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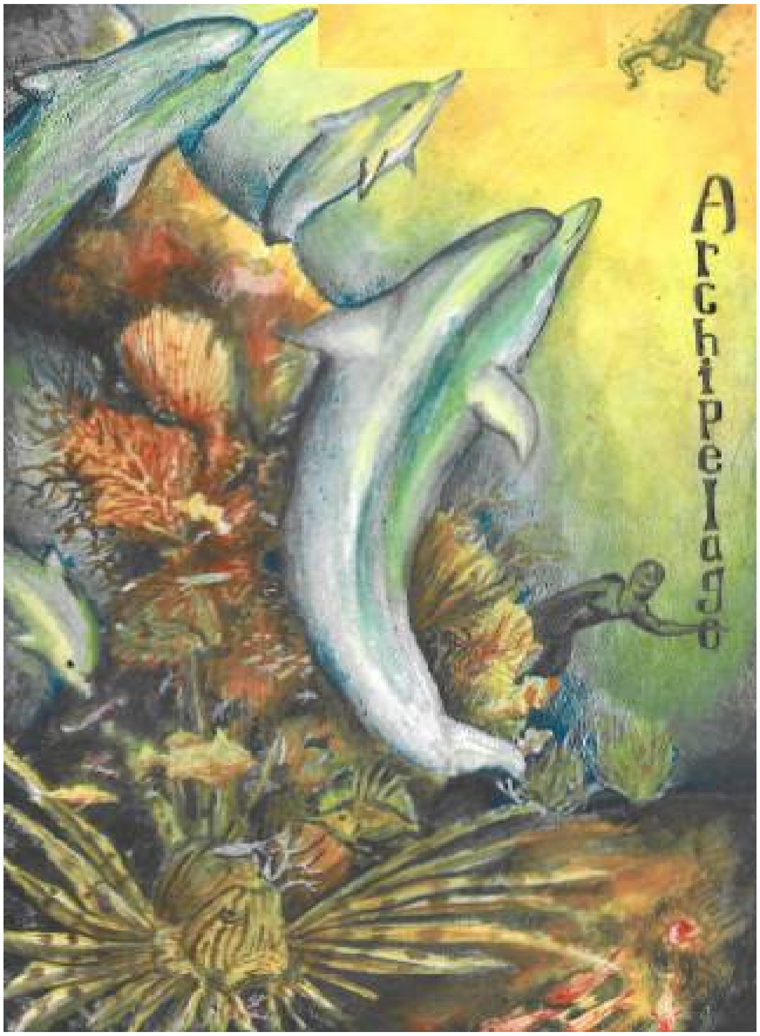
COUNCIL

Fishery Ecosystem Plan for the Hawaii Archipelago



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EXECUTIVE SUMMARY

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) authorizes fishery management councils to create fishery management plans (FMP). The Western Pacific Regional Fishery Management Council developed this Fishery Ecosystem Plan (FEP) as an FMP, consistent with the MSA and the national standards for fishery conservation and management. The FEP represents the first step in an incremental and collaborative approach to implement ecosystem approaches to fishery management in the Hawaiian Archipelago. Since the 1980s, the Council has managed fisheries throughout the Western Pacific Region through separate species-based fishery management plans (FMP) – the Bottomfish and Seamount Groundfish FMP (WPRFMC 1986a), the Crustaceans FMP (WPRFMC 1981), the Precious Corals FMP (WPRFMC 1979), the Coral Reef Ecosystems FMP (WPRFMC 2001) and the Pelagic FMP (WPRFMC 1986b).

However, the Council is now moving towards an ecosystem-based approach to fisheries management and is restructuring its management framework from species-based FMPs to place-based FEPs. Recognizing that a comprehensive ecosystem approach to fisheries management must be initiated through an incremental, collaborative, and adaptive management process, a multi-step approach is being used to develop and implement the FEPs. To be successful, this will require increased understanding of a range of issues including biological and trophic relationships, ecosystem indicators and models, and the ecological effects of non-fishing activities on the marine environment.

The Hawaii Archipelago FEP establishes the framework under which the Council will manage fishery resources, and begin the integration and implementation of ecosystem approaches to management in the Hawaii Archipelago. This FEP does not establish any new fishery management regulations at this time, but rather consolidates existing fishery regulations for demersal species. Specifically, this FEP identifies as management unit species those current management unit species known to be present in waters around the Hawaii Archipelago and incorporates all of the management provisions of the Bottomfish and Seamount Groundfish FMP, the Crustaceans FMP, the Precious Corals FMP, and the Coral Reef Ecosystems FMP that are applicable to the area. Although pelagic fishery resources play an important role in the biological as well as the socioeconomic environment of these islands, they will be managed separately through the Pacific Pelagic FEP.

In 1998, the U.S. Congress charged the National Marine Fisheries Service (NMFS, also known as NOAA Fisheries Service), with the establishment of an Ecosystem Principles Advisory Panel (EPAP), which was responsible for assessing the extent that ecosystem principles were being used in fisheries management and research, and recommending how to further the use of ecosystem pricipals to improve the status and management of marine resources. The EPAP (1999) reached consensus that FEPs should be developed and implemented to manage U.S. fisheries and marine resources. According to the EPAP, a FEP should contain and implement a management framework to control harvests of marine resources on the basis of available information regarding the structure and function of the ecosystem in which such harvests occur. The EPAP constructed eight ecosystem principles that it believes to be important to the successful management of marine ecosystems. These were recognized and used as a guide by the Council in developing this FEP. The principles are as follows:

- The ability to predict ecosystem behavior is limited.
- Ecosystems have real thresholds and limits that, when exceeded, can affect major system restructuring.
- Once thresholds and limits have been exceeded, changes can be irreversible.
- Diversity is important to ecosystem functioning.
- Multiple scales interact within and among ecosystems.
- Components of ecosystems are linked.
- Ecosystem boundaries are open.
- Ecosystems change with time.

The National Oceanic and Atmospheric Administration (NOAA) defines an ecosystem approach as "management that is adaptive, specified geographically, takes account of ecosystem knowledge and uncertainties, considers multiple external influences, and strives to balance diverse social objectives." In addition, because of the wide ranging nature of ecosystems, successful implementation of ecosystem approaches will need to be incremental and collaborative (NOAA 2004).

The overall goal of the Hawaii Archipelago FEP is to establish a framework under which the Council will improve its abilities to realize the goals of the MSA through the incorporation of ecosystem science and principles. To achieve this goal, the Council has adopted the following ten objectives for the Hawaii Archipelago FEP:

Objective 1: To maintain biologically diverse and productive marine ecosystems and foster the long-term sustainable use of marine resources in an ecologically and culturally sensitive manner through the use of a science-based ecosystem approach to resource management.

Objective 2: To provide flexible and adaptive management systems that can rapidly address new scientific information and changes in environmental conditions or human use patterns.

Objective 3: To improve public and government awareness and understanding of the marine environment in order to reduce unsustainable human impacts and foster support for responsible stewardship.

Objective 4: To encourage and provide for the sustained and substantive participation of local communities in the exploration, development, conservation, and management of marine resources.

Objective 5: To minimize fishery bycatch and waste to the extent practicable.

Objective 6: To manage and comanage protected species, protected habitats, and protected areas.

Objective 7: To promote the safety of human life at sea.

Objective 8: To encourage and support appropriate compliance and enforcement with all applicable local and federal fishery regulations.

Objective 9: To increase collaboration with domestic and foreign regional fishery management and other governmental and non-governmental organizations, communities, and the public at large to successfully manage marine ecosystems.

Objective 10: To improve the quantity and quality of available information to support marine ecosystem management.

This document discusses the key components of the Hawaii Archipelago ecosystem, including an overview of the region's non-pelagic fisheries, and details how the measures contained here are consistent with the MSA and other applicable laws. This FEP, in conjunction with the Council's American Samoa Archipelago, Mariana Archipelago, Pacific Remote Island Areas, and Pacific Pelagic FEPs, incorporates by reference and replaces the Council's existing Bottomfish and Seamount Groundfish, Crustaceans, Precious Corals, Coral Reef Ecosystems and Pelagics Fishery Management Plans (and their amendments) and reorganizes their associated regulations into a place-based structure aligned with the FEPs.In addition, under the Hawaii Archipelago FEP, the organizational structure for developing and implementing Fishery Ecosystem Plans explicitly incorporates community input and local knowledge into the management process.

Future fishery management actions are anticipated to incorporate additional information as it becomes available. An adaptive management approach will be used to further advance the implementation of ecosystem science and principles. Such actions would be taken in accordance with the Magnuson-Stevens Fishery Conservation and Management Act, the National Environmental Policy Act, the Endangered Species Act, the Marine Mammal Protection Act, and other applicable laws and statutes.

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ACRONYMS

APA:	Administrative Procedure Act
B:	Stock Biomass
B_{FLAG}:	Minimum Biomass Flag
B_{MSY}:	Biomass Maximum Sustainable Yield
B_{OY}:	Biomass Optimum Yield
BMUS:	Bottomfish Management Unit Species
CFR:	Code of Federal Regulations
CITES:	Council on International Trade and Endangered Species
cm:	centimeters
CNMI:	Commonwealth of the Northern Mariana Islands
CPUE:	Catch per Unit Effort
$CPUE_{MSY}$:	Catch per unit effort Maximum Sustainable Yield
$CPUE_{REF}$:	Catch per unit effort at the Reference Point
CRAMP:	Coral Reef Assessment and Monitoring Program
CRE:	Coral Reef Ecosystem
CRE-FMP:	Coral Reef Ecosystem Fishery Management Plan
CRTF:	Coral Reef Task Force
CZMA:	Coastal Zone Management Act
DAR:	Division of Aquatic Resources, Government of Hawaii
DBEDT:	Department of Business, Economic Development and Tourism, State of Hawaii
DLNR:	Department of Land and Natural Resources, Government of Hawaii
DOC:	United States Department of Commerce
DOD:	United States Department of Defense
DOI:	United States Department of the Interior
EEZ:	Exclusive Economic Zone
EFH:	Essential Fish Habitat
EIS:	Environmental Impact Statement
E_{MSY}:	Effort Maximum Sustainable Yield
ENSO:	El Niño Southern Oscillation
EO:	Executive Order
EPAP:	Ecosystem Principals Advisory Panel
ESA:	Endangered Species Act
F:	Fishing mortality
F_{MSY}:	Fishing mortality Maximum Sustainable Yield
F_{OY}:	Fishing mortality Optimum Yield
FEP:	Fishery Ecosystem Plan
FDM:	Farallon de Medinilla, CNMI
FEP:	Fishery Ecosystem Plan
FFS:	French Frigate Shoals
FLPMA:	Federal Land Policy and Management Act
fm:	fathoms
FMP:	Fishery Management Plan
FR:	Federal Register

FRFA:	Final Regulatory Flexibility Analysis
FWCA:	Fish and Wildlife Coordination Act
GIS:	Geographic information systems
GPS:	Global Positioning System
HAPC:	Habitat Areas of Particular Concern
HCRI:	Hawaii Coral Reef Initiative Research Program
HINWR:	Hawaiian Islands National Wildlife Refuge
HIR:	Hawaiian Islands Reservation
HMSRT	Hawaiian Monk Seal Recovery Team
IRFA	Initial Regulatory Flexibility Analysis
kg:	kilograms
km:	kilometers
LOF	List of Fisheries
LORAN	Long Range Aid to Navigation
m:	meters
mt:	metric tons
MFMT:	Maximum Fishing Mortality Threshold
MHI:	Main Hawaiian Islands
mm:	millimeters
MMPA:	Marine Mammal Protection Act
MPA:	Marine Protected Area
MSA:	Magnuson-Stevens Fisheries Conservation and Management Act
MSST:	Minimum Stock Size Threshold
MSY:	Maximum Sustainable Yield
MUS:	Management Unit Species
NDSA:	Naval Defense Sea Areas
NEPA:	National Environmental Policy Act
nm or nmi:	nautical miles
NMFS:	National Marine Fisheries Service (also known as NOAA Fisheries Service)
NOAA:	National Oceanic and Atmospheric Administration
NWHI:	Northwestern Hawaiian Islands
NWR:	National Wildlife Refuge
NWRSAA:	National Wildlife Refuge System Administration Act
OMB:	Office of Management and Budget
OY:	Optimum Yield
PBR:	Potential Biological Removal
PIFSC:	Pacific Islands Fisheries Science Center, NMFS
PIRO:	Pacific Islands Regional Office, NMFS
PRA:	Paperwork Reduction Act
PRIA:	Pacific Remote Island Areas
RFA:	Regulatory Flexibility Act
RIR:	Regulatory Impact Review
SFA:	Sustainable Fisheries Act
SLA:	Submerged Lands Act
SPR:	Spawning Potential Ratio
SWR:	State Wildlife Refuge

SSC:	Scientific and Statistical Committee
TALFF:	Total Allowable Level of Foreign Fishing
TSLA:	Territorial Submerged Lands Act
USCG:	United States Coast Guard
USFWS:	United States Fish and Wildlife Service
VMS:	Vessel Monitoring System
WPacFIN:	Western Pacific Fisheries Information Network, NMFS
WPRFMC	Western Pacific Regional Fishery Management Council

DEFINITIONS

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

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

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

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

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

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

Consensual Management: Decision making process where stakeholders meet and reach consensus on management measures and recommendations.

