marine boundaries in the Western Pacific Region. Delineation of current marine boundaries is discussed and specific areas of contention between various federal and state authorities are summarized.

Exclusive Economic Zone

The 1976 Fishery Conservation and Management Act (the Magnuson Act, and later, after amendments, the MSFCMA)[6] established U.S. jurisdiction from the seaward boundary of the territorial sea out to 200 miles for the purpose of managing fishery resources. Passage of the Magnuson Act was the first unilateral declaration of jurisdiction over a 200-mile zone by a major power. Presidential Proclamation 5030 of March 10, 1983, expanded Magnuson Act jurisdiction by establishing the U.S. exclusive economic zone; it declared, "to the extent permitted by international law ... sovereign rights for the purpose of exploring, exploiting, conserving and managing natural resources, both living and non-living, of the seabed and subsoil and the superjacent waters" in the 200-mile zone. The assertion of jurisdiction over the EEZ of the United States provided a basis for economic exploration and exploitation, scientific research, and protection of the environment under the exclusive control of the U.S. government. Congress confirmed presidential designation of the EEZ in 1986 amendments to the Magnuson Act. Under the Magnuson Act, fishery management authority in the EEZ off American Samoa, Guam, Hawaii, the Northern Mariana Islands, and other U.S. islands in the central and western Pacific is the responsibility of the Western Pacific Regional Fishery Management Council.

[6]The MSFCMA was initially referred to as the Magnuson Fishery Conservation and Management Act, which was changed to the Magnuson-Stevens Fishery Conservation and Management Act by the 1996 amendment to the Act.

The EEZ is measured from the "baseline" of U.S. states and overseas territories and possessions out to 200 nautical miles. Under the Magnuson Act, the shoreward boundary of the EEZ is a line coterminous with the seaward boundary, baseline, of each "state." (As used elsewhere in this document, U.S. territories and possessions in the Western Pacific fall within the definition of state under the Magnuson Act (16 U.S.C. 1802, MSFCMA § 3 104-297). In the case of the CNMI and the PRIAs, the EEZ extends to the shoreline (Beuttler 1995).

Seaward boundaries (territorial seas) for states are recognized as extending out to a distance of three miles from the ordinary low-water mark, as established by the Submerged Lands Act (SLA) of 1953.[7] The Territorial Submerged Lands Act (TSLA) of 1960 was enacted to convey to the governments of American Samoa, Guam and Virgin Islands the submerged lands from the mean high-tide line out to three geographical miles from their coast lines (Beuttler 1995).

The CNMI was part of the United Nations Trust Territory of the Pacific Islands (administered by the U.S.) until 1984 when its citizens by plebiscite chose to be become a U.S. commonwealth and it was agreed to by Congress and the United Nations. Although title of the emergent land was conveyed to the Commonwealth, the U.S. government withheld title to the submerged lands of the archipelago.[8] Submerged lands and underlying resources adjacent to CNMI remain owned by the federal government and subject to its management authority (Beuttler 1995).

In the PRIAs, for which there are no sovereign entities similar to states or territories, various federal agencies have jurisdictional authority. Authority is often established through statutes, Executive Orders, and Presidential Proclamations, and marine boundaries are often unclear. For this reason, the extent to which an agency exercises its jurisdictional authority is subject to legal interpretation.

Territorial Seas

State of Hawaii

The State of Hawaii consists of all islands, together with their appurtenant reefs and territorial waters, which were included in the Territory of Hawaii under the Organic Act of 1900. Under the Admissions Act of 1959, Congress granted to Hawaii the status of statehood and all amenities of a state, which included the reversion of title and ownership of the lands beneath the navigable waters from the mean high-tide line seaward, out to a distance of three miles, as

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[7]Under the SLA, the term "boundaries'" or the term "lands beneath navigable waters'" is interpreted as extending from the coastline to three geographical miles into the Atlantic Ocean or the Pacific Ocean, or three marine leagues (9 miles) into the Gulf of Mexico.

[8] The Territorial Submerged Lands Act was enacted for CNMI on October 5, 1974 (Beuttler 1995). Congress approved the mutually negotiated "Covenant to Establish a Commonwealth of the Northern Marianas (CNMI in political union with the U.S.)". However, the Covenant was not fully implemented until 1986, pursuant to Presidential Proclamation number 5564, which terminated the trusteeship agreement (Beuttler 1995).

stated by the SLA of 1953. Congress excluded Palmyra Atoll, Kingman Reef, and Johnston Atoll, including Sand Island, from the definition of the State of Hawaii in 1959. The federal government also retained 1,765 acres of emergent land in the NWHI, which had been set aside by Executive Order 1019 in 1909, establishing the Hawaiian Islands Reservation (HIR). The HIR was later renamed the Hawaiian Islands National Wildlife Refuge (HINWR) after it was transferred from the Department of Agriculture to the Department of the Interior in 1939 (Yamase 1982).

Territories of Guam and American Samoa

Pursuant to the TSLA of 1960, the Territories of Guam and American Samoa own and have management responsibilities over the marine resources out to three "geographic" miles. In general, the authority of the MSFCMA begins at three nautical miles from the shoreline at Guam and American Samoa. There are, however, exceptions to the management authority in the Territories. For example, the federal government administers waters in National Wildlife Refuges (NWR) and naval defense sea areas (NDSA)(see below).

U.S. Fish and Wildlife Refuges and Units

The USFWS has been given authority to manage a number of NWRs in the Western Pacific Region. The USFWS asserts the authority to manage marine resources and activities, including fishing activities within Refuge boundaries pursuant to the National Wildlife Refuge System Administration Act (NWRSAA) of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997, and other authorities (Gillman 2000). The USFWS asserts that NWRs are closed to all uses until they are specifically opened for such uses. They also claim that the USFWS is "solely" charged with making decisions whether to open NWRs for specific purposes that are compatible with the refuge's primary purposes and mission (Smith 2000a).

Executive Order 1019 reserved and set apart Laysan and Lisanski Islands, and Maro and Pearl and Hermes Reefs, excluding Midway Atoll, "as a preserve and breeding ground for native birds" to be administered by the Department of Agriculture. The HIR was transferred to the DOI in 1939 and in 1940, renamed the HINWR through Presidential Proclamation 2466, with control transferred to the USFWS. Within the HINWR, the USFWS asserts management authority over coral reef resources to a depth of 10 fm around all islands with the exception of Necker Island, where it asserts a 20 fm boundary. The USFWS acknowledges that all HINWR islands are part of the State of Hawaii, but asserts that the islands are federally owned and administered as a NWR by the USFWS (Smith 2000b; USFWS 1999a).

Kure Atoll was initially included in Executive Order 1019 in 1909, which established the HIR. However, Kure Atoll was returned to the Territory of Hawaii in 1952 by Executive Order 10413 (Yamase 1982). Kure Atoll is the only State Wildlife Refuge in the NWHI and extends out three miles, to the State's seaward boundary.

In the PRIAs, the USFWS—based on interpretation of Executive Order 7358—asserts that its refuge boundaries extend to the extent of the NDSA, which was administered by the Department of Defense before the transfer of surplus land to the USFWS. The USFWS currently manages seven wildlife refuges in the PRIAs: Palmyra Atoll; Kingman Reef; Jarvis Island; Baker Island; Howland Island; Johnston Atoll; and, Midway Atoll (Smith 2000b).