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

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

Critical Habitat: Those geographical areas that are essential for bringing an endangered or threatened species to the point where it no longer needs the legal protections of the Endangered Species Act (ESA), and which may require special management considerations or protection. These areas are designated pursuant to the ESA as having physical or biological features essential to the conservation of listed species.

Dealer: One who (1) Obtains, with the intention to resell management unit species, or portions thereof, that were harvested or received by a vessel that holds a permit or is otherwise regulated; or (2) Provides recordkeeping, purchase, or sales assistance in obtaining or selling such management unit species (such as the services provided by a wholesale auction facility).

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

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

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

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

Ecosystem: A geographically specified system of organisms (including humans), the environment, and the processes that control its dynamics.

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

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

Environmental Impact Statement (EIS): A document required under the National Environmental Policy Act (NEPA) to assess alternatives and analyze the impact on the environment of proposed major Federal actions significantly affecting the human environment.

Essential Fish Habitat (EFH): Those waters and substrate necessary to a species or species group or complex, for spawning, breeding, feeding or growth to maturity.

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

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

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

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

Fishery Ecosystem Plan: A fishery ecosystem management plan that contains conservation and management measures necessary and appropriate for fisheries within a given ecosystem to prevent overfishing and rebuild overfished stocks, and to protect, restore, and promote the long-term health and stability of the fishery.

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

Fishing Community: A community that is substantially dependent on or substantially engaged in the harvest or processing of fishery resources to meet social and economic needs and includes fishing vessel owners, operators and crews and United States fish processors that are based in such community.

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

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

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

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

Habitat Area of Particular Concern (HAPC): Those areas of EFH identified pursuant to Section 600.815(a)(8). In determining whether a type or area of EFH should be designated as a HAPC, one or more of the following criteria should be met: (1) ecological function provided by the habitat is important; (2) habitat is sensitive to human-induced environmental degradation; (3) development activities are, or will be, stressing the habitat type; or (4) the habitat type is rare.

Harvest: The catching or taking of a marine organism or fishery MUS by any means.

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

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

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

Low-Use MPA: A Marine Protected Area zoned to allow limited fishing activities.

Main Hawaiian Islands (MHI): The islands of the Hawaiian islands archipelago consisting of Niihau, Kauai, Oahu, Molokai, Lanai, Maui, Kahoolawe, Hawaii and all of the smaller associated islets lying east of 161° W longitude.

Marine Protected Area (MPA): An area designated to allow or prohibit certain fishing activities.

Maximum Sustainable Yield (MSY): The largest long-term average catch or yield that can be taken from a stock or stock complex under prevailing ecological and environmental conditions, fishery technological characteristics (e.g., gear slectivity), and distribution of catch among fleets.

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

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

Northwestern Hawaiian Islands (NWHI): The islands of the Hawaii Archipelago lying to the west of 161° W longitude.

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

Overfished: A stock or stock complex is considered "overfished" when its biomass has declined below a level that jeopardizes the capacity of the stock or stock complex to produce maximum sustainable yield on a continuing basis.

Overfishing: (to overfish) occurs whenever a stock or stock complex is subjected to a level of fishing mortality or total annual catch that jeopardizes the capacity of a stock or stock complex to produce maximum sustainable yield on a continuing basis.

Pacific Remote Island Areas (PRIA): Baker Island, Howland Island, Jarvis Island, Johnston Atoll, Kingman Reef, Midway Atoll, Wake Island and Palmyra Atoll.

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

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

Recreational Fishing: Fishing for sport or pleasure.

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

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

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

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

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

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

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

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

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

Secretary: The Secretary of Commerce or a designee.

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

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

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

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

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

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

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

Subsistence Fishing: Fishing to obtain food for personal and/or community use rather than for profit sales or recreation.

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

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

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

Western Pacific Regional Fishery Management Council (WPRFMC or Council): A Regional Fishery Management Council established under the MSA, consisting of the State of Hawaii, the Territory of American Samoa, the Territory of Guam, and the Commonwealth of the Northern Mariana Islands which has authority over the fisheries in the Pacific Ocean seaward of such States, Territories, Commonwealths, and Possessions of the United States in the Pacific Ocean Area. The Council has 13 voting members including eight appointed by the Secretary of Commerce at least one of whom is appointed from each of the following States: Hawaii, the Territories of American Samoa and Guam, and the Commonwealth of the Northern Mariana Islands.

CHAPTER 1: INTRODUCTION

1.1 Introduction

In 1976, the United States Congress passed the Magnuson Fishery Conservation and Management Act, which was subsequently twice reauthorized as the Magnuson–Stevens Fishery Conservation and Management Act (MSA). Under the MSA, the United States (U.S.) has exclusive fishery management authority over all fishery resources found within its Exclusive Economic Zone (EEZ). For purposes of the MSA, the inner boundary of the U.S. EEZ extends from the seaward boundary of each coastal state to a distance of 200 nautical miles from the baseline from which the breadth of the territorial sea is measured. The Western Pacific Regional Fishery Management Council (Council) has authority over the fisheries based in, and surrounding, the State of Hawaii, the Territory of American Samoa, the Territory of Guam, the Commonwealth of the Northern Mariana Islands, and the U.S. Pacific Remote Island Areas (PRIA) of the Western Pacific Region (Figure 1). [1]

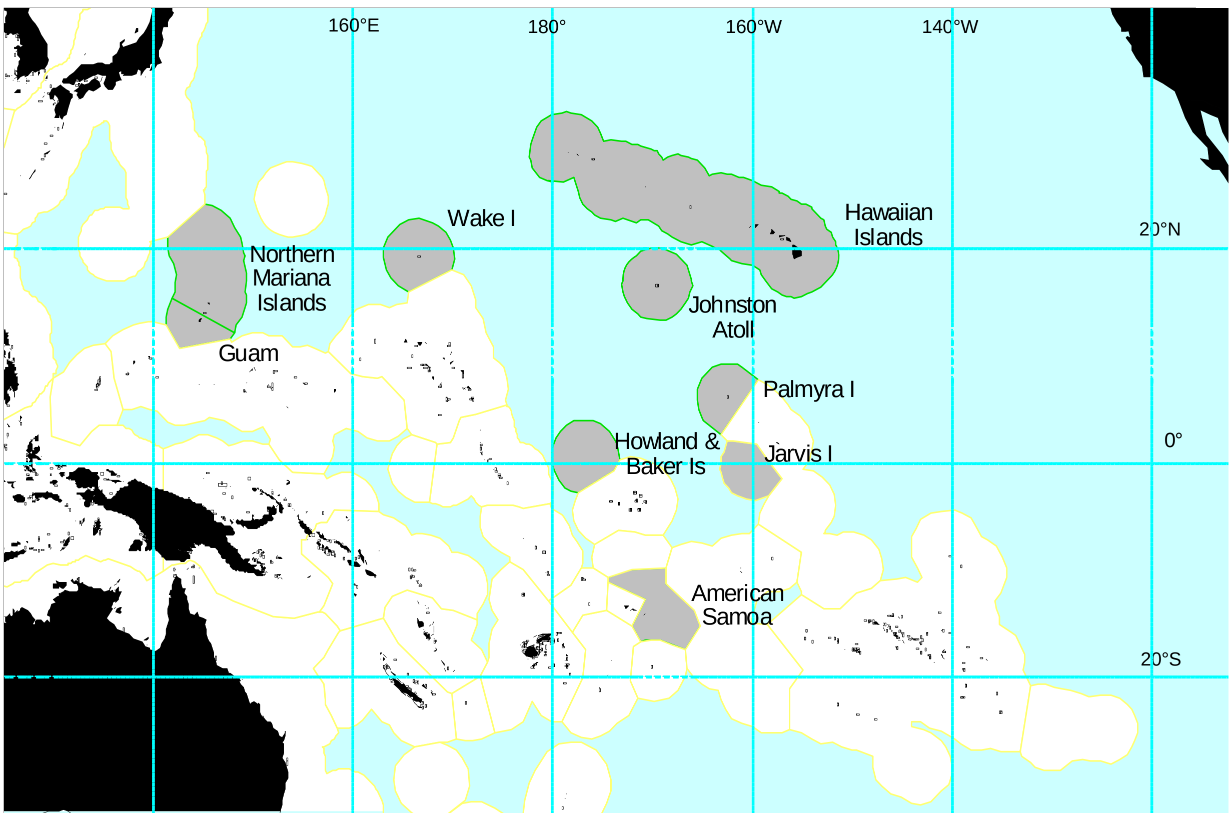

Figure 1: Western Pacific Region

[1] The Pacific Remote Island Areas comprise Baker Island, Howland Island, Jarvis Island, Johnston Atoll, Kingman Reef, Wake Island, Palmyra Atoll, and Midway Atoll. Although physically located in the Hawaii Archipelago, administratively, Midway is considered part of the PRIA because it is not a part of the State of Hawaii. However, because Midway is located in the Hawaii Archipelago, it is included in the Hawaii Archipelago FEP. As used in the remainder of this document, “Pacific Remote Island Areas” and “PRIA” does not include Midway Atoll.

In the Western Pacific Region, responsibility for the management of marine resources is shared by a number of federal and local government agencies. At the federal level, the Council, the National Marine Fisheries Service (NMFS, also known as NOAA Fisheries Service), the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Department of Commerce develop and implement fishery management measures. Additionally, NOAA's Ocean Service co-manages (with the State of Hawaii) the Hawaiian Islands Humpback Whale National Marine Sanctuary, manages the Fagatele Bay National Marine Sanctuary in American Samoa, and administers the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve.

The U.S. Department of the Interior, through the U.S. Fish and Wildlife Service, manages ten National Wildlife Refuges throughout the Western Pacific Region. Some refuges are co-managed with other federal and state agencies, while others are not.

The U.S. Department of Defense, through the Air Force, Army, Navy, and Marine Corps, controls access and use of various marine waters throughout the region.

The Territory of American Samoa, the Territory of Guam, and the State of Hawaii manage all marine resources within waters 0–3 miles from their shorelines. In the Commonwealth of the Northern Mariana Islands (CNMI), the submerged lands and marine resources from the shoreline to 200 miles have been found to be owned by the federal government, although CNMI is currently seeking to acquire jurisdiction of the area from 0 to 3 miles through various legal means.

1.2 Purpose and Need for Action

The Western Pacific Region includes a series of archipelagos with distinct cultures, communities, and marine resources. For thousands of years, the indigenous people of these Pacific islands relied on healthy marine ecosystems to sustain themselves, their families, and their island communities. Today's Pacific island communities continue to depend on the ecological, economic, and social benefits of healthy marine ecosystems.

On international, national, and local levels, institutions and agencies tasked with managing marine resources are moving toward an ecosystem approach to fisheries management. One reason for this shift is a growing awareness that many of Earth's marine resources are stressed and the ecosystems that support them are degraded. In addition, increased concern regarding the potential impacts of fishing and non-fishing activities on the marine environment, and a greater understanding of the relationships between ecosystem changes and population dynamics, have all fostered support for a holistic approach to fisheries management that is science based and forward thinking (Pikitch et al. 2004).

In 1998, the U.S. Congress charged NMFS with the establishment of an Ecosystem Principles Advisory Panel (EPAP), which was responsible for assessing the extent that ecosystem principles were being used in fisheries management and research, and recommending how to further the use of ecosystem principals to improve the status and management of marine resources. The EPAP was composed of members of academia, fishery and conservation organizations, and fishery management agencies.

The EPAP (1999) reached consensus that Fishery Ecosystem Plans (FEPs) should be developed and implemented to manage U.S. fisheries and marine resources. According to the EPAP, a FEP should contain and implement a management framework to control harvests of marine resources on the basis of available information regarding the structure and function of the ecosystem in which such harvests occur. The EPAP constructed eight ecosystem principles that it believes to be important to the successful management of marine ecosystems and these were recognized and used as a guide by the Council in developing this FEP. These principles are as follows:

- The ability to predict ecosystem behavior is limited.
- Ecosystems have real thresholds and limits that, when exceeded, can affect major system restructuring.
- Once thresholds and limits have been exceeded, changes can be irreversible.
- Diversity is important to ecosystem functioning.
- Multiple scales interact within and among ecosystems.
- Components of ecosystems are linked.
- Ecosystem boundaries are open.
- Ecosystems change with time.

The Food and Agriculture Organization of the United Nations provides that the purpose of an ecosystem approach to fisheries "is to plan, develop and manage fisheries in a manner that addresses the multiple needs and desires of societies, without jeopardizing the options for future generations to benefit from a full range of goods and services provided by marine ecosystems" (Garcia et al. 2003).

Similarly, NOAA defines an ecosystem approach as "management that is adaptive, specified geographically, takes account of ecosystem knowledge and uncertainties, considers multiple external influences, and strives to balance diverse social objectives." In addition, because of the wide ranging nature of ecosystems, successful implementation of ecosystem approaches will need to be incremental and collaborative (NOAA 2004).

Given the above, on December 20, 2005 the Council recommended the establishment and implementation of this FEP for the Federal non-pelagic fisheries of the Hawaii Archipelago. In particular, this FEP:

1. Identifies the management objectives of the Hawaii Archipelago FEP;
2. Delineates the boundaries of the Hawaii Archipelago FEP;
3. Designates the management unit species included in the Hawaii Archipelago FEP;
4. Details the federal fishery regulations applicable under the Hawaii Archipelago FEP; and
5. Etablishes appropriate Council structures and advisory bodies to provide scientific and management advice to the Council regarding the Hawaii Archipelago FEP.

In addition, this document provides the information and rationale for these measures; discusses the key components of the Hawaii Archipelago ecosystem, including an overview of the region's non-pelagic fisheries, and explains how the measures contained here are consistent with the MSA and other applicable laws. This FEP, in conjunction with the Council's American Samoa Archipelago, Mariana Archipelago, Pacific Remote Island Areas, and Pacific Pelagic FEPs, replaces the Council's existing Bottomfish and Seamount Groundfish, Coral Reef Ecosystems, Crustaceans, Precious Corals and Pelagics Fishery Management Plans and reorganizes their associated regulations into a place-based structure aligned with the FEPs.

1.3 Incremental Approach to Ecosystem-based Management

As discussed above, fishery scientists and managers have recognized that a comprehensive ecosystem approach to fisheries management must be implemented through an incremental and collaborative process (Jennings 2004; NOAA 2004; Sissenwine and Murawski 2004). The Hawaii Archipelago FEP establishes the framework under which the Council will manage fishery resources, and begin the integration and implementation of ecosystem approaches to management. This FEP does not establish any new fishery management regulations at this time but rather consolidates existing fishery regulations for demersal species. Specifically, this FEP identifies as management unit species those current management unit species known to be present in waters in Hawaii and incorporates all of the management provisions of the Bottomfish and Seamount Groundfish FMP, the Crustaceans FMP, the Precious Corals FMP, and the Coral Reef Ecosystems FMP that are applicable to the area. Although pelagic fishery resources play an important role in the biological as well as socioeconomic environment of these islands, they will be managed separately through the Pacific Pelagic FEP. The goal of the measures contained in this document is to begin this process by establishing a place-based FEP with appropriate boundaries, management unit species, and advisory structures.

Successful ecosystem-based fisheries management will require an increased understanding of a range of social and scientific issues, including appropriate management objectives, biological and trophic relationships, ecosystem indicators and models, and the ecological effects of non-fishing activities on the marine environment. Future fishery management actions are anticipated to utilize this information as it becomes available, and adaptive management will be used to further advance the implementation of ecosystem science and principles.

1.4 Hawaii Archipelago FEP Boundaries

NOAA defines an ecosystem as a geographically specified system of organisms (including humans), the environment, and the processes that control its dynamics (NOAA 2004). Ecosystems can be considered at various geographic scales—from a coral reef ecosystem with its diverse species and benthic habitats to a large marine ecosystem such as the Pacific Ocean.

From a marine ecosystem management perspective, the boundary of an ecosystem cannot be readily defined and depends on many factors, including life history characteristics, habitat requirements, and geographic ranges of fish and other marine resources including their interdependence between species and their environment. Additionally, processes that affect and influence abundance and distribution of natural resources, such as environmental cycles, extreme natural events, and acute or chronic anthropogenic impacts, must also be considered. Serious considerations must also be given to social, economic, and/or political constraints. Humans and their society are considered to be an integral part of these ecosystems, and the alternatives considered here are cognizant of the human jurisdictional boundaries and varying management authorities that are present in the Western Pacific Region. This is also consistent with NMFS's

EPAP's 1999 report to Congress recommending that Councils should develop FEPs for the ecosystems under their jurisdiction and delineate the extent of those ecosystems.

Taking these factors into account, the Council has determined that at this time, the Hawaii FEP boundary includes all waters and associated marine resources with EEZ waters surrounding the Hawaiian Islands (Figure 2). Although this overlaps with the boundaries of the Council's Pacific Pelagic FEP for pelagic fisheries, the Hawaii Archipelago FEP specifically manages those demersal resources and habitats associated with the federal waters of the Hawaii Archipelago.

Under the approach described in this document, continuing adaptive management could include subsequent actions to refine these boundaries if and when supported by scientific data and/or management requirements. Such actions would be taken in accordance with the MSA, the National Environmental Policy Act (NEPA), the Endangered Species Act (ESA), the Marine Mammal Protection Act (MMPA), and other applicable laws and statutes.

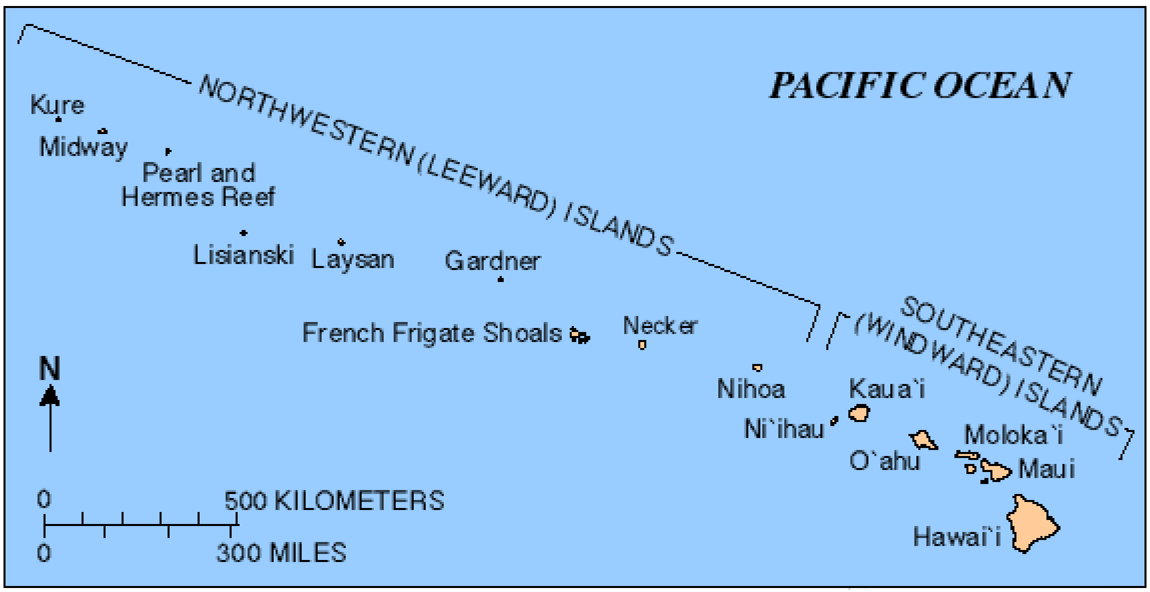

Figure 2: Map of the Hawaii Archipelago
Source: http://en.wikipedia.org/wiki/Hawaiian Archipelago

1.4.1 Papahanaumokuakea Marine National Monument

In June, 2006, the President issued a proclamation establishing the Northwestern Hawaiian Islands Marine National Monument, since renamed Papahanaumokuakea Marine National Monument, a status which significantly affects the NWHI commercial fishing operations. The National monument designation superseded the proposed NWHI National Marine Sanctuary.

The President's proclamation calls for the closure of commercial fisheries, including the limited entry crustacean fishery within the Monument's boundaries immediately and of the NWHI bottomfish fishery by June 15, 2011. Native Hawaiian cultural practices, including sustenance fishing may, however, be permitted to continue. Although the commercial bottomfish and associated pelagic fishing operations in the NWHI may continue over the five-year period, they will be subject to a landing limit on each species complex. No more than 350,000 pounds of bottomfish and no more than 180,000 pounds of pelagic fish may be landed within a given year. Furthermore, over the next five years, all bottomfish fishing operations in the NWHI must comply with new area closures, vessel monitoring and reporting requirements in addition to existing regulations.

1.5 Hawaii Archipelago FEP Management Objectives

The MSA mandates that fishery management measures achieve long-term sustainable yields from domestic fisheries while preventing overfishing. In 1999, the EPAP submitted a report to Congress arguing for management that—while not abandoning optimum yield and overfishing principles—takes an ecosystem-based approach (EPAP 1999).

Heeding the basic principles, goals, and policies for ecosystem-based management outlined by the EPAP, the Council initiated the development of FEPs for each major ecosystem under its jurisdiction beginning with the Coral Reef Ecosystems Fishery Management Plan (FMP), which was implemented in March 2004. This Hawaii Archipelago FEP represents—along with the Pacific Pelagic FEP, the American Samoa FEP, the Mariana Archipelago FEP, and the Pacific Remote Island Areas FEP—the next step in the establishment and successful implementation of place-based FEPs for all of the fisheries within its jurisdiction.

The overall goal of the Hawaii Archipelago FEP is to establish a framework under which the Council will improve its abilities to realize the goals of the MSA through the incorporation of ecosystem science and principles.

To achieve this goal, the Council has adopted the following ten objectives for the Hawaii Archipelago FEP:

Objective 1: To maintain biologically diverse and productive marine ecosystems and foster the long-term sustainable use of marine resources in an ecologically and culturally sensitive manner through the use of a science-based ecosystem approach to resource management.

Objective 2: To provide flexible and adaptive management systems that can rapidly address new scientific information and changes in environmental conditions or human use patterns.

Objective 3: To improve public and government awareness and understanding of the marine environment in order to reduce unsustainable human impacts and foster support for responsible stewardship.

Objective 4: To encourage and provide for the sustained and substantive participation of local communities in the exploration, development, conservation, and management of marine resources.

Objective 5: To minimize fishery bycatch and waste to the extent practicable.

Objective 6: To manage and comanage protected species, protected habitats, and protected areas.

Objective 7: To promote the safety of human life at sea.

Objective 8: To encourage and support appropriate compliance and enforcement with all applicable local and federal fishery regulations.

Objective 9: To increase collaboration with domestic and foreign regional fishery management and other governmental and non-governmental organizations, communities, and the public at large to successfully manage marine ecosystems.

Objective 10: To improve the quantity and quality of available information to support marine ecosystem management.

1.6 Hawaii Archipelago FEP Management Unit Species

Management unit species (MUS) are those species that are managed under each FEP (formerly under the FMPs). The primary impact of inclusion of species in an MUS list is that the species (i.e., the fishery targeting that species) can be directly managed. In fisheries management, MUS typically include those species that are caught in quantities sufficient to warrant management or specific monitoring by NMFS and the Council. An exception to this general rule is the inclusion of a range of little harvested species (termed Potentially Harvested Coral Reef Taxa) in the Coral Reef Ecosystems FMP. This FMP was the Council's first step towards ecosystem management and inclusion of these species as MUS allowed the Council to require that harvesters obtain federal permits and submit federal logbooks detailing their catch and effort and other fishery information. Although not currently the target of focused harvests, the PHCRT are believed to be vulnerable to potentially rapid localized depletion should they become commercially valuable due to shifting consumer tastes.

National Standard 3 of the MSA requires that, to the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination. Under the Hawaii Archipelago FEP, MUS include only those current bottomfish and seamount MUS, crustacean MUS, precious coral MUS, and coral reef ecosystem MUS that are known to be present within EEZ waters around the Hawaii Archipelago. Although, certain pelagic MUS are known to occur within the boundary of the Hawaii Archipelago FEP, they are managed under a separate Pelagic FEP.