On January 18, 2001, the USFWS, through Secretarial Order 3223, declared Kingman Reef and the surrounding submerged lands and waters a National Wildlife Refuge out to a distance of 12 nautical miles. Additionally, Secretarial Order 3224, issued the same day, declared the tidal lands and submerged lands and waters of Palmyra Atoll as a National Wildlife Refuge out to a distance of 12 nautical miles. Certain tidal and submerged lands were excluded from this order.[9]

Midway Atoll NWR, established under Executive Order 13022 in 1996, is located in the NWHI and has a refuge boundary that is within a 22 by 22 mile quadrant surrounding the atoll (the exact boundary is disputed). The U.S. Navy established a Naval Air Facility at Midway Atoll in 1941. The USFWS established an overlay refuge in 1988, to manage the fish and wildlife on the Atoll. Through the Base Alignment Closure Act of 1990, as amended, the Naval Air Facility closed in 1993, and the property was transferred to the USFWS in 1996 (USFWS 1999b). The mission of the refuge is to protect and restore biological diversity and historic resources of Midway Atoll, while providing opportunities for compatible recreational activities, education and scientific research (Shallenberger 2000). Through a long-term cooperative agreement with a private company (i.e., Midway Phoenix Corp.), the refuge has been open to the public for marine recreation and education (Shallenberger 2000).

Johnston Atoll NWR is managed cooperatively with the Navy. The atoll was first established as a federal bird refuge on June 29, 1926, through Presidential Executive Order 4467 to be administered by the Department of Agriculture. In 1934, through Executive Order 6935, the atoll was placed under the jurisdiction of the Navy for administrative purposes and has been used as a military installation since 1939. In 1941, Executive Order 8682 designated Johnston and other Pacific atolls NDSAs. Since 1976, the USFWS, under agreement with the military, assists in management of fish and wildlife resources on the atoll. The USFWS manages a recreational fishing program in the NWR (Smith 2000b).

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[9]A September 15 2000, legal opinion by Randolph Moss, Assistant Attorney General, U.S. Department of Justice, states that they are "unconvinced that the President has the authority to establish or expand a wildlife refuge within the U.S. territorial sea (12 miles) or the EEZ using presidential authority recognized in *Midwest Oil*." Because the National Wildlife Refuge System Administration Act does not itself contain a provision authorizing the President to withdraw land for a wildlife refuge, the DOI argues that the President could rely on the implied authority to reserve public lands recognized in *United States v. Midwest Oil Co.* 236, U.S. 459 (1915). The Federal Land Policy and Management Act (FLPMA) of 1976 repealed the President's authority, effective on and after approval of the Act, to make withdrawals and reservations resulting from acquiescence of Congress (*U.S. v. Midwest Oil Co.*). Moss continued by stating that they find "it likely that a court would find that §704(a) of the FLPMA prohibits the President from relying on the implied *Midwest Oil* authority to withdraw lands, regardless of where those lands are located." Also, he notes that "they do not think history makes it clear that the President may continue to make *Midwest Oil* withdrawals in the territorial sea or EEZ following the enactment of the FLPMA."

Administration of Jarvis, Howland, and Baker Islands was transferred from the Office of Territorial Affairs to the USFWS in 1936 to be run as NWRs. The USFWS asserts refuge boundaries out to three nautical miles, and it prohibits fishing and any type of unauthorized entry (Smith 2000b). The USFWS acknowledges the Council's fishery management authority, in coordination with the NMFS, within the "200-nautical mile EEZ" (Smith 2000b).

Rose Atoll NWR, located in American Samoa, was established through a cooperative agreement between the Territory of American Samoa and the USFWS in 1973. Presidential Proclamation 4347 exempted Rose Atoll from a general conveyance of submerged lands around American Samoa to the Territorial Government. The boundary of the refuge extends out to three miles around the atoll and is under the joint jurisdiction of the Departments of Commerce and Interior, in cooperation of the Territory of American Samoa. Here too, the USFWS acknowledges fishery management authority of the Council, in coordination with the NMFS, within the "200-nautical mile EEZ" (Smith 2000b).

In the Ritidian Unit of the Guam National Wildlife Refuge, USFWS has fee title, which includes 371 acres of emergent land and 401 acres of submerged lands down to the 100-foot bathymetric contour. The submerged lands adjacent to Ritidian were never transferred to the Territory of Guam pursuant to the TSLA by the federal government. In 1993, the USFWS acquired the emergent land of the Ritidian Unit and the surrounding submerged lands from the Navy at no cost (Smith 2000b).

Department of Defense Naval Defensive Sea Areas

A number of Executive Orders have given administrative authority over territories and possessions to the Army, Navy, or the Air Force for use as military airfields and for weapons testing. In particular, Executive Order 8682 of 1941 authorizes the Secretary of the Navy to control entry into NDSAs around Johnston, and Midway Atolls, Wake Island, and Kingman Reef. The NDSA includes "territorial waters between the extreme high-water marks and the three-mile marine boundaries surrounding" the areas noted above. The objectives of the NDSA are to control entry into naval defensive sea areas; to provide for the protection of military installations; and to protect the physical security of, and ensure the full effectiveness of, bases, stations, facilities, and other installations (32 CFR Part 761). In addition, the Navy has joint administrative authority with the USFWS of Johnston Atoll and has recently transferred administrative authority over Kingman Reef to the USFWS. In 1996, Executive Order 13022 rescinded the Midway Atoll NDSA. Additionally, the Wake Island NDSA has also been suspended until further notice.

The Navy exerts jurisdiction over Farallon de Mendinilla in the CNMI and Kaula Rock in the MHI, which are used as military bombing ranges. The Navy also exerts jurisdiction over a variety of waters offshore from military ports and air bases in Hawaii, the PRIAs, Guam, and the CNMI.

Issues

Claims between "state" and federal resource management agencies involving marine boundaries over individual islands, reefs and atolls, continue to be unresolved in the Western Pacific Region. These agencies also have also established or propose to establish management over marine resources within various depths. Tables 3.7 -3.9 summarize these various claims.

Northwestern Hawaiian Islands

The NWHI are primarily uninhabited atolls, islands, banks and shoals and are currently under multi-agency jurisdiction including the State of Hawaii, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service and the Western Pacific Regional Fishery Management Council. Overlaps in jurisdiction and the varying regulatory authorities embodied in the management of this area can create numerous challenges and have led to contention regarding access and use for the region.

The State of Hawaii claims jurisdiction of all submerged lands from the shoreline to the extent of the State's jurisdiction in the NWHI. In accordance with the Hawaii Organic Act of April 30, 1900, c 339, 31 Stat 141 Section 2, and the Hawaii Admissions Act of March 18, 1959, Pub Law 86-3, 73 Stat 4 Section 2, the Islands of the Hawaiian Archipelago, together with their appurtenant reefs and territorial waters, with the exception of Midway Atoll, are part of the territory of Hawaii and are managed by the State of Hawaii including all submerged lands and marine resources. The State of Hawaii, Department of Land and Natural Resources has stewardship responsibility for managing, administering and exercising control over the coastal and submerged lands, ocean waters and marine resources under State jurisdiction around each of the Northwestern Hawaiian Islands under Title 12, Chapter 171.3 Hawaii Revised Statutes. Under an Executive Order issued by President Truman, the emergent lands at Kure Atoll are also managed as a State Wildlife Refuge.

In addition to the State of Hawaii, the USFWS also claims jurisdiction over atolls, islands, banks and shoals in the NWHI. Following the Hawaii Admissions Act of March 18,1959, federal agencies were directed to inventory all lands for which there was a continuing need. The USFWS in 1963, reported a continuing need of 1,765 acres of land in the NWHI. This area consisted of only the emergent land in the NWHI as was claimed by the Department of Agriculture as the original boundary of the Hawaiian Island Refuge (Yamase 1982). More recently however, the USFWS claims that the HINWR includes 252,000 acres of submerged lands based on their interpretation of the terms "reef and inlets" contained in Executive Order 1019 (U.S. Fish and Wildlife Service 1986). Within the HINWR, the USFWS asserts management authority over coral reef resources to a depth of 10 fathoms around all islands with the exception of Necker Island where it asserts a 20 fathom boundary. The USFWS acknowledges that all HINWR islands are part of the State of Hawaii, but asserts that the islands are federally owned and administered as a NWR by the USFWS (U.S. Fish and

Wildlife Service 1999a, Smith 2000). Other jurisdictional disputes also involve East and Tern Islands in French Frigate Shoals [10] [11]

Issues have developed from a series of directives from President Clinton that focused public attention on protection of U.S. coral reef ecosystems. Executive Order 13089, Coral Reef Protection, issued in June 1998, requires agencies to: (1) identify actions that may affect U.S. coral reef ecosystems; (2) use their programs and authorities to protect and enhance the condition of such ecosystems; and (3) ensure that any actions they authorize, fund, or carry out will not degrade the conditions of coral reef ecosystems. Agencies whose actions affect U.S. coral reef ecosystems must provide for implementation of measures needed to research, monitor, manage and restore affected ecosystems, including, but not limited to, measures reducing impacts from pollution, sedimentation, and fishing. The EO also established the U.S. Coral Reef Task Force composed of the heads of 11 federal agencies and the Governors of the seven states, territories, or commonwealths with responsibilities for coral reefs. In March 2000, the Task Force issued the National Action Plan to Conserve Coral Reefs, which presents a cohesive national strategy to implement EO 13089.

In May 2000, the President issued a Memorandum stating that it is time to implement the Coral Reef Task Force's recommendations in order to comprehensively protect the coral reef ecosystem of the NWHI.[12] The Memorandum directed the Secretaries of Interior and Commerce, in cooperation with the State of Hawaii, and in consultation with the WPRFMC, to develop recommendations for a new, coordinated management regime to increase protection for the NWHI coral reef ecosystem and provide for sustainable use. After considering their recommendations and comments received during the public visioning

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[10] In 1940, Territorial Governor Poindexter, issued an Executive Order in concurrence with the President of the U.S. to set aside East Island, for the use and purpose of the United States as a radar station communication base under the DOC (Yamase 1982). Prior to statehood, the DOC returned East Island to the Territory of Hawaii (Yamase, 1982). However, the DOI contends that East Island was part of the HIR as established by Executive Order 1019 in 1909 and later transferred to the DOI in 1939. Therefore, East Island remains included in the HINWR and under authority of DOI.

[11] Tern Island was expanded from 11 to 37 acres in 1942 by military dredging (Yamase 1982). In 1948, the Navy conveyed Tern Island to the Territory of Hawaii which then permitted the U.S. Coast Guard in 1952 to establish a navigational Loran station (Yamase 1982). In 1979, USCG operations were terminated and the Hawaii State Legislature adopted resolutions requesting the Governor to take immediate action to acquire and return Tern Island for use as a fishing base to support commercial activities (Yamase 1982). The Federal government asserts that it retains jurisdiction over Tern Island based on Executive Order 1019 and that the Navy did not have the authority to legally convey title to the Territory of Hawaii, therefore, the conveyance is void (Yamase 1982).

[12] The President's directive coincided with Executive Order 13158, which requires federal agencies to establish a comprehensive national network of marine protected areas throughout US marine waters. The Executive Order calls for expansion of the nation's MPA system to include examples of all types of marine ecosystems. According to the executive order, a MPA means any area of the marine environment that has been reserved by federal, state, territorial, tribal, or local laws or has regulations to provide lasting protection for part or all of the natural and cultural resources therein.

process on this initiative, President Clinton issued Executive Order 13178 on December 4, 2000, establishing the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve, pursuant to the National Marine Sanctuaries Amendments Act of 2000 (NMSA). The EO was revised and finalized by Executive Order 13196, issued January 18, 2001. Pursuant to Executive Order 13178 and the NMSA, NOAA is initiating the process to designate the Reserve as a national marine sanctuary (66 FR 5509, January 19, 2001). These actions to protect the coral reef ecosystem of the NWHI and provide for sustainable use of the area underscore the immediate need for a comprehensive assessment of the impacts of fishing activity on this ecosystem. (For more details on these Executive Orders and a description of its conservation measures, see section 9.2 of the FMP.)

Because the final rules for the CRE Reserve have not yet been published, and an EIS will be prepared for the marine sanctuary, a comprehensive analysis of the impact of the Reserve cannot be made at this time. Preliminary potential impacts to the human environment are addressed in the environmental consequences section of this EIS. Two alternatives considered by this EIS (3 and 4, described in Chapter 2) are consistent with the concept of establishing marine reserves in the NWHI, as described in the CRE-FMP.

The USFWS and the Council have different opinions about primary fishery management responsibilities in EEZ waters within NWR boundaries. Since the late 1960s, citing USFWS interim administrative policy and interpretation of Executive Order 1019, the USFWS has asserted that they would enforce refuge regulations within the *"de facto"* boundaries of the HINWR, which include all emergent land and their surrounding waters out to a depth of 10 fm for all islands and later 20 fm around Necker Island (Smith 2000b). Under the authority of the MSFCMA, the Council promulgated fishery regulations within federal waters that correspond with USFWS refuge boundaries of 0-10 fathoms within NWHI federal waters, except at Necker where it is 20 fm (WPRFMC 1986). The Council recognizes state waters in the NWHI from 0-3 miles and asserts management authority over fishery resources in all federal waters (3-200 miles), except at Midway Atoll where it asserts authority from 0-200 miles (Gillman 2000).

Main Hawaiian Islands

The State of Hawaii claims jurisdiction beyond its territorial seas of 0-3 nautical miles by claiming archipelagic status over channel waters between the main Hawaiian islands (MacDonald and Mitsuyasu 2000). The federal government does not recognize the State's claim of archipelagic jurisdiction, but interprets the State's seaward authority to stop at three nautical miles from the baseline (Feder 1997; MacDonald and Mitsuyasu 2000). The authority of the MSFCMA, therefore, begins at three miles from the shoreline around all main Hawaiian islands in the State of Hawaii. However, the State of Hawaii does not agree with this interpretation.

American Samoa

The legal relationship between the Territory of American and the U.S. with regard to fisheries management is unresolved due to a discrepancy in the wording of the deeds of cession signed by the chiefs of what is now American Samoa and the law enacted by Congress which extended U.S. sovereignty over the eastern Samoa islands in 1900. Language contained in the deeds of cession signed by the chiefs of Tutuila district state that they ceded, transferred and yielded up "all these islands of Tutuila and Aunu'u and all other islands, rocks, reefs, foreshores and waters lying between the 13th degree and the 15th degree of south latitude and between the 171st degree and 167th degree of west longitude...." Likewise, the chiefs of the Manu'a Islands also ceded to the U.S. "the whole of eastern portion of the Samoan Islands lying east of 171 degrees west of Greenwich and known as Tau, Olosega, Ofu and Rose Islands, and all other , the waters and property adjacent thereto...."

In contrast, Title 48 United States Code, Section 661, by which Congress accepted, confirmed and ratified these cessions by the chiefs, refer only to the islands, and not to the reefs, foreshores and waters or property adjacent to or lying between the referenced coordinates. Whether Congress deliberately or unintentionally failed to extend sovereignty over reef and ocean waters transferred by the chiefs of Tutuila and Manu'a is uncertain. However, many American Samoans assert that management over the waters and submerged lands surrounding the islands, including submerged lands within the EEZ, should remain with the territorial government.

A central premise for ceding eastern Samoa to the U.S. was to preserve the rights and property of the islands' inhabitants. Additionally, American Samoa's constitution makes it government policy to protect persons of Samoan ancestry from the alienation of their lands and the destruction of the Samoan way of life and language and to encourage business enterprise among persons of Samoan ancestry. Therefore, any federal actions within the EEZ waters of American Samoa that would stymie these rights, including restriction on fishing, may be perceived to be contrary to American Samoa's constitution.