Tables 1–5 list those current bottomfish and seamount MUS, crustacean MUS, precious coral MUS, and coral reef ecosystem MUS that are known to be present within the boundary of the Hawaii Archipelago FEP and are thus managed under this plan. Those species for which maximum sustainable yields (MSYs) have been estimated are indicated with an asterisk and their MSY values can be found in Sections 4.2.4 (bottomfish MUS), 4.3.4 (crustacean MUS), 4.4.4 (precious coral MUS) and 4.5.4 (coral reef ecosystem MUS). Some of the species included as MUS are not subject to significant fishing pressure; and there are no estimates of MSY or minimum stock size threshold (MSST, the level of biomass below which a stock or stock complex is considered overfished) or maximum fishing mortality threshold (MFMT, the level of fishing mortality, on an annual basis, above which overfishing is occurring), available for these species at this time. However, these species are important components of the ecosystem and for that reason are included in this FEP. Permits, data collection measures (e.g., vessel registration, reporting, etc.) and gear and harvest restrictions established under the existing FMPs will be continued under this FEP. Including these species as MUS in the FEP is consistent with MSA National Standard 3 which states at 50 CFR 600.320 that “To the extent practicable, an individual stock of fish shall be managed as a stock throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination.” 50 CFR 600.320 goes on to say that “A management unit may contain, in addition to regulated species, stocks of fish for which there is not enough information available to specify MSY and optimum yield (OY) or to establish management measures, so that data on these species may be collected under the FMP”. Under the adaptive approach that utilizes the best available scientific information, the Council, in coordination with NMFS, will continue to develop and refine estimates or proxies of MSY for these species when sufficient data are available. The establishment of MSY proxies is consistent with 50 CFR 600.310 text regarding MSA National Standard 1 which states that “When data are insufficient to estimate MSY directly, Councils should adopt other measures of productive capacity that can serve as reasonable proxies of MSY to the extent possible.” Future management measures that would directly affect the harvest of any MUS contained in this FEP will be subject to the requirements of the MSA and other applicable laws.

Table 1: Hawaii Archipelago Bottomfish Management Unit Species

Scientific Name	English Common Name	Local Name
**Aphareus rutilans*	silver jaw jobfish	lehi
**Aprion virescens*	gray jobfish	uku
**Caranx ignobilis*	giant trevally	white papio/ulua au kea
**C. lugubris*	black jack	ulua la‘uli
**E. quernus*	sea bass	hāpu‘upu‘u
**Etelis carbunculus*	red snapper	ehu
**E. coruscans*	longtail snapper	onaga or ‘ula‘ula koa‘e
**Lutjanus kasmira*	blue stripe snapper	ta‘ape
**Pristipomoides auricilla*	yellowtail snapper	kalekale
**P. filamentosus*	pink snapper	‘ōpakapaka
**P. seiboldii*	pink snapper	kalekale
**P. zonatus*	snapper	gindai

Scientific Name	English Common Name	Local Name
**Pseudocaranx dentex*	thicklip trevally	pig ulua, butaguchi
**Seriola dumerili*	amberjack	kahala
Seamount Groundfish		
Hyperoglyphe japonica	raftfish	NA
**Beryx splendens*	alfonsin	NA
**Pseudopentaceros wheeleri*	armorhead	NA

*** Indicates a species for which there is an estimated MSY value.**

Table 2: Hawaii Archipelago Crustaceans Management Unit Species

Scientific Name	English Common Name	Local Name
**Panulirus marginatus*	spiny lobster	ula
**Panulirus penicillatus*	spiny lobster	ula
Family Scyllaridae	slipper lobster	ula papapa
Ranina ranina	Kona crab	papa‘i kua loa
**Heterocarpus* spp.	deepwater shrimp	NA

*** Indicates a species for which there is an estimated MSY value.**

Table 3: Hawaii Archipelago Precious Corals Management Unit Species

Scientific Name	English Common Name	Local Name
**Corallium secundum*	pink coral (also called red coral)	NA
**Corallium regale*	pink coral (also called red coral)	NA
**Corallium laauense*	pink coral (also called red coral)	NA
**Gerardia* spp.	gold coral	NA
**Narella* spp.	gold coral	NA
**Lepidisis olapa*	bamboo coral	NA

**Antipathes dichotoma*	black coral	NA
**Antipathes grandis*	black coral	NA
**Antipathes ulex*	black coral	NA

Table 4: Hawaii Archipelago Coral Reef Ecosystem Management Units Species, Currently Harvested Coral Reef Taxa

Family Name	Scientific Name	English Common Name	Local Name
Acanthuridae (Surgeonfishes)	*Acanthurus olivaceus*	orange-spot surgeonfish	na‘ena‘e
	Acanthurus xanthopterus	yellowfin surgeonfish	pualu
	Acanthurus triostegus	convict tang	manini
	Acanthurus dussumieri	eye-striped surgeonfish	palani
	Acanthurus nigroris	blue-lined surgeon	maiko
	Acanthurus leucopareius	whitebar surgeonfish	maiko or maikoiko
	Acanthurus nigricans	whitecheek surgeonfish	NA
	Acanthurus guttatus	white-spotted surgeonfish	‘api
	Acanthurus blochii	ringtail surgeonfish	Pualu
	Acanthurus nigrofuscus	brown surgeonfish	mai‘i‘i
	Ctenochaetus strigosus	yellow-eyed surgeonfish	kole
	Ctenochaetus striatus	striped bristletooth	NA

Family Name	Scientific Name	English Common Name	Local Name
Acanthuridae (Surgeonfishes)	*Naso unicornus*	bluespine unicornfish	kala
	Naso lituratus	orangespine unicornfish	kalalei or umaumalei
	Naso hexacanthus	black tongue unicornfish	kala holo
	Naso annulatus	whitemargin unicornfish	kala
	Naso brevirostris	spotted unicornfish	kala lolo
	Naso caesius	gray unicornfish	NA
	Zebrasoma flavescens	yellow tang	lau‘ipala
Balistidae (Triggerfish)	*Melichthys vidua*	pinktail triggerfish	humuhumu hi‘ukole
	Melichthys niger	black triggerfish	humuhumu ‘ele‘ele
	Rhinecanthus aculeatus	picassofish	humuhumu nukunuku apua‘a
	Sufflamen fraenatum	bridled triggerfish	NA
Carangidae (Jacks)	*Selar crumenophthalmus*	bigeye scad	akule or hahalu
	Decapterus macarellus	mackerel scad	‘opelu or ‘opelu mama
Carcharhinidae (Sharks)	*Carcharhinus amblyrhynchos*	grey reef shark	manō
	Carcharhinus galapagensis	galapagos shark	manō
	Carcharhinus melanopterus	blacktip reef shark	manō
	Triaenodon obesus	whitetip reef shark	manō lalakea

Family Name	Scientific Name	English Common Name	Local Name
Holocentridae (Solderfish/ Squirrelfish	*Myripristis berndti*	bigscale soldierfish	menpachi or ‘u‘u
	Myripristis amaena	brick soldierfish	menpachi or ‘u‘u
	Myripristis chryseres	yellowfin soldierfish	menpachi or ‘u‘u
	Myripristis kuntee	pearly soldierfish	menpachi or ‘u‘u
	Sargocentron microstoma	file-lined squirrelfish	‘ala‘ihi
	Sargocentron diadema	crown squirrelfish	‘ala‘ihi
	Sargocentron punctatissimum	peppered squirrelfish	‘ala‘ihi
	Sargocentron tiere	blue-lined squirrelfish	‘ala‘ihi
	Sargocentron xantherythrum	hawaiian squirrelfish	‘ala‘ihi
	Sargocentron spiniferum	saber or long jaw squirrelfish	‘ala‘ihi
	Neoniphon spp.	spotfin squirrelfish	‘ala‘ihi
Kuhliidae (Flagtails)	*Kuhlia sandvicensis*	Hawaiian flag-tail	‘aholehole
Kyphosidae (Rudderfish)	*Kyphosus biggibus*	rudderfish	nenue
	Kyphosus cinerascens	rudderfish	nenue
	Kyphosus vaigiensis	rudderfish	nenue
Labridae (Wrasses)	*Bodianus bilunulatus*	saddleback hogfish	‘a‘awa
	Oxycheilinus unifasciatus	ring-tailed wrasse	po‘ou
	Xyrichtys pavo	razor wrasse	laenihi or nabeta

Family Name	Scientific Name	English Common Name	Local Name
	Cheilio inermis	cigar wrasse	kupoupou
	Thalassoma purpureum	surge wrasse	ho‘u
	Thalassoma quinquevittatum	red ribbon wrasse	NA
	Thalassoma lutescens	sunset wrasse	NA
	Novaculichthys taeniourus	rockmover wrasse	NA
Mullidae (Goatfishes)	*Mulloidichthys* spp.	yellow goatfish	weke
	Mulloidichthys pfleugeri	orange goatfish	weke nono
	Mulloidichthys vanicolensis	yellowfin goatfish	weke‘ula
	Mulloidichthys flavolineatus	yellowstripe goatfish	weke‘a or weke a‘a
	Parupeneus spp.	banded goatfish	kumu or moano
	Parupeneus bifasciatus	doublebar goatfish	munu
	Parupeneus cyclostomas	yellowsaddle goatfish	moano kea or moano kale
	Parupeneus pleurostigma	side-spot goatfish	malu
	Parupeneus multifaciatus	multi-barred goatfish	moano
	Upeneus arge	bandtail goatfish	weke pueo
Mugilidae (Mullets)	*Mugil cephalus*	stripped mullet	‘ama‘ama
	Neomyxus leuciscus	false mullet	uouoa

Family Name	Scientific Name	English Common Name	Local Name
Muraenidae (Moray eels)	*Gymnothorax flavimarginatus*	yellowmargin moray eel	puhi paka
	Gymnothorax javanicus	giant moray eel	puhi
	Gymnothorax undulatus	undulated moray eel	puhi laumilo
	Enchelycore pardalis	dragon eel	puhi
Octopodidae (Octopus)	*Octopus cyanea*	octopus	he‘e mauli or tako
	Octopus ornatus	octopus	he‘e or tako
Polynemidae	*Polydactylus sexfilis*	threadfin	moi
Priacanthidae (Big-eyes)	*Heteropriacanthus cruentatus*	glasseye	‘aweoweo
	Priacanthus hamrur	bigeye	‘aweoweo
Scaridae (Parrotfish)	*Scarus* spp.	parrotfish	uhu or palukaluka
	Calotomus carolinus	stareye parrotfish	panuhunuhu
Sphyraenidae (Barracuda)	*Sphyraena helleri*	Heller’s barracuda	kawele‘a or kaku
	Sphyraena barracuda	great barracuda	kaku
Turbinidae	*Turbo* spp.	green snails turban shells	NA
Zanclidae	*Zanclus cornutus*	moorish idol	kihikihi
Chaetodontidae	*Chaetodon auriga*	butterflyfish	kikakapu
	Chaetodon lunula	raccoon butterflyfish	kikakapu
	Chaetodon ephippium	saddleback butterflyfish	kikakapu

Family Name	Scientific Name	English Common Name	Local Name
Sabellidae		featherduster worm	NA

Table 5: Hawaii Archipelago Coral Reef Ecosystem Management Unit Species, Potentially Harvested Coral Reef Taxa

Scientific Name	English Common Name	Local Name
Labridae	wrasses (Those species not listed as CHCRT)	hinalea
Carcharhinidae Sphyrnidae	sharks (Those species not listed as CHCRT)	manō
Dasyatididae Myliobatidae	rays and skates	hihimanu
Serrandiae	groupers, seabass (Those species not listed as CHCRT or in BMUS)	roi, hapu‘upu‘u
Malacanthidae	tilefishes	NA
Carangidae	jacks and scads (Those species not listed as CHCRT or in BMUS)	dobe, kagami, pa‘opa‘o, papa, omaka, ulua,
Holocentridae	solderfishes and squirrelfishes (Those species not listed as CHCRT)	‘u‘u
Mullidae	goatfishes (Those species not listed as CHCRT)	weke, moano, kumu
Acanthuridae	surgeonfishes (Those species not listed as CHCRT)	na‘ena‘e, maikoiko

Scientific Name	English Common Name	Local Name
Echeneidae	remoras	NA
Muraenidae Congridae Ophichthidae	eels (Those species not listed as CHCRT)	puhi
Apogonidae	cardinalfishes	‘upapalu
Clupeidae	herrings	NA
Engraulidae	anchovies	nehu
Caracanthidae	coral crouchers	NA
Gobiidae	gobies	‘o‘opu
Lutjanidae	snappers (Those species not listed as CHCRT or in BMUS)	to‘au
Aulostomus chinensis	trumpetfish	nunu
Fistularia commersoni	cornetfish	nunu peke
Zanclidae	moorish Idols	kihikihi
Chaetodontidae	butterflyfishes	kikakapu
Pomacanthidae	angelfishes	NA
Pomacentridae	damselfishes	mamo
Scorpaenidae	scorpionfishes, lionfishes	nohu, okoze
Blenniidae	blennies	pa o‘o
Sphyraenidae	barracudas (Those species not listed as CHCRT)	kaku
Pinguipedidae	sandperches	NA
Bothidae Soleidae Pleurnectidae	flounders and soles	paki‘i
Ostraciidae	trunkfishes	makukana
Balistidae	trigger fishes (Those species not listed as CHCRT)	humu humu