CNMI

Currently, the EEZ includes all waters surrounding CNMI from the shore out to 200 miles. However, through the legal system CNMI is pursuing a claim that the Commonwealth is vested authority out to 12 miles from the archipelagic baseline. The Council, for the purposes of fisheries management, defers management in waters 0-3 nm off shore to the CNMI while managing fishery resources 3-200 nm.

Guam

The Territory of Guam questions the legality of the transference of the Ritidian Unit from the Navy to the USFWS. In its property inventory to the General Services Administration the Navy listed the Ritidian Unit as excess lands, not of continual need and available for reversion to the Territory. The area formerly used by the Navy had been claimed as ancestral lands by Chamorro families. Therefore, the Territory asserts that the fee title should not have been transferred to the USFWS (J. Guthertz pers. comm.). With respect to fisheries management, this area geographically within the three mile territorial boundary. However, the United States, through the Territorial Submerged Lands Act of 1974 retained certain lands and mineral rights within the three mile territorial boundary (Beuttler 1995).

In 1976, the Federal Fishery Conservation Zone (later known as the EEZ) was extended to 200 nm around Guam which allowed the federal government authority in managing federal fishery resources within the EEZ. In 1980, the Guam Legislature passed and the Governor signed legislation providing for a 200 mile territorial limit for Guam (DOI 1993). The purpose of this legislation, reportedly was to allow the government of Guam to sell foreign fishing rights within Guam's EEZ. In 1996, changes to the MSFCMA authorized the Secretary of State to establish foreign fishing agreements for fishing within the EEZ around Guam. However, in addition to the "state" waters around Guam, the government has also expressed a continuing interest in obtaining greater authority in managing the EEZ surrounding Guam.

PRIAs

In the PRIAs, primary jurisdiction over nearshore fisheries is an ongoing issue between the USFWS and the Council. Management authority is currently unresolved because no clear baseline boundary has been designated from which the seaward boundary of the PRIAs are measured. Seaward boundaries are not clearly defined because some islands in the PRIAs do not appear to have a seaward boundary as defined by U.S. law (i.e., MSFCMA) (Beuttler 1995). For this reason, jurisdictional boundaries have been claimed by federal agencies in terms of fathoms, miles, or the territorial sea. Furthermore, it is recognized that various Executive Orders have given administrative authority of the PRIAs to either the Department of Defense (DOD) or DOI. However, Executive Orders themselves do not convey title of submerged lands, unless specifically stated. In any case, based on tentative interpretation by the NOAA legal counsel, MSFCMA authority applies to all marine waters around federally owned possessions (i.e., PRIAs), including marine resources within bays, inlets, and other marine waters to the shoreline (Beuttler 1995).

Additionally, because the National Wildlife Refuge System Administration Act (NWRSAA) does not explicitly authorize the President to withdraw land for a wildlife refuge, the DOI argues that the President could rely on the implied authority to reserve public lands recognized in United States v. Midwest Oil Co. 236, U.S. 459 (1915). However, since the Federal Land and Policy Act of 1976 (FLPMA) repealed the President's authority, effective on and after approval of the Act, to make withdrawals and reservations resulting from the acquiescence of Congress (U.S. v. Midwest Oil Co.), it appears that since 1976 the President has not had the authority to establish or expand a wildlife refuge within the U.S. territorial sea (12 miles) or the EEZ using presidential authority recognized in Midwest Oil (Moss 2000). This could call into question asserted marine boundaries of any NWRs established after enactment of the FLPMA.

Table 3.7 : Marine boundary claims by various jurisdictions in the Western Pacific Region. Note: a dashed line (-) indicates no jurisdiction.

Island or Area	State/Commonwealth/ Territory	Department of Commerce	Department of the Interior and Department of Defense (as noted)
PRIAs			
Howland I.	-	WPRFMC/NMFS 0-200 nm	USFWS: 0-3 nm
Baker I.	-	WPRFMC/NMFS 0-200 nm	USFWS: 0-3 nm
Jarvis I.	-	WPRFMC/NMFS 0-200 nm	USFWS: 0-3 nm
Johnston I.*	-	WPRFMC/NMFS 0-200 nm	USFWS/US Navy: 0-3 nm
Kingman R.	-	WPRFMC/NMFS 0-200 nm	USFWS: 0-12 nm[1]
Palmyra A.*	-	WPRFMC/NMFS 0-200 nm	USFWS: 0-12 nm[2]
Wake I.***	-	WPRFMC/NMFS 0-200 nm	DOI/USArmy: 0-3 nm
Midway A.*	-	WPRFMC/NMFS 0-200 nm	USFWS: 22x22 nm quad
Hawaii			
MHI	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	
Nihoa I.	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	USFWS: 0-10 fm**
Necker I.	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	USFWS: 0-20 fm**

[1] Boundary formerly 0-3 miles under the jurisdiction of the U.S. Navy. Secretarial Order 3223 extended Department of the Interior's jurisdiction to 12 nm.
[2] Secretarial Order 3224 (Palmyra Atoll) extended USFWS administrative authority from 3 to 12 nm.
*At Palymyra, Johnston, and Midway special permit fishing is only for recreational and on-island consumption; at Midway, the northern half of the atoll would be a no-take MPA and the southern half a low-use MPA.
**USFWS boundary begins at the shoreline; legally defined outer boundary of the Hawaiian Islands NWR is unresolved.
*** As of 1962, the jurisdiction over Wake Island has been vested with the Department of the Interior. Since 1994, the Department of the Army has maintained administrative use of Wake Island.

Table 3.7 (cont.)

Island or Area	State/Territory/Commonwealth	Department of Commerce	Department of the Interior and Department of Defense (as noted)
FFS	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	USFWS: 0-10 fm**
Gardner Pinnacles	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	USFWS: 0-10 fm**
Maro R.	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	USFWS: 0-10 fm**
Laysan I.	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	USFWS: 0-10 fm**
Lisanski I.	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	USFWS: 0-10 fm**
Pearl and Hermes R.	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	USFWS: 0-10 fm**
Kure A.	Hawaii: 0-3 nm	WPRFMC/NMFS 3-200 nm	-
Guam	Guam: 0-3 nm	WPRFMC/NMFS 3-200 nm	
Ritadan Unit			USFWS: 100 ft. isobath
CNMI	CNMI: 0-3 nm***	WPRFMC/NMFS 3-200 nm	
American Samoa	American Samoa: 0-3 nm	WPRFMC/NMFS 3-200 nm	
Rose Atoll		WPRFMC/NMFS 0-200 nm	USFWS: 0-3 nm[3]

[3]At Rose Atoll, the Department of the Interior/U.S. Fish and Wildlife Service has a cooperative agreement with the Territory of American Samoa to manage the atoll as a national wildlife refuge, and shares jurisdiction with the Department of Commerce.
**USFWS boundary begins at the shoreline; legally defined outer boundary of the Hawaiian Islands NWR is unresolved.
***The CRE-FMP proposes to defer management in 0-3 nm to the CNMI while managing fisheries 3-200 nm.

Table 3.8 : Comparison of No-take and Low-use Marine Protected Areas of the Coral Reef Ecosystem FMP with the NWHI Reserve Preservation Areas (RPAs), U.S. Fish and Wildlife Service and State/Commonwealth/Territory (a dash (-) indicates no jurisdiction).