Scientific Name	English Common Name	Local Name
Kyphosidae	rudderfishes (Those species not listed as CHCRT)	nenue
Cirrhitidae	hawkfishes (Those species not listed as CHCRT)	po‘opa‘a
Tetradontidae	puffer fishes and porcupine fishes	‘o‘opu hue or fugu
Antennariidae	frogfishes	NA
Syngnathidae	pipefishes and seahorses	NA
Echinoderms	sea cucumbers and sea urchins	namako, lole, wana
Mollusca	(Those species not listed as CHCRT)	NA
Azooxanthellates	ahermatypic corals	ko‘a
Fungiidae	mushroom corals	ko‘a
	small and large coral polyps	ko‘a
	soft corals and gorgonians	NA
Actinaria	anemones	NA
Zoanthinaria	soft zoanthid corals	NA
Solanderidae	hydroid corals	NA
Stylasteridae	lace corals	ko‘a
Crustaceans	lobsters, shrimps, mantis shrimps, true crabs and hermit crabs (Those species not listed as CMUS)	ula, a‘ama, mo‘ala, ‘alakuma
Hydrozoans and Bryzoans		NA
Pinctada margaritifera	black lipped pearl oyster	NA
Other Bivalves	other clams	NA
Tunicates	sea squirts	NA
Porifera	sponges	NA

Scientific Name	English Common Name	Local Name
Cephalopods	octopi	tako, heʻe
Gastropoda	sea snails	NA
Opistobranchs	sea slugs	NA
Algae	seaweed	limu
Live rock		NA
Annelids	segmented worms (Those species not listed as CHCRT)	NA
All other coral reef ecosystem management unit species that are marine plants, invertebrates, and fishes that are not listed in the preceding tables or are not bottomfish management unit species, crustacean management unit species, Pacific pelagic management unit species, precious coral or seamount groundfish.		

1.7 Regional Coordination

In the Western Pacific Region, the management of ocean and coastal activities is conducted by a number of agencies and organizations at the federal, state, county, and even village levels. These groups administer programs and initiatives that address often overlapping and sometimes conflicting ocean and coastal issues.

To be successful, ecosystem approaches to management must be designed to foster intra- and interagency cooperation and communication (Schrope 2002). Increased coordination with state and local governments and community involvement will be especially important to the improved management of near-shore resources that are heavily used. To increase collaboration with domestic and international management bodies, as well as other governmental and non-governmental organizations, communities, and the public, the Council has adopted the multi-level approach described below.

1.7.1 Council Panels and Committees

FEP Advisory Panel

The FEP Advisory Panel advises the Council on fishery management issues, provides input to the Council regarding fishery management planning efforts, and advises the Council on the content and likely effects of management plans, amendments, and management measures.

The place-based structure of the Advisory Panel and its sub-panels supports the Council's objective of management based on geographically-based ecosystems with the substantive participation of local communities in the management and conservation process.

The Advisory Panel consists of four sub-panels. In general, each Advisory Sub-panel includes two representatives from the area's commercial, recreational, and subsistence fisheries, as well as two additional members (fishermen or other interested parties) who are knowledgeable about the area's ecosystems and habitat. The exception is the Mariana FEP Sub-panel, which has four representatives from each group to represent the combined areas of Guam and the Northern Mariana Islands (see Table 6). The Hawaii FEP Sub-panel addresses issues pertaining to demersal fishing in the PRIA due to the lack of a permanent population and because such PRIA fishing has primarily originated in Hawaii. The FEP Advisory Panel meets at the direction of the Council to provide continuing and detailed participation by members representing various fishery sectors and the general public. FEP Advisory Panel members are representatives from various fishery sectors that are selected by the Council and serve two-year terms.

Table 6: FEP Advisory Panel and Sub-panel Structure

Representative	**American Samoa FEP Sub-panel**	**Hawaii FEP Sub-panel**	**Mariana FEP Sub-panel**	**Pelagic FEP Sub-panel**
Commercial representatives	Two members	Two members	Four members	Two members
Recreational representatives	Two members	Two members	Four members	Two members
Subsistence representatives	Two members	Two members	Four members	Two members
Ecosystems and habitat representatives	Two members	Two members	Four members	Two members

Archipelagic FEP Plan Team

The Archipelagic FEP Plan Team oversees the ongoing development and implementation of the American Samoa, Hawaii, Mariana, and PRIA FEPs and is responsible for reviewing information pertaining to the performance of all the fisheries and the status of all the stocks managed under the four Archipelagic FEPs. Similarly, the Pelagic FEP Plan Team oversees the ongoing development and implementation of the Pacific Pelagic FEP. These teams monitor the performance of the FEP through production of an annual stock assessment and fishery evaluation (SAFE) report and provide information on the status of the fish stocks and other components of the ecosystem. The FEP Plan Team also makes recommendations for conservation and management adjustments under framework procedures to better achieve management objectives.

The Archipelagic Plan Team meets at least once annually and comprises individuals from local and federal marine resource management agencies and non-governmental organizations. It is led by a Chair who is appointed by the Council Chair after consultation with the Council's Executive Standing Committee. The Archipelagic Plan Team's findings and recommendations are reported to the Council at its regular meetings. Plan teams are a form of advisory panel authorized under Section 302(g) of the MSA. FEP Plan Team members comprise Federal, State and non-government specialists that are appointed by the Council and serve indefinite terms.

Science and Statistical Committee

The Scientific and Statistical Committee (SSC) is composed of scientists from local and federal agencies, academic institutions, and other organizations. These scientists represent a range of disciplines required for the scientific oversight of fishery management in the Western Pacific Region. The role of the SSC is to (a) identify scientific resources required for the development of FEPs and amendments, and recommend resources for Plan Teams; (b) provide multi-disciplinary review of management plans or amendments, and advise the Council on their scientific content; (c) assist the Council in the evaluation of such statistical, biological, economic, social, and other scientific information as is relevant to the Council's activities, and recommend methods and means for the development and collection of such information; and (d) advise the Council on the composition of both the Archipelagic and Pelagic Plan Teams. Members of the SSC are selected by the Council from a pool of applicants with appropriate education and training in physical, natural, and social sciences and serve indefinite terms.

The recently amended MSA may affect the duties of some of the various subgroups identified in this section. For example, the SSC will now have a strong role in specifying total allowable catches for stocks managed under this FEP.

FEP Standing Committees

The Council’s four FEP Standing Committees are composed of Council members who, prior to Council action, review all relevant information and data including the recommendations of the FEP Advisory Panels, the Archipelagic and Pelagic Plan Teams, and the SSC. The Standing Committees are the American Samoa FEP Standing Committee, the Hawaii FEP Standing Committee (as in the Advisory Panels, the Hawaii Standing Committee will also consider demersal issues in the PRIA), the Mariana FEP Standing Committee, and the Pelagic FEP Standing Committee. The recommendations of the FEP Standing Committees, along with the recommendations from all of the other advisory bodies described above, are presented to the full Council for their consideration prior to taking action on specific measures or recommendations.

Regional Ecosystem Advisory Committees

Regional Ecosystem Advisory Committees for each inhabited area (American Samoa, Hawaii, and the Mariana archipelago) comprise Council members and Council selected representatives from federal, state, and local government agencies; businesses; and non-governmental organizations that have responsibility or interest in land-based and non-fishing activities that potentially affect the area’s marine environment. Committee membership is by invitation and provides a mechanism for the Council and member agencies to share information on programs and activities, as well as to coordinate management efforts or resources to address non-fishing related issues that could affect ocean and coastal resources within and beyond the jurisdiction of the Council. Committee meetings coincide with regularly scheduled Council meetings and recommendations made by the Committees to the Council are advisory as are recommendations made by the Council to member agencies. Regional Ecosystem Advisory Committees are a form of advisory panel authorized under Section 302(g) of the MSA.

1.7.2 Community Groups and Projects

As described above, communities and community members are involved in the Council's management process in explicit advisory roles, as sources of fishery data and as stakeholders invited to participate in public meetings, hearings, and comment periods. In addition, cooperative research initiatives have resulted in joint research projects in which scientists and fishermen work together to increase both groups' understanding of the interplay of humans and the marine environment, and both the Council's Community Development Program and the Community Demonstration Projects Program foster increased fishery participation by indigenous residents of the Western Pacific Region.

The Council is sponsoring the Hoohanohano I Na Kupuna (Honoring our Ancestors) conference series in partnership with the Association of Hawaiian Civic Clubs and in consultation with the native Hawaiian community. The conference has received the support of the Kamehameha Schools/Bishop Estate, Office of Hawaiian Affairs, various departments of the State of Hawaii, the Hawaii Tourism Authority and numerous community organizations and projects throughout the State of Hawaii. Fishery ecosystem management provides the Council with the opportunity to utilize the manao (thoughts) and ike (knowledge) of our kupuna (elders) – ideas and practices that have sustained na kanaka maoli (native Hawaiian) culture for millennia.

The conference series was initiated by the Council to engage the Kanaka Maoli community in the development of the Hawaii Archipelago FEP and to increase their participation in the management of fisheries under the FEP's authority. A series of workshops with the Kanaka Maoli community to promote the concept of ahupuaa (traditional natural resource unit) management began in 2003 through the AOHCC. This endeavor was continued by the Council in order to take the ahupuaa concept to the next level, the development of a process to implement traditional resource management practices into today's management measures.

Conference attendees, many of them native practitioners who continue traditional practices and relationships with the natural environment taught to them by their kupuna, requested that traditional resource management be incorporated into contemporary resource management and that education play a major role in this effort. A motivation for the series was the often heard manao that "we want to teach our keiki (children) a practice, not a memory."

The first conference (Puwalu I) was held in August 2006 and included over 100 ahupuaa practitioners who discussed the development of aha moku (traditional councils which governed one or more ahupuaa) that would manage natural resources for the aha moku through the implementation of culturally based, site-specific conservation and utilization practices.

The second conference (Puwalu II) was held in November 2006. At this conference cultural practitioners and educators met and developed a declaration regarding the education of Hawaii's children, the development of appropriate consultation protocols, the customary and traditional rights of na kanaka maoli, and a commitment to further action as follows:

Having met to deliberate on how to incorporate traditional Hawaiian practices and knowledge, into the daily education of Hawai'i's children;

Believing that na kanaka maoli have the right of self-determination and that the natural resources of ka pae ʻaina Hawaiʻi and associated traditional knowledge are by birthright the kuleana and intellectual property of na kanaka maoli, and, as such, the hana pono (for sustaining, developing, managing, utilizing and educating about ʻaina, kai, and wai, and shall be utilized to sustain these natural resources and promote the culture of na kanaka maoli;

Emphasizing that it is the kuleana of na kanaka maoli to perpetuate their culture and knowledge, which if maintained, can sustain Hawaiʻi's natural resources for the benefit of future generations;

Recognizing that the vast cumulative knowledge of kanaka maoli kupuna, practitioners and experts on Hawaiʻi's marine and terrestrial environments represents hundreds of years of knowledge gained by hands on observation and experimentation integral to Native Hawaiian culture and values;

Agreeing that educating Hawaiʻi's kamaliʻI and opio on Native Hawaiian culture, values, practices, requiring learning through oli, moʻolelo, place names, and ecosystem observations held by na kanaka maoli kupuna;

Recognizing that there are examples of existing programs and schools that are attempting to integrate traditional Native Hawaiian knowledge and practices into curriculum; however, the effort lacks coordination and adequate funding as well as is being hindered by school policies on liability issues;

Recognizing that this ʻike is imparted through moʻolelo and place names and not from books, requires the skill of patient listening and observing and teaches from the naʻau and not just the poʻo;

Agreeing that while the details of a practice may evolve, the relationship to a particular place, to a practice, to a resource remains, and that this relationship is important to the identity of na kanaka maoli, imparting values such as malama ʻaina, aloha ʻaina, and sharing;

Believing that we must teach this ʻike to people of all ages, all nationalities, be theyʻ ohana, neighbors or visitors;

We customary and traditional practitioners of the second Hoʻohanohano I Na Kupuna Puwalu, building on the resolution of the first Hoʻohanohano I Na Kupuna Puwalu, which called upon na kanaka maoli to begin the process to uphold and continue traditional land and ocean practices in the governance and education of the Hawaii Archipelago,

Affirm that na hana kupono (righteous procedures) shall be acknowledged as encompassing na mea Hawaiʻi (all things Hawaiian) and that the sharing of knowledge between cultural informants and others shall include the following nah ana kupono:

Kekipa ana e kahui ana (visiting and meeting procedures)

1. *Hoʻomakaukau ana (preparing for the call and interview)*

2. *Ke kahea (proper introduction or call to the informant)*
3. *Ka ho'okupu (appropriate gift presented to the informant*
4. *Ke kukakuka ana e kahuiana (discussion and negotiation)*
5. *kapanina e ho'okupu (closure)*

Ke ike (sharing knowledge and understanding procedures)

1. *Ka ho'omakaumakau ana (preparation for sharing)*
2. *Ke a'o mai ana (sharing knowledge with the informant)*
3. *Ka malama ana (agreement on how the knowledge will be used and protecting the knowledge)*
4. *Ke a'o aku ana (instruction to the guest and sharing of 'ike)*

Furthermore we declare that Native Hawaiians today are entitled to all customary and traditional subsistence, cultural and religious rights that were possessed by ahupuaa tenants prior to 1778, and .

We further recommend, and will act to establish the following:

- *An Aha Moku on each island*
- *Laws that prohibit the introduction of alien invasive species that would negatively impact on native, endemic and indigenous species,*
- *Provisions to remove such species as noted above to make the land pono,*
- *The inventory and monitoring of our natural resources,*
- *Recommendations to be made based on the results of the above,*
- *A State holiday (e.g., January 17 or July 31) to celebrate the Kanaka Maoli during which we shall walk our aina, and*
- *Recognition and establishment by the State and county governments of a means for community-based self enforcement (such as Native Hawaiian rangers) of the rules and practices of each ahupua'a.*

Translation notes: aha moku (district island councils); ahupua'a (Hawaiiian land division); 'aina (land); ike (knowledge or information); keiki (children); kuleana (responsibility); kupuna (elders or teachers); mo'olelo (story or stories); ohana (family); oli (story chant); pono (righteous or correct).

The third conference (Puwalu III) brought together practitioners, educators, government agencies and policy makers to discuss the implementation of a community and cultural consultation process through the development of na aha moku for each island.

Under the Hawaii Archipelago FEP, this conference series will continue in Hawaii and will subsequently be extended to the other areas of the Western Pacific Region. Although the specific format will be tailored to each area's cultures and communities, in all cases the Council will seek to increase the participation of indigenous communities in the harvest, research, conservation and management of marine resources as called for in Section 305 of the MSA.

1.7.3 International Management

The Council is an active participant in the development and implementation of international agreements regarding marine resources. The majority deal with management of the highly migratory pelagic species and include decisions made by the Inter-American Tropical Tuna Commission (IATTC), of which the U.S. is a member, and under the Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Central and Western Pacific Region (Convention). On September 4, 2000, the United States voted for the adoption of and signed the Convention along with 19 other participants in the Conference on the Conservation and Management of Highly Migratory Fish Stocks of the Central and Western Pacific (or MHLC, for Multilateral High-Level Conference). The Convention established the Commission (WCPFC) to conserve and manage highly migratory species in the vast area of the western and central Pacific west of 150° meridian of west longitude. As of December 8, 2006, with passage of the amended MSA, the WCPFC was ratified and the U.S. will be a member of the Convention upon depositing the articles of association with the repository nation (New Zealand).

The Council is serving as a role model to other member nations with regards to ecosystem based-management through its participation in these and other international organizations and it will continue to do so after implementation of this FEP. For example, the Council’s comprehensive and interdisciplinary approach to pelagics fisheries management is an example of advances in conservation through improved gear technology; community participation through the public meeting process; sustainable fishing through limited entry programs and adherence to quota management; and using the best available science through cooperative research, improved stock assessments, and sharing knowledge within the regional fishery management organization (RFMO) process.

The Council also participates in and promotes the formation of regional and international arrangements through other RFMOs (e.g., the Forum Fisheries Agency, the Secretariat of the Pacific Community’s Oceanic Fisheries Programme, the Food and Agriculture Organization of the UN, the Intergovernmental Oceanographic Commission of UNESCO, the Inter-American Convention for the Protection and Conservation of Sea Turtles, the International Scientific Council, and the North Pacific Marine Science Organization) for assessing and conserving all marine resources throughout their range, including the ecosystems and habitats that they depend on. The Council is also developing similar linkages with the Southeast Asian Fisheries Development Center and its turtle conservation program. Of increasing importance are bilateral agreements regarding demersal resources such as those authorized under Pacific Insular Fishing Agreements.

CHAPTER 2: TOPICS IN ECOSYSTEM APPROACHES TO MANAGEMENT

2.1 Introduction

An overarching goal of an ecosystem-based approach to fisheries management is to maintain and conserve the structure and function of marine ecosystems by managing fisheries in a holistic manner that considers the ecological linkages and relationships between a species and its environment, including its human uses and societal values (Garcia et al. 2003; Laffoley et al. 2004; Pikitch et al. 2004). Although the literature on the objectives and principles of ecosystem approaches to management is extensive, there remains a lack of consensus and much uncertainty among scientists and policy makers on how to best apply these often theoretical objectives and principles in a real-world regulatory environment (Garcia et al. 2003; Hilborn 2004). In many cases, it is a lack of scientific information that hinders their implementation (e.g., ecosystem indicators); in other cases, there are jurisdictional and institutional barriers that need to be overcome before the necessary changes can be accomplished to ensure healthy marine fisheries and ecosystems (e.g., ocean zoning). These and other topics are briefly discussed below to provide a context for the Council's increasing focus on ecosystem approaches to management.

2.2 Ecosystem Boundaries

It is widely recognized that ecosystems are not static, but that their structure and functions vary over time due to various dynamic processes (Christensen et al. 1996; Kay and Schneider 1994; EPAP 1999). The term *ecosystem* was coined in 1935 by A. G. Tansley, who defined it as "an ecological community together with its environment, considered as a unit" (Tansley 1995). The U.S. Fish and Wildlife Service has defined an ecosystem as "a system containing complex interactions among organisms and their non-living, physical environment" (USFWS 1994), while NOAA defines an ecosystem as "a geographically specified system of organisms (including humans), the environment, and the processes that control its dynamics" (NOAA 2004).

Although these definitions are more or less consistent (only NOAA explicitly includes humans as part of ecosystems), the identification of ecosystems is often difficult and dependent on the scale of observation or application. Ecosystems can be reasonably identified (e.g., for an intertidal zone on Maui, Hawaii, as well as the entire North Pacific Ocean). For this reason, hierarchical classification systems are often used in mapping ecosystem linkages between habitat types (Allen and Hoekstra 1992; Holthus and Maragos 1995). NOAA's Ecosystem Advisory Panel found that although marine ecosystems are generally open systems, bathymetric and oceanographic features allow their identification on a variety of bases. In order to be used as functional management units, however, ecosystem boundaries need to be geographically based and aligned with ecologically meaningful boundaries (FAO 2002). Furthermore, if used as a basis for management measures, an ecosystem must be defined in a manner that is both scientifically and administratively defensible (Gonsalez 1996). Similarly, Sissenwine and Murawski (2004) found that delineating ecosystem boundaries is necessary to an ecosystem approach, but that the scale of delineation must be based on the spatial extent of the system that is to be studied or influenced by management. Thus, the identification of ecosystem boundaries for management purposes may differ from those resulting from purely scientific assessments, but in all cases ecosystems are geographically defined, or in other words, place-based.

2.3 Precautionary Approach, Burden of Proof, and Adaptive Management

There is general consensus that a key component of ecosystem approaches to resource management is the use of precautionary approaches and adaptive management (NMFS 1999). The FAO Code of Conduct for Responsible Fisheries states that under a precautionary approach:

> …in the absence of adequate scientific information, cautious conservation management measures such as catch limits and effort limits should be implemented and remain in force until there is sufficient data to allow assessment of the impacts of an activity on the long-term sustainability of the stocks, whereupon conservation and management measures based on that assessment should be implemented. (FAO 1995)

This approach allows appropriate levels of resource utilization through increased buffers and other precautions where necessary to account for environmental fluctuations and uncertain impacts of fishing and other activities on the ecology of the marine environment (Pikitch et al. 2004).

A notion often linked with the precautionary approach is shifting the "burden of proof" from resource scientists and managers to those who are proposing to utilize those resources. Under this approach, individuals would be required to prove that their proposed activity would not adversely affect the marine environment, as compared with the current situation that, in general, allows uses unless managers can demonstrate such impacts (Hildreth et al. 2005). Proponents of this approach believe it would appropriately shift the responsibility for the projection and analysis of environmental impacts to potential resource users and fill information gaps, thus shortening the time period between management decisions (Hildreth et al. 2005). Others believe that it is unrealistic to expect fishery participants and other resource users to have access to the necessary information and analytical skills to make such assessments.

The precautionary approach is linked to adaptive management through continued research and monitoring of approved activities (Hildreth et al. 2005). As increased information and an improved understanding of the managed ecosystem become available, adaptive management requires resource managers to operate within a flexible and timely decision structure that allows for quick management responses to new information or to changes in ecosystem conditions, fishing operations, or community structures.

2.4 Ecological Effects of Fishing and Non-fishing Activities

Fisheries may affect marine ecosystems in numerous ways, and vice versa. Populations of fish and other ecosystem components can be affected by the selectivity, magnitude, timing, location, and methods of fish removals. Fisheries can also affect marine ecosystems through vessel disturbance, bycatch or discards, impacts on nutrient cycling, or introduction of exotic species, pollution, and habitat disturbance. Historically, federal fishery management focused primarily on ensuring long-term sustainability by preventing overfishing and by rebuilding overfished stocks. However, the reauthorization of the MSA in 1996 placed additional priority on reducing non-target or incidental catches, minimizing fishing impacts to habitat, and eliminating interactions with protected species. While fisheries management has significantly improved in these areas in recent years, there is now an increasing emphasis on the need to account for and minimize the unintended and indirect consequences of fishing activities on other components of the marine environment such as predator–prey relationships, trophic guilds, and biodiversity (Browman and Stergiou 2004; Dayton et al. 2002).

For example, fishing for a particular species at a level below its maximum sustainable yield can nevertheless limit its availability to predators, which, in turn, may impact the abundance of the predator species. Similarly, removal of top-level predators can potentially increase populations of lower level trophic species, thus causing an imbalance or change in the community structure of an ecosystem (Pauly et al. 1998). Successful ecosystem management will require significant increases in our understanding of the impacts of these changes and the formulation of appropriate responses to adverse changes.

Marine resources are also affected by non-fishing aquatic and land-based activities. For example, according to NOAA's (2005b) *State of Coral Reefs Ecosystems of the United States and Pacific Freely Associated States*, anthropogenic stressors that are potentially detrimental to coral reef resources include the following:

- Coastal development and runoff
- Coastal pollution
- Tourism and recreation
- Ships, boats, and groundings
- Anchoring
- Marine debris
- Aquatic invasive species
- Security training activities

Non-anthropogenic impacts arise from events such as weather cycles, hurricanes, and environmental regime changes. While managers cannot regulate or otherwise control such events, their occurrence can often be predicted and appropriate management responses can lessen their adverse impacts.

Understanding the complex inter-relationships between marine organisms and their physical environment is a fundamental component of successful ecosystem approaches to management. Obtaining the necessary information to comprehensively assess, interpret, and manage these inter-relationships will require in-depth and long-term research on specific ecosystems.

2.5 Data and Information Needs

Numerous research and data collection projects and programs have been undertaken in the Western Pacific Region and have resulted in the collection of huge volumes of potentially valuable detailed bathymetric, biological, and other data. Some of this information has been processed and analyzed by fishery scientists and managers; however, much has proven difficult to utilize and integrate due to differences in collection methodologies coupled with a lack of meta-data or documentation of how the data were collected and coded. This has resulted in incompatible datasets as well as data that are virtually inaccessible to anyone except the primary researchers. The rehabilitation and integration of existing datasets, as well as the establishment of shared standards for the collection and documentation of new data, will be an essential part of successful and efficient ecosystem management in the Western Pacific Region.

2.6 Use of Indicators and Models

Clearly, ecosystem-based management is enhanced by the ability to understand and predict environmental changes, as well as the development of measurable characteristics (e.g., indices) related to the structure, composition, or function of an ecological system (de Young et al. 2004; EPAP 1999; MAFAC 2003).