Island or Area	CRE-FMP	NWHI Reserve	USFWS	State/Commonwealth/Territory
PRIAs				
Howland I.	No-take zone 0-50 fathoms.	–	Howland Island NWR to 3 nm; No fishing allowed.	–
Baker I.	No-take zone 0-50 fathoms.	–	Baker Island NWR to 3 nm; No fishing allowed.	–
Jarvis I.	No-take zone 0-50 fathoms.	–	Jarvis Island NWR to 3 nm; No fishing allowed.	–
Johnston I.	Low-use special permit zone 0-50 fathoms.	–	Johnston Atoll NWR/Navy (Overlay Refuge) to 3 nm; Recreational fishing program.	–
Kingman R.	No-take zone 0-50 fathoms.	–	Kingman Reef NWR to 12 nm; No fishing allowed.	–
Palmyra A.	Low-use special permit zone 0-50 fathoms.	–	Palmyra Atoll NWR to 12 nm; Recreational fishing allowed.	–
Wake I.	Low-use special permit zone 0-50 fathoms.	–	DOI/US Army to 3 nm; Fishing allowed.	–
Midway A.	No-take zone 0-50 fathoms around northern half of Midway. Low-use special permit zone around southern half of Midway.	–	Midway Atoll NWR between 28°5' and 28°25'; 177°10' and 177°30'; following fishing allowed within Refuge boundaries: 1 lobster/person/day; pelagic rec and charter fishing allowed; no bottomfishing; catch and release ulua fishing.	–

Table 3.8 (cont)

Island or Area	CRE-FMP	NWHI Reserve	USFWS	State/Commonwealth/Territory
Hawaii				
MHI	Special permits for "potentially harvested" species.	–	10 wildlife refuges (none with marine boundaries)	State of Hawaii bottomfish area closures (20 closures across MHI); 10 Marine Life Conservation Districts and 14 Marine Fishery Management Areas in MHI (rules and regulations vary with location)
Nihoa I.	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms around Nihoa and nearby banks.	RPA extends from the seaward boundary of Hawaii State waters (3nm) out to a mean depth of 100 fathoms. Bottomfish and recreational trolling for pelagics permitted seaward of 25 fathoms.	HINWR 0 to 10 fathoms. No fishing allowed.	State of Hawaii proposed NWHI Marine Fisheries Management Area (NWHI FMA) 0-3 miles.
Misc. banks around Nihoa and Necker (8)	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	no current restrictions	HINWR 0 to 10 fathoms. No fishing allowed.	–
Necker	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA extends from the seaward boundary of Hawaii State waters (3nm) out to a mean depth of 100 fathoms. Bottomfish and recreational trolling for pelagics permitted seaward of 25 fathoms.	HINWR to 20 fathoms. No fishing allowed.	State of Hawaii proposed NWHI Marine Fisheries Management Area (NWHI FMA) 0-3 miles.
Unnamed bank east of French Frigate Shoal	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA to 12 nm from geographic center. No fishing allowed.	HINWR 0 to 10 fathoms. No fishing allowed.	–

Table 3.8 (cont)

Island or Area	CRE-FMP	NWHI Reserve	USFWS	State/Commonwealth/Territory
FFS	No-take zone 0-50 fathoms.	RPA extends from the seaward boundary of Hawaii State waters (3nm) out to a mean depth of 100 fathoms. No fishing allowed.	HINWR to 10 fathoms. No fishing allowed.	State of Hawaii proposed NWHI Marine Fisheries Management Area (NWHI FMA) 0-3 miles.
Brooks Banks (2)	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms around three banks southeast of St. Rogatien including two Brooks Banks and one bank NW of St. Rogatien.	RPA to 12 nm from geographic center of southeast Brooks Bank, but not closer than 3 nm to the next bank west (northwest Brooks Bank). No fishing allowed.	HINWR 0 to 10 fathoms. No fishing allowed.	–
St. Rogatien Bank	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA to 12 nm from geographic center, but not closer than 3 nm to the next bank east. Bottomfish and recreational trolling for pelagics permitted.	HINWR 0 to 10 fathoms. No fishing allowed.	–
Unnamed bank between Gardner Pinnacles and St. Rogatien Bank	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA to 12 nm from geographic center. Bottomfish and recreational tolling for pelagics allowed for 5 years from order.	HINWR 0 to 10 fathoms. No fishing allowed.	–
Gardner Pinnacles	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA extends from the seaward boundary of Hawaii State waters (3nm) out to a mean depth of 100 fathoms. Bottomfish and recreational trolling for pelagics permitted seaward of 25 fathoms.	HINWR to 10 fathoms. No fishing allowed.	State of Hawaii proposed NWHI Marine Fisheries Management Area (NWHI FMA) 0-3 miles.

Table 3.8 (cont)

Island or Area	CRE-FMP	NWHI Reserve	USFWS	State/Commonwealth/Territory
Raita Bank	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA to 12 nm from geographic center. Bottomfish and recreational trolling for pelagics allowed for 5 years from order.	HINWR 0 to 10 fathoms. No fishing allowed.	–
Maro R.	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA extends from the seaward boundary of Hawaii State waters (3nm) out to a mean depth of 100 fathoms. Bottomfish and recreational trolling for pelagics permitted seaward of 25 fathoms.	HINWR to 10 fathoms. No fishing allowed.	State of Hawaii proposed NWHI Marine Fisheries Management Area (NWHI FMA) 0-3 miles.
Laysan I.	No-take zone 0-50 fathoms. (Crustaceans FMP: Lobster fishing prohibited to 20 nm from geographic center)	RPA extends from the seaward boundary of Hawaii State waters (3nm) out to a mean depth of 100 fathoms. Bottomfish and recreational trolling for pelagics permitted seaward of 50 fathoms.	HINWR to 10 fathoms. No fishing allowed.	State of Hawaii proposed NWHI Marine Fisheries Management Area (NWHI FMA) 0-3 miles.
Misc banks near (SW of) Laysan (4)	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	No current restrictions.	HINWR 0 to 10 fathoms. No fishing allowed.	–
Pioneer Bank	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	Preservation Area to 12 nm from geographic center. Bottomfish and recreational trolling for pelagics permitted.	HINWR 0 to 10 fathoms. No fishing allowed.	–

Table 3.8 (cont)

Island or Area	CRE-FMP	NWHI Reserve	USFWS	State/Commonwealth/Territory
Lisanski I.	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA extends from the seaward boundary of Hawaii State waters (3nm) out to a mean depth of 100 fathoms. Bottomfish and recreational trolling for pelagics permitted seaward of 25 fathoms.	HINWR to 10 fathoms. No fishing allowed.	State of Hawaii proposed NWHI Marine Fisheries Management Area (NWHI FMA) 0-3 miles.
Misc banks near (W of) Lisianski (2)	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	No current restrictions.	HINWR 0 to 10 fathoms. No fishing allowed.	–
Pearl and Hermes R.	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA extends from the seaward boundary of Hawaii State waters (3nm) out to a mean depth of 100 fathoms. No fishing allowed.	Hawaiian Islands NWR (HINWR) to 10 fathoms. No fishing allowed.	State of Hawaii proposed NWHI Marine Fisheries Management Area (NWHI FMA) 0-3 miles.
Misc. banks in the vicinity of Kure, Midway and Pearl and Hermes (4)	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	No current restrictions.	HINWR 0 to 10 fathoms. No fishing allowed.	–
Kure A.	No-take MPA in federal waters shallower than 10 fathoms. Low-use special permit zone 10-50 fathoms.	RPA extends from the seaward boundary of Hawaii State waters (3nm) out to a mean depth of 100 fathoms. No fishing allowed.	–	State of Hawaii Wildlife Refuge shoreline to 3 nm. Fishing not prohibited.