Indicators

The development and use of indicators are an integral part of an ecosystem approach to management as they provide a relatively simple mechanism to track complex trends in ecosystems or ecosystem components. Indicators can be used to help answer questions about whether ecosystem changes are occurring, and the extent (state variables; e.g., coral reef biomass) to which causes of changes (pressure variables; e.g., bleaching) and the impacts of changes influence ecosystem patterns and processes. This information may be used to develop appropriate response measures in terms of management action. This pressure–state–response framework provides an intuitive mechanism for causal change analyses of complex phenomena in the marine environment and can clarify the presentation and communication of such analyses to a wide variety of stakeholders (Wakeford 2005).

Monitoring and the use of indicator species as a means to track changes in ecological health (i.e., as an identifier of stresses) have been studied in various marine ecosystems including Indo-Pacific coral reefs using butterflyfishes (Crosby and Reese 1996) and boreal marine ecosystems in the Gulf of Alaska using pandalid shrimp, a major prey of many fish species (Anderson 2000). Others have examined the use of spatial patterns and processes as indicators of management performance (Babcock et al. 2005), and others have used population structure parameters, such as mean length of target species, as an indicator of biomass depletion (Francis and Smith 1995). Much has been written on marine ecosystem indicators (FAO 1999; ICES 2000, 2005). There are, however, no established reference points for optimal ecosystem structures, composition, or functions. Due to the subjective nature of describing or defining the desirable ecosystems that would be associated with such reference points (e.g., a return to some set of prehistoric conditions vs. an ecosystem capable of sustainable harvests), this remains a topic of much discussion.

Models

The ecosystem approach is regarded by some as endlessly complicated as it is assumed that managers need to completely understand the detailed structure and function of an entire ecosystem in order to implement effective ecosystem-based management measures (Browman and Stergiou 2004). Although true in the ideal, interim approaches to ecosystem management need not be overly complex to achieve meaningful improvements.

Increasing interest in ecosystem approaches to management has led to significant increases in the modeling of marine ecosystems using various degrees of parameter and spatial resolution. Ecosystem modeling of the Western Pacific Region has progressed from simple mathematical models to dynamically parameterized simulation models (Polovina 1984; Polovina et al. 1994; Polovina et al. 2004).

While physical oceanographic models are well developed, modeling of trophic ecosystem components has lagged primarily because of the lack of reliable, detailed long-term data. Consequently, there is no single, fully integrated model that can simulate all of the ecological linkages between species and the environment (de Young et al. 2004).

De Young et al. (2004) examined the challenges of ecosystem modeling and presented several approaches to incorporating uncertainty into such models. However, Walters (2005) cautioned against becoming overly reliant on models to assess the relative risks of various management alternatives and suggested that modeling exercises should be used as aids in experimental design rather than as precise prescriptive tools.

2.7 Single-species Management Versus Multi-species Management

A major theme in ecosystem approaches to fisheries management is the movement from conventional single-species management to multi-species management (Mace 2004; Sherman 1986). Multi-species management is generally defined as management based on the consideration of all fishery impacts on all marine species rather than focusing on the maximum sustainable yield for any one species. The fact that many of the ocean’s fish stocks are believed to be overexploited (FAO 2002) has been used by some as evidence that single-species models and single-species management have failed (Hilborn 2004; Mace 2004). Hilborn (2004) noted that some of the species that were historically overexploited (e.g., whales, bluefin tuna) were not subject to any management measures, single- species or otherwise. In other cases (e.g., northern cod), it was not the models that failed but the political processes surrounding them (Hilborn 2004). Thus, a distinction must be made between the use of single-species or multi-species models and the application of their resultant management recommendations. Clearly, ecosystem management requires that all fishery impacts be considered when formulating management measures, and that both single-species and multi-species models are valuable tools in this analysis. In addition, fishery science and management must remain open and transparent, and must not be subjected to distorting political perspectives, whether public or private. However, it also appears clear that fishery regulations must continue to be written on a species-specific basis (e.g., allowing participants to land no more than two bigeye tuna and two fish of any other species per day), as to do otherwise would lead to species highgrading (e.g., allowing participants to land no more than four fish [all species combined] per day could result in each participant landing four bigeye tuna per day) and likely lead to overexploitation of the most desirable species.

Although successful ecosystem management will require the holistic analysis and consideration of marine organisms and their environment, the use of single-species models and management measures will remain an important part of fishery management (Mace 2004). If applied to all significant fisheries within an ecosystem, conservative single-species management has the potential to address many ecosystem management issues (ICES 2000; Murawski 2005; Witherell et al. 2000).

Recognizing the lack of a concise blueprint to implement the use of ecosystem indicators and models, there is growing support for building upon traditional single-species management to incrementally integrate and operationalize ecosystem principles through the use of geographically parameterized indicators and models (Browman and Stergiou 2004; Sissenwine and Murawski 2004).

2.8 Ocean Zoning

The use of ocean zoning to regulate fishing and non-fishing activities has been a second major theme in the development of marine ecosystem management theory (Browman and Stergiou 2004). In general, these zones are termed *Marine Protected Areas* (MPAs) and are implemented for a wide variety of objectives ranging from establishing wilderness areas to protecting economically important spawning stocks (Lubchenco et al. 2003). In 2000, Executive Order 13158 was issued for the purpose of expanding the Nation's existing system of MPAs to "enhance the conservation of our Nation's natural and cultural marine heritage and the ecologically and economically sustainable use of the marine environment for future generations." The Executive Order also established an MPA Federal Advisory Committee charged with providing expert advice and recommendations on the development of a national system of MPAs. In June 2005, this Committee released its first report, which includes a range of objectives and findings including the need for measurable goals, objectives, and assessments for all MPAs (NOAA 2005). Today, MPAs can be found throughout the Western Pacific Region and are considered to be an essential part of marine management. Ongoing research and outreach is anticipated to result in the implementation of additional MPAs as ecosystem research provides additional insights regarding appropriate MPA locations and structures to achieve specific objectives.

2.9 Intra-agency and Inter-agency Cooperation

To be successful, ecosystem approaches to management must be designed to foster intra- and inter-agency cooperation and communication (Schrope 2002). As discussed in Chapter 1, the Western Pacific Region includes an array of federal, state, commonwealth, territory, and local government agencies with marine management authority. Given that these many agencies either share or each has jurisdiction over certain areas or activities, reaching consensus on how best to balance resource use with resource protection is essential to resolving currently fragmented policies and conflicting objectives. Coordination with state and local governments will be especially important to the improved management of near-shore resources as these are not under federal authority. The recently released U.S. Ocean Action Plan (issued in response to the report of the U.S. Ocean Commission on Policy) recognized this need and established a new cabinet level Committee on Ocean Policy (U.S. Ocean Action Plan 2004) to examine and resolve these issues. One alternative would be to centralize virtually all domestic marine management authority within one agency; however, this would fail to utilize the local expertise and experience contained in existing agencies and offices, and would likely lead to poor decision making and increased social and political conflict.

2.10 Community-based Management

Communities are created when people live or work together long enough to generate local societies. Community members associate to meet common needs and express common interests, and relationships built over many generations lead to common cultural values and understandings through which people relate to each other and to their environment. At this point, collective action may be taken to protect local resources if they appear threatened, scarce, or subject to overexploitation. This is one example of community-based resource management.

As ecosystem principles shift the focus of fishery management from species to places, increased participation from the primary stakeholders (i.e., community members) can enhance marine management by (a) incorporating local knowledge regarding specific locations and ecosystem conditions; (b) encouraging the participation of stakeholders in the management process, which has been shown to lead to improved data collection and compliance; and (c) improving relationships between communities and often centralized government agencies (Dyer and McGoodwin 1994).

Top-down management tends to center on policy positions that polarize different interest groups and prevent consensus (Yaffee 1999). In contrast, "place"—a distinct locality imbued with meaning—has value and identity for all partners and can serve to organize collaborative partnerships. Despite often diverse backgrounds and frequently opposing perspectives, partners are inspired to take collective on-the-ground actions organized around their connections and affiliations with a particular place (Cheng et al. 2003).

In August 2004, President Bush issued Executive Order 13352 to promote partnerships between federal agencies and states, local governments, tribes, and individuals that will facilitate cooperative conservation and appropriate inclusion of local participation in federal decision making regarding the Nation's natural resources. Similarly, the U.S. Ocean Action Plan (2004) found that "local involvement by those closest to the resource and their communities is critical to ensuring successful, effective, and long-lasting conservation results."

Successful resource management will need to incorporate the perspectives of both local and national stakeholder groups in a transparent process that explicitly addresses issues of values, fairness, and identity (Hampshire et al. 2004). Given their long histories of sustainable use of marine resources, indigenous residents of the Western Pacific Region have not universally embraced increasingly prohibitive management necessitated by the modern influx of foreign colonizers and immigrants. In addition, some recent campaigns by non-governmental organizations representing often far-off groups vigorously opposed to virtually all use of marine resources have increased what many see as the separation of local residents from the natural environment that surrounds them. As humans are increasingly removed and alienated from the natural environment, feelings of local ownership and stewardship are likely to decline, and subsequent management and enforcement actions will become increasingly difficult (Hampshire et al. 2004). This is especially relevant in the Western Pacific Region, which comprises a collection of remote and far-flung island areas, most of which have poorly funded monitoring and enforcement capabilities.

2.10.1 Community Participation

The Council's community program developed out of the need for an indigenous program to address barriers to the participation of indigenous communities in fisheries managed by the Council. An objective of the indigenous program is to arrive at a point of collaboration, reconciliation and consensus between the native indigenous community and the larger immigrant communities in CNMI, Guam and Hawaii. The community in American Samoa is 80- 90 percent native but the objective is the same—to arrive at a point of collaboration, reconciliation and consensus with the larger U.S..

The Council's community program is consistent with the need for the development of Fishery Ecosystem Plans. Fishery Ecosystem Plans are place-based fishery management plans that allow the Council to incorporate ecosystem principles into fishery management. Human communities are important elements for consideration in ecosystem-based resource management plans. Resources are managed for people, communities. NOAA has recognized that communities are part of the ecosystem.

Any community-based initiative is about empowering the community. The Council's efforts to develop Fishery Ecosystem Plans are focused on community collaboration, participation and partnership. The efforts result in the development of strong community projects such as community-led data collection and monitoring programs and revitalization of traditional and cultural fishing practices. Finding and partnering with communities and organizations is time-consuming and resource depleting. Outreach to communities in the form of presentations and participation in school and community activities and other fora is ongoing to find projects that the Council can support.

Community-Based Resource Management (CBRM) is a way for communities to gain control of and manage their resources in ways that allow them to harvest and cultivate products in a sustainable manner. CBRM is based on the principle of empowering people to manage the natural and material resources that are critical to their community and regional success. This FEP increases the community's capacity and expertise in natural resource management, and provides viable alternatives to uncontrolled resource depletion.

Because of the Council's role in fishery conservation and management, many resources and skills are available within the Council. These assets form the base for the application of Asset Based Community Development (ABCD) – Community assets connected to organization assets produce strong community-based projects.

Community assets include, but are not limited to, cultural knowledge, resource areas, habitats, sites, organizations, schools, individuals, families, community diversity and all of the attributes that bring value to and define a community.

The community program of the Council is the application of Council assets to community assets to produce community-based projects that strengthen the community's ability to conserve and manage their marine resources.

2.10.2 Community Development

In recent years, attention has been given to the potential impact of growth and development on communities. In general, growth has been viewed as healthy and desirable for communities because it leads to additional jobs; increased economic opportunities; a broader tax base; increased access to public services and the enhancement of cultural amenities. Growth is also accompanied by changes in social structure, increased fiscal expenditures for necessary public services and infrastructure, increased traffic, increased and changed utilization and consumption of local natural resources and loss of open space and unique cultural attributes. Development decisions are often made without a sufficient understanding of the consequences of those decisions on overall community well-being. Changes induced by growth in a community are not always positive. Fishery ecosystem planning requires the participation of communities. Careful, planned decision-making is necessary for ensuring that growth and development is consistent with the long-range goals of the community.

CHAPTER 3: DESCRIPTION OF THE ENVIRONMENT

3.1 Introduction

Chapter 3 describes the environment and resources included within the Hawaii Archipelago FEP. For more information, please see the Council's FMP, FMP amendments and associated annual reports. Additional information is available[2] in a 2008 environmental assessment for the Crustaceans FMP (WPRFMC 2008a), a 2001 Final EIS for the Coral Reef Ecosystems FMP (WPRFMC 2001a), 2007 and 2008 environmental assessments for the Precious Corals FMP (WPRFMC 2007b, WPRFMC 2008b), a 2005 Final EIS to the Bottomfish FMP (WPRFMC 2005b), and a 2007 Final Supplemental EIS to the Bottomfish FMP (WPRFMC 2007a) which are incorporated here by reference. Although this FEP will not manage the Western Pacific Region's pelagic resources, successful ecosystem-based management requires consideration of interactions between the pelagic and demersal environments at an ecosystem level, and thus both are discussed here. Similarly, although this FEP will apply only to Federal waters around the Hawaii Archipelago, the environment and resources of nearshore (i.e., State of Hawaii) waters are also discussed so as to provide an overview of the area's entire demersal ecosystem.