Table 3.8 (cont)

Island or Area	CRE-FMP	NWHI Reserve	USFWS	State/Commonwealth/Territory
American Samoa				
Rose Atoll	No-take zone 0-50 fathoms.	–	Rose Atoll NWR to 3 nm; no fishing allowed.	DOI has a cooperative agreement with the Territory of American Samoa to manage Rose Atoll as a national wildlife refuge and shares jurisdiction with DOC
Guam				
Ritadan Unit	–	–	Ritidian Unit to 100 foot contour. Recreational fishing allowed	–
CNMI	–	–	–	–

Table 3.9: Comparison of Resource Management Authorities and Fishery Management Measures for Coral Reef Ecosystems in Federal Waters of the Western Pacific Region.

NIHOA, NECKER, GARDNER, MARO, LISIANSKI (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
NWHI Coral Reef Ecosystem Reserve (Reserve) (Federal waters to 50 miles around all islands)	No fishing portion of RPA: Federal waters 0-25 fm.	No fishing.	None.
	Bottomfishing/trolling portion of RPA: Federal waters 25-100 fm.	Limited commercial bottomfishing by permit holders and limited commercial and recreational pelagic trolling (all subject to fishing caps based on catch history).	No anchoring in areas where mooring is available; no discharging of any material except cooling water or engine exhaust.
	Other Reserve waters: Federal waters 100 fm-50 miles.	Limited commercial and recreational fishing (all subject to fishing caps based on catch history).	No increase in level of effort or take; no change in gear type or species targeted.
CRE FMP Federal waters to 200 miles	No-take MPA: Federal waters 0-10 fm.	No fishing.	Insurance requirement.
	Low-use MPA: Federal waters 10-50 fm.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders.	CRE special permit needed to target any coral reef ecosystem resources, insurance requirement.
	Non-MPA: Federal waters 50 fm-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS Federal waters to 10 fathoms [0-20 at Necker]	Refuge: Federal waters 0-10 fathoms [0-20 at Necker].	Activities consistent with Refuge mission- no commercial fishing.	USFWS special use permit required to enter.

Distinguishing Characteristics (this is the most common scenario):

NWHI Reserve

Reserve Preservation Area (RPA)
No fishing RPA 0-25 fm
Fishing RPA 25-100 fm
Recreational fishing 100 fm - 50 miles

CRE FMP

Marine Protected Area (MPA)
No-take MPA 0-10 fm
Low-take MPA 10-50 fm
Non-MPA 50 fm-200 miles

USFWS

Refuge 0-10 fm, 0-20 fm at Necker (no fishing)

NIHOA, NECKER, GARDNER, MARO, LISIANSKI (details)			
Federal waters	**NWHI Reserve**	**CRE FMP**	**USFWS**
0-10 fathoms	No fishing (RPA).	No fishing, insurance requirement (No-take MPA).	No fishing (Refuge). Beyond 10 fathoms, no current restrictions.
10-25 fathoms	No fishing (RPA).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target <u>any</u> coral reef ecosystem resources, insurance requirement (Low-use MPA).	No fishing 0-20 fm at Necker (Refuge). Beyond 20 fm no current restrictions.
25-50 fathoms	Limited bottomfish and pelagic trolling by current permit holders; limited recreational trolling for pelagic (RPA).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target <u>any</u> coral reef ecosystem resources, insurance requirement (Low-use MPA).	No current restrictions.
50-100 fathoms	Limited bottomfish and pelagic trolling by current permit holders; limited recreational trolling for pelagic (RPA).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
100 fm-50 miles	Recreational fishing commercial fishing by bottomfish permit holders; all pelagic trollers (Reserve).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
50 - 200 miles	Outside of Reserve.	Lobster, bottomfish, precious corals, troll/handline and longline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.

FRENCH FRIGATE SHOALS (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
NWHI Coral Reef Ecosystem Reserve (Federal waters to 50 miles)	Entire no fishing RPAs: Federal waters 0-100 fm.	No fishing.	None.
	Other Reserve Areas: Federal waters 100 fm to 50 miles.	Limited commercial bottomfishing by permit holders and limited commercial and recreational pelagic trolling (all subject to fishing caps based on catch history).	No anchoring in areas where mooring is available; no discharging of any material except cooling water or engine exhaust.
CRE FMP Federal waters to 200 miles	No-take MPA: Federal waters 0-50 fm.	Limited commercial and recreational fishing (all subject to fishing caps based on catch history).	No increase in level of effort or take; no change in gear type or species targeted.
	Non-MPA: Federal waters 50 fm-50 miles.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
	Non-MPA: Federal waters 50-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS Federal waters to 10 fathoms	Refuge: Federal waters 0-10 fm.	Activities consistent with Refuge mission-no commercial fishing.	USFWS special use permit required to enter.

Distinguishing characteristics:

CRE FMP

(1) No-take MPA from 0-50 fathoms.

NWHI Reserve

(2) No fishing RPAs extend from 0-100 fathoms.

FRENCH FRIGATE SHOALS (details)			
Federal waters	**NWHI Reserve**	**CRE FMP**	**USFWS**
0-10 fathoms	No fishing (RPA).	No fishing, insurance requirement (No-take MPA).	No fishing (Refuge).
10-50 fathoms	No fishing (RPA).	No fishing, insurance requirement (No-take MPA).	No current restrictions beyond 10 fm.
50-100 fathoms	No fishing (RPA).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
100 fm-50 miles	Recreational fishing, commercial fishing by bottomfish permit holders, and all pelagic trollers (Reserve).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
50 - 200 miles	Outside of Reserve.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.

S.E. BROOKS BANK, 1ST BANK EAST OF FFS, ST. ROGATIEN, 1ST BANK WEST OF ST. ROGATIEN*, RAITA*, PIONEER (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
NWHI Coral Reef Ecosystem Reserve (Federal waters to 50 miles around all islands)	Bottomfishing/trolling RPA: Federal waters 0 - 12 miles. (All fishing is prohibited within 12 miles around S.E. Brooks Banks, and the 1st bank west of FFS).	Limited commercial bottomfishing by permit holders and limited commercial and recreational pelagic trolling (all subject to fishing caps based on catch history).	No anchoring in areas where mooring is available; no discharging of any material except cooling water or engine exhaust.
	Other Reserve waters: Federal waters 12-50 miles.	Limited commercial and recreational fishing (all subject to fishing caps based on catch history).	No increase in level of effort or take; no change in gear type or species targeted.
CRE FMP Federal waters to 200 miles	No-take MPA: Federal waters 0-10 fm.	No fishing.	Insurance requirement.
	Low-use MPA: Federal waters 10-50 fm.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders.	CRE special permit needed to target <u>any</u> coral reef ecosystem resources, insurance requirement.
	Non-MPA: Federal waters 50 fm-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS Federal waters to 10 fathoms	Refuge: Federal waters 0-10 fm.	Activities consistent with Refuge mission- no commercial fishing.	USFWS special use permit required to enter.

Distinguishing characteristics:

<u>NWHI Reserve</u>

(1) The NWHI EO fishing RPA extends from 0-12 miles;
(2) All fishing is prohibited within 12 miles around S.E. Brooks Banks, and the 1st bank east of FFS.

* Under the NWHI EO, the fishing RPAs at these banks will be reviewed after five years.

S.E. BROOKS BANK, 1ST BANK EAST OF FFS, ST. ROGATIEN, 1ST BANK WEST OF ST. ROGATIEN, RAITA, PIONEER (details)			
Federal waters	**NWHI Reserve**	**CRE FMP**	**USFWS**
0-10 fathoms	Limited bottomfish and pelagic trolling by current permit holders; limited recreational trolling for pelagic (RPA).	No fishing, insurance requirement (No-take MPA).	No fishing (Refuge).
10 - 50 fathoms	Limited bottomfish and pelagic trolling by current permit holders; limited recreational trolling for pelagic (RPA).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target <u>any</u> coral reef ecosystem resources, insurance requirement (Low-use MPA).	No current restrictions beyond 10 fm.
50 fm-12 miles	Limited bottomfish and pelagic trolling by current permit holders; limited recreational trolling for pelagic (RPA).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
12 - 50 miles	Recreational fishing, commercial fishing by bottomfish permit holders, and all pelagic trollers (Reserve).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
50 - 200 miles	Outside of Reserve.	Lobster, bottomfish, precious corals, troll/handline and longline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.

Note: All fishing is prohibited within 12 miles around S.E. Brooks Banks, and the 1st bank east of FFS.

LAYSAN (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
NWHI Coral Reef Ecosystem Reserve (Federal waters to 50 miles around all islands)	No fishing portion of RPA: Federal waters 0-50 fm.	No fishing.	None.
	Bottomfishing/trolling portion of RPA: Federal waters 50-100 fm.	Limited commercial bottomfishing by permit holders and limited commercial and recreational pelagic trolling (all subject to fishing caps based on catch history).	No anchoring in areas where mooring is available; no discharging of any material except cooling water or engine exhaust.
	Other Reserve waters: Federal waters 100 fm-50 miles.	Limited commercial and recreational fishing (all subject to fishing caps based on catch history).	No increase in level of effort or take; no change in gear type or species targeted.
CRE FMP Federal waters to 200 miles	No-take MPA: Federal waters 0-50 fm.	No fishing.	Insurance requirement.
	Non-MPA Federal waters 50 fm-20 miles.	Bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders (no lobster fishing).	CRE special permit needed to target potentially harvested coral reef taxa.
	Non-MPA: Federal waters 50 fm-50 miles.	Lobster*, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
	Non-MPA: Federal waters 50-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS Federal waters to10 fathoms	Refuge: Federal waters 0-10 fm.	Activities consistent with Refuge mission- no commercial fishing.	USFWS special use permit required to enter.

Distinguishing characteristics:

<u>**CRE FMP**</u>

(1) no-take MPA from 0-50 fathoms.

(2) *Crustacean FMP prohibits lobster fishing from 0- 20 miles.

<u>**USFWS**</u>

(1) assert HINWR also includes State waters 0-10 fm.

LAYSAN (details)			
Federal waters	**NWHI Reserve**	**CRE FMP**	**USFWS**
0-10 fathoms	No fishing (RPA).	No fishing, insurance requirement (No-take MPA).	No fishing (Refuge).
10-50 fathoms	No fishing (RPA).	No fishing, insurance requirement (No-take MPA).	No current restrictions beyond 10 fm.
50-100 fathoms	Limited bottomfish and pelagic trolling by current permit holders; limited recreational trolling for pelagic (RPA).	Bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
100 fm-50 miles	Recreational fishing, commercial fishing by bottomfish permit holders, and all pelagic trollers (Reserve).	Lobster*, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
50 - 200 miles	Outside of Reserve.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.

*Crustacean FMP prohibits lobster fishing from 0- 20 miles at Laysan.

PEARL & HERMES REEF (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
NWHI Coral Reef Ecosystem Reserve (Federal waters to 50 miles)	Entire no fishing RPA: Federal waters 0-100 fm.	No fishing.	None.
	Other Reserve waters: Federal waters 100 fm-50 miles.	Limited commercial and recreational fishing (all subject to fishing caps based on catch history).	No increase in level of effort or take; no change in gear type or species targeted.
CRE FMP Federal waters to 200 miles	No-take MPA: Federal waters 0-10 fm.	No fishing.	Insurance requirement.
	Low-use MPA: Federal waters 10-50 fm.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders.	CRE special permit needed to target any coral reef ecosystem resources, insurance requirement.
	Non-MPA: Federal waters 50 fm-50 miles.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
	Non-MPA: Federal waters 50-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS Federal waters to 10 fathoms	Refuge: Federal waters 0-10 fm.	Activities consistent with Refuge mission- no commercial fishing.	USFWS special use permit required to enter.

Distinguishing characteristics:

NWHI Reserve

(1) No fishing RPAs extend from 0-100 fathoms.

PEARL & HERMES REEF (details)			
Federal waters	**NWHI Reserve**	**CRE FMP**	**USFWS**
0-10 fathoms	No fishing (RPA).	No fishing, insurance requirement (No-take MPA).	No fishing (Refuge).
10-50 fathoms	No fishing (RPA).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target <u>any</u> coral reef ecosystem resources, insurance requirement (Low-use MPA).	No current restrictions beyond 10 fathoms.
50-100 fathoms	No fishing (RPA).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa , insurance requirement (Non-MPA).	No current restrictions.
100 fm-50 miles	Recreational fishing, commercial fishing by bottomfish permit holders, and all pelagic trollers (Reserve).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
50 - 200 miles	Outside of Reserve.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.

MIDWAY (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
NWHI Coral Reef Ecosystem Reserve (0-50 miles around all islands)	Midway Atoll NWR: approximately 22 x 22 miles around islands (not part of Reserve).	No restrictions.	None.
	Other Reserve waters: Federal waters approximately 22-50 miles.	Limited commercial and recreational fishing (all subject to fishing caps based on catch history).	No increase in level of effort or take; no change in gear type or species targeted.
CRE FMP 0 - 200 miles	No-take MPA: 0-50 fm in northern half of Refuge waters.	No fishing.	Insurance requirement.
	Low-use MPA: 0-50 fm in southern half of Refuge waters.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders.	CRE special permit needed to target <u>any</u> coral reef ecosystem resources - will be issued for recreational fishing for on-island consumption only, insurance requirement.
	Non-MPA: 50 fm-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permits.	CRE special permit needed to target potentially harvested coral reef taxa, insurance requirement.
USFWS approximately 22 x 22 mile square around islands	Refuge: approximately 22 x 22 miles around Midway.	Pelagic and lobster recreational and charter fishing permitted within refuge boundaries.	One lobster per person/day, all other catch and release unless record setting, USFWS special use permit required to enter.

Distinguishing characteristics:

<u>USFWS</u>

(1) Refuge waters extend to 22 miles x 22 miles delineated by specific latitude/longitude coordinates;
(2) Midway Atoll NWR not included as part of the NWHI CRE Reserve;
(3) No State claims to territorial waters.

MIDWAY (details)			
Waters	**NWHI Reserve**	**CRE FMP**	**USFWS**
0-50 fathoms in northern half of Refuge waters	No restrictions.	No fishing, insurance requirement (No-take MPA).	Pelagic and lobster recreational and charter fishing (Refuge).
0-50 fathoms in southern half of Refuge waters	No restrictions.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target any coral reef ecosystem resources - will be issued for recreational fishing for on-island consumption only, insurance requirement (Low-use MPA).	Pelagic and lobster recreational and charter fishing (Refuge).
50 fm - 22 miles	No restrictions.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	Pelagic and lobster recreational and charter fishing (Refuge).
22-50 miles	Recreational fishing, commercial fishing by bottomfish permit holders, and all pelagic trollers (Reserve).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	Outside of Refuge.
22 - 200 miles	No restrictions.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	Outside of Refuge.

KURE (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
NWHI Coral Reef Ecosystem Reserve (Federal waters to 50 miles around all islands)	Entire no fishing RPA: Federal waters 0 - 100 fm.	No fishing.	None.
	Other Reserve waters: Federal waters 100 fm-50 miles.	Limited commercial and recreational fishing (all subject to fishing caps based on catch history).	No increase in level of effort or take; no change in gear type or species targeted.
CRE FMP Federal waters to 200 miles	No-take MPA: Federal waters 0-10 fm.	No fishing.	Insurance requirement.
	Low-use MPA: Federal waters 10-50 fm.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders.	CRE special permit needed to target any coral reef ecosystem resources, insurance requirement.
	Non-MPA: Federal waters 50 fm-50 miles.	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
	Non-MPA: Federal waters 50-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS None	None.	No restrictions.	No restrictions.
State of Hawaii 0-3 miles	State Wildlife refuge: 0-3 miles from shore.	Fishing with a NWHI Taking Permit.	Hand harvest of lobsters permitted.

Distinguishing characteristics:

State of Hawaii

(1) Kure Atoll State Wildlife refuge, 0-3 miles.

KURE (details)			
Waters	**NWHI Reserve**	**CRE FMP**	**State of HI**
0-3 miles	Not part of Reserve.	No restrictions.	NWHI Taking Permit requirement.
0-10 fathoms (outside of state waters)	No fishing (RPA).	No fishing, insurance requirement (No-take MPA).	No current restrictions.
10-50 fathoms (outside of state waters)	No fishing (RPA).	Lobster, bottomfish, precious corals, troll/handline pelagic fishing by other FMP permit holders, CRE special permit needed to target any coral reef ecosystem resources, insurance requirement (Low-use MPA).	No current restrictions.
50 - 100 fm (outside of state waters)	No fishing (RPA).	Lobster, bottomfish, precious corals, troll/handline and longline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
100 fm-50 miles (outside of state waters)	Recreational fishing, commercial fishing by bottomfish permit holders, and all pelagic trollers (Reserve).	Lobster, bottomfish, precious corals, troll/handline and longline pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.
50 - 200 miles	Outside of Reserve.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No current restrictions.

Howland, Baker, Jarvis and Kingman Reef (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
CRE FMP 0 - 200 miles	No-take MPA: 0-50 fm.	No fishing.	Insurance requirement.
	Non-MPA: 50 fm-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS 0 - 3 miles (0-12 miles at Kingman Reef)	Refuge: 0-3 miles 0-12 miles (Kingman).	Activities consistent with Refuge mission - no commercial fishing.	USFWS special use permit required to enter.

Howland, Baker, Jarvis and Kingman Reef (details)		
Waters	**CRE FMP**	**FWS**
0-50 fathoms	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target <u>any</u> coral reef ecosystem resources will be issued for recreational fishing for on-island consumption only, insurance requirement (Low-use MPA).	No fishing (Refuge).
50 fm - 3 miles	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target <u>potentially harvested coral reef taxa</u> (Non-MPA).	No fishing (Refuge).
3-12 miles	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target <u>potentially harvested coral reef taxa</u> (Non-MPA).	No fishing (Kingman Reef NWR only).
12 - 200 miles	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target <u>potentially harvested coral reef taxa</u> (Non-MPA).	Outside of Refuge.

PALMYRA (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
CRE FMP 0 - 200 miles	Low-use MPA: 0-50 fm.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target any coral reef ecosystem resources - will be issued for recreational fishing for on-island consumption only, insurance requirement.
	Non-MPA: 50 fm-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS 0 - 12 miles	Refuge: 0-12 miles.	Activities consistent with Refuge mission- no commercial fishing.	USFWS special use permit required to enter.

Distinguishing characteristics:

CRE FMP Low-use MPA 0-50 fathoms, harvest of CRE species w/special permit for recreational fishing for on island consumption only.

PALMYRA (details)		
Waters	**CRE FMP**	**FWS**
0-50 fathoms	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target any coral reef ecosystem resources will be issued for recreational fishing for on-island consumption only, insurance requirement (Low-use MPA).	No commercial fishing (Refuge).
50 fm - 12 miles	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No commercial fishing (Refuge).
12 - 200 miles	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	Outside of Refuge.

Johnston and Wake Atoll (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
CRE FMP 0 - 200 miles	Low-use MPA: 0-50 fm.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target <u>any</u> coral reef ecosystem resources - will be issued for recreational fishing for on-island consumption only, insurance requirement.
	Non-MPA: 50 fm-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS 0 - 3 miles	Refuge: 0-3 miles.	Recreational fishing, activities consistent with Refuge mission- no commercial fishing.	USFWS special use permit required to enter.

Distinguishing characteristics:

CRE FMP Low-use MPA 0-50 fathoms, harvest of CRE species w/special permit for recreational fishing for on island consumption only

Johnston and Wake Atoll (details)		
Waters	**CRE FMP**	**FWS**
0-50 fathoms	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target <u>any</u> coral reef ecosystem resources will be issued for recreational fishing for on-island consumption only, insurance requirement (Low-use MPA).	No commercial fishing at Johnston Atoll (Refuge).
50 fm - 3 miles	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No commercial fishing at Johnston Atoll (Refuge).
3 - 200 miles	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	Outside of Refuge.

AMERICAN SAMOA (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
Government of American Samoa (Territorial waters 0-3 miles)	None.	Local regulations.	None.
CRE FMP Federal waters to 200 miles	No-take MPA: Federal waters 0-50 fathoms around Rose Atoll.	No fishing.	Insurance requirement.
	Non-MPA: Federal waters 3-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
USFWS Cooperative Agreement with American Samoa (0-3 miles at Rose Atoll NWR)	Refuge: (1) The area inside of the extreme low-water line around the seaward side of the atoll reef; (2) The lands and waters from the Refuge boundary out to 3 miles.	No fishing.	USFWS special use permit required to enter.

Distinguishing characteristics:

The USFWS has a cooperative agreement with the Territory of American Samoa to manage Rose Atoll as a National Wildlife Refuge, and the submerged lands and waters out to 3 miles around the refuge. MSFCMA jurisdiction begins at the shoreline at Rose Atoll. Under the CRE-FMP Rose Atoll is designated as a no-take MPA from 0-50 fathoms.

AMERICAN SAMOA (details)			
Waters	**GOV'T OF American SAMOA**	**CRE FMP**	**USFWS**
0-3 miles (except at Rose Atoll)	Local regulations.	No restrictions.	-
3-200 miles	No restrictions.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	-
0-50 fathoms around Rose Atoll	No fishing.	No fishing, insurance requirement (no-take MPA).	No fishing (Refuge).
50 fm-3 miles around Rose Atoll	No fishing.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No fishing (Refuge).

COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
CRE FMP 0-200 miles	Non-MPA: 0-3 miles.	No restrictions.	None.
	Non-MPA: 3-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.

Distinguishing characteristics:

There are no "state" (territorial) waters around CNMI. However, the CRE FMP will not impose any management measures within 0-3 miles from shore.

COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS (details)	
Federal waters	**CRE FMP**
0-3 miles	No restrictions (Non-MPA).
3-200 miles	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).

GUAM (summary)			
Authority Jurisdiction	**Subareas**	**Permitted activities**	**Special restrictions**
Government of Guam 0-3 miles	None.	Local regulations.	None.
CRE FMP Federal waters to 200 miles	Non-MPA: Federal waters 3-200 miles.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa.
	Non-MPA: Guam's Southern Banks.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders.	CRE special permit needed to target potentially harvested coral reef taxa , no anchoring by vessels greater than 50' in length.
USFWS Federal waters to 100 ft at Ritidian	Refuge: Federal waters 0-100 foot isobath.	Recreational fishing.	USFWS special permit required to enter.

Distinguishing characteristics:

There are no CRE MPAs around Guam, but there is an anchoring restriction for the Southern Banks for vessels larger than 50 ft in length.

GUAM (details)			
Federal Waters	**GOV'T OF GUAM**	**CRE FMP**	**USFWS**
0-3 miles	Local regulations.	No restrictions.	None.
0-10 fathoms (at Ritidian, outside of Guam waters)	No restrictions.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	No commercial fishing (Refuge).
10 fathoms-200 miles (outside of Guam waters)	No restrictions.	Lobster, bottomfish, precious corals, pelagic fishing by other FMP permit holders, CRE special permit needed to target potentially harvested coral reef taxa (Non-MPA).	-