3.2 Physical Environment

The following discussion presents a broad summary of the physical environment of the Pacific Ocean. The dynamics of the Pacific Ocean's physical environment have direct and indirect effects on the occurrence and distribution of life in marine ecosystems.

3.2.1 The Pacific Ocean

The Pacific Ocean is world's largest body of water. Named by Ferdinand Magellan as *Mare Pacificum* (Latin for "peaceful sea"), the Pacific Ocean covers more than one third of Earth's surface (~64 million square miles). From north to south, it's more than 9,000 miles long; from east to west, the Pacific Ocean is nearly 12,000 miles wide (on the Equator). The Pacific Ocean contains several large seas along its western margin including the South China Sea, Celebes Sea, Coral Sea, and Tasman Sea.

3.2.2 Geology and Topography

Pacific islands have been formed by geologic processes associated with plate tectonics, volcanism, and reef accretion. The theory of plate tectonics provides that Earth's outer shell, the "lithosphere", is constructed of more than a dozen large solid "plates" that migrate across the planet surface over time and interact at their edges. The plates sit above a solid rocky mantle that is hot, and capable of flow. Figure 3 is a schematic diagram of Earth's lithospheric plates. These are made of various kinds of rock with different densities and can be thought of as pieces of a giant jigsaw puzzle–where the movement of one plate affects the position of others. Generally, the oceanic portion of plates is composed of basalt enriched with iron and magnesium which is

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[2] Available from the Council at www.wpcouncil.org or at 1164 Bishop St. Ste 1400, Honolulu, HI 96813.

denser than the continental portion composed of granite which is enriched with silica.[3] Tectonic processes and plate movements define the contours of the Pacific Ocean. Generally, the abyssal plain or seafloor of the central Pacific basin is relatively uniform, with a mean depth of about 4270 m (14,000 ft).[4] Within the Pacific basin, however, are underwater plate boundaries that define long mountainous chains, submerged volcanoes, islands and archipelagos, and various other bathymetric features that influence the movement of water and the occurrence and distribution of marine organisms.

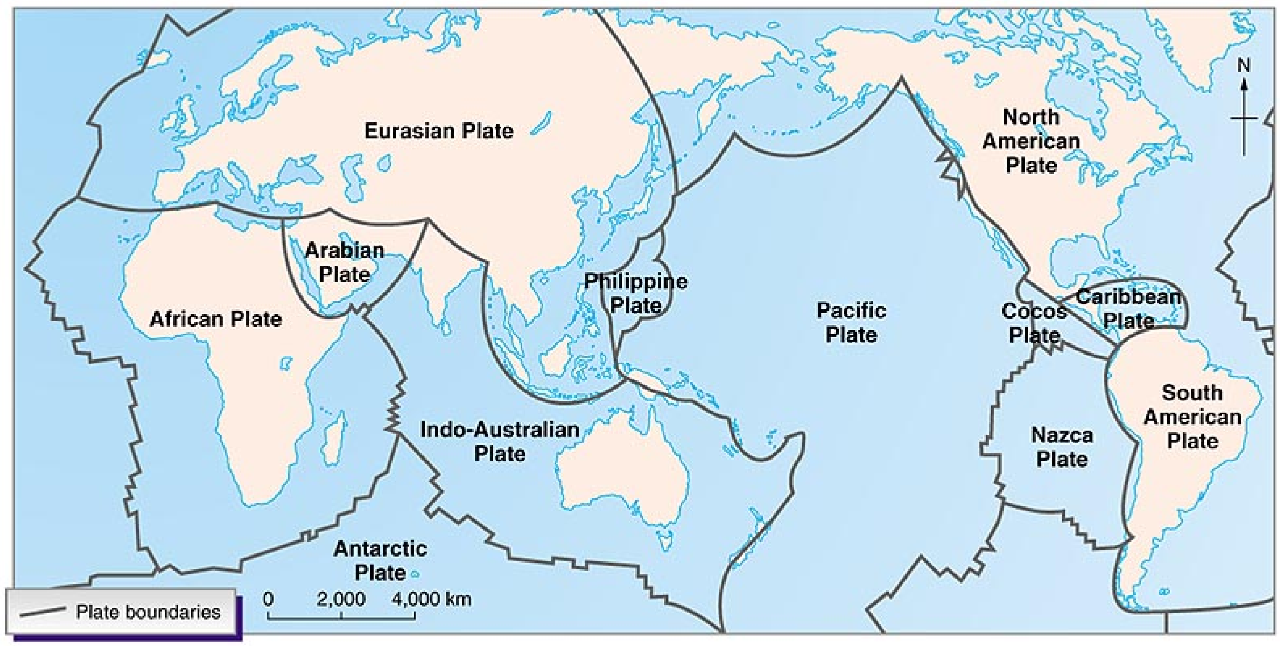

Figure 3: Schematic Diagram of the Earth's Lithospheric Plates
Source: Dr. C.H. Fletcher III, UH Dept. of Geology and Geophysics, personal communication

Divergent plate boundaries —locations where lithospheric plates separate from each other—form "spreading centers" where new seafloor is constructed atop high mid-ocean ridges. These ridges stretch for thousands of kilometers[5] and are characterized by active submarine volcanism and earthquakes. At these ridges, magma is generated at the top of the mantle immediately underlying an opening, or rift, in the lithosphere. As magma pushes up under the spreading lithosphere it inflates the ridges until a fissure is created and lava erupts onto the sea floor (Fryer and Fryer 1999). The erupted lava, and its subsequent cooling, forms new seafloor on the edges of the separating plates. This process is responsible for the phenomenon known as "seafloor spreading", where new ocean floor is constantly forming and sliding away from either side of the ridge.[6]

Convergent plate boundaries are locations where two plates move together and one plate, usually composed of denser basalt, subducts or slides beneath the other which is composed of less dense

[3] http://www.soest.hawaii.edu/coasts/chip/ch02/ch_2_7.asp
[4] http://www.physicalgeography.net/fundamentals/8o.html (accessed January 2007)
[5] http://www.washington.edu/burkemuseum/geo_history_wa/The Restless Earth v.2.0.htm (accessed July 2006)
[6] http://www.washington.edu/burkemuseum/geo_history_wa/The Restless Earth v.2.0.htm (accessed July 2006)

rock, and is recycled into the mantle. When two plates of equivalent density converge, the rock at the boundary fractures and shears like the front ends of two colliding cars, and forms a large mountain range. The Himalayan Range has this origin. There are three different types of plate convergence: 1) ocean-continent convergence, 2) ocean-ocean convergence, and 3) continent-continent convergence (Fryer and Fryer 1999). A well known example of ocean-ocean convergence is observed in the western Pacific, where the older and denser Pacific Plate subducts under the younger and less dense Philippine Plate at a very steep angle. This results in the formation of the Marianas Trench which at nearly 11 km (~36,000 ft) is the deepest point of the seafloor.[7] Ocean-ocean convergent boundary movements may result in the formation of island arcs, where the denser (generally older) plate subducts under the less dense plate. Melting in the upper mantle above the subducting plate generates magma that rises into the overlying lithosphere and may lead to the formation of a chain of volcanoes known as an island arc.[8] The Indonesian Archipelago has this geologic origin, as does the Aleutian Island chain.

Transform boundaries, a third type of plate boundary, occur when lithospheric plates neither converge nor diverge, but shear past one another horizontally, like two ships at sea that rub sides. The result is the formation of very hazardous seismic zones of faulted rock, of which California's San Andreas Fault is an example (Fryer and Fryer 1999).

In addition to the formation of island arcs from ocean-ocean convergence, dozens of linear island chains across the Pacific Ocean are formed from the movement of the Pacific Plate over stationary sources of molten rock known as hot spots (Fryer and Fryer 1999). A well known example of hot spot island formation is the Hawaiian Ridge-Emperor Seamounts chain that extends some 6,000 km from the "Big Island" of Hawaii (located astride the hotspot) to the Aleutian Trench off Alaska where ancient islands are recycled into the mantle.[9] Although less common, hot spots can also be found at mid-ocean ridges, exemplified by the Galapagos Islands in the Pacific Ocean.[10]

The Pacific Ocean contains nearly 25,000 islands which can be simply classified as high islands or low islands. High islands, like their name suggests, extend higher above sea level, and often support a larger number of flora and fauna and generally have fertile soil. Low islands are generally atolls built by layers of calcium carbonate secreted by reef building corals and calcareous algae on a volcanic core of a former high island that has submerged below sea level. Over geologic time, the rock of these low islands has eroded or subsided to where all that is remaining near the ocean surface is a broad reef platform surrounding a usually deep central lagoon (Nunn 2003).

3.2.3 Ocean Water Characteristics

Over geologic time, the Pacific Ocean basin has been filled in by water produced by physical and biological processes. A water molecule is the combination of two hydrogen atoms bonded with one oxygen atom. Water molecules have asymmetric charges, exhibiting a positive charge on the

[7] http://www.soest.hawaii.edu/coasts/chip/ch02/ch_2_7.asp
[8] http://www.soest.hawaii.edu/coasts/chip/ch02/ch_2_7.asp
[9] http://pubs.usgs.gov/publications/text/Hawaiian.html
[10] http://pubs.usgs.gov/publications/text/hotspots.html#anchor19620979

hydrogen sides and a negative charge on the oxygen side of the molecule. This charge asymmetry allows water to be an effective solvent, thus the ocean contains a diverse array of dissolved substances. Relative to other molecules, water takes a lot of heat to change temperature, and thus the oceans have the ability to store large amounts of heat. When water evaporation occurs, large amounts of heat are absorbed by the ocean (Tomczak and Godfrey 2003). The overall heat flux observed in the ocean is related to the dynamics of four processes: (a) incoming solar radiation, (b) outgoing back radiation,(c) evaporation, and (d) mechanical heat transfer between ocean and atmosphere (Bigg 2003).

The major elements (> 100 ppm) present in ocean water include chlorine, sodium, magnesium, calcium, and potassium, with chlorine and sodium being the most prominent, and their residue (sea salt–NaCL) is left behind when seawater evaporates. Minor elements (1–100 ppm) include bromine, carbon, strontium, boron, silicon, and fluorine. Trace elements (< 1 ppm) include nitrogen, phosphorus, and iron (Levington 1995).

Oxygen is added to seawater by two processes: (a) atmospheric mixing with surface water and (b) photosynthesis. Oxygen is subtracted from water through respiration and bacterial decomposition of organic matter (Tomczak and Godfrey 2003).

3.2.4 Ocean Layers

On the basis of the effects of temperature and salinity on the density of water (as well as other factors such as wind stress on water), the ocean can be separated into three layers: the surface layer or mixed layer, the thermocline or middle layer, and the deep layer. The surface layer generally occurs from the surface of the ocean to a depth of around 400 meters (or less depending on location) and is the area where the water is mixed by currents, waves, and weather. The thermocline is generally from 400 meters –to 800 meters and where water temperatures significantly differ from the surface layer, forming a temperature gradient that inhibits mixing with the surface layer. More than 90 percent of the ocean by volume occurs in the deep layer, which is generally below 800 meters and consists of water temperatures around 0–4° C. The deep zone is void of sunlight and experiences high water pressure (Levington 1995).

The temperature of ocean water is important to oceanographic systems. For example, the temperature of the mixed layer has an affect on the evaporation rate of water into the atmosphere, which in turn is linked to the formation of weather. The temperature of water also produces density gradients within the ocean, which prevents mixing of the ocean layers (Bigg 2003). See Figure 4 for a generalized representation of water temperatures and depth profiles.

The amount of dissolved salt or salinity varies between ocean zones, as well as across oceans. For example, the Atlantic Ocean has higher salinity levels than the Pacific Ocean due to input from the Mediterranean Sea (several large rivers flow into the Mediterranean). The average salt content of the ocean is 35 ppt, but it can vary at different latitudes depending on evaporation and precipitation rates. Salinity is lower near the equator than at middle latitudes due to higher rainfall amounts. Salinity also varies with depth causing vertical salinity gradients often observed in the oceans (Bigg 2003). See Figure 4 for a generalized representation of salinity at various ocean depths.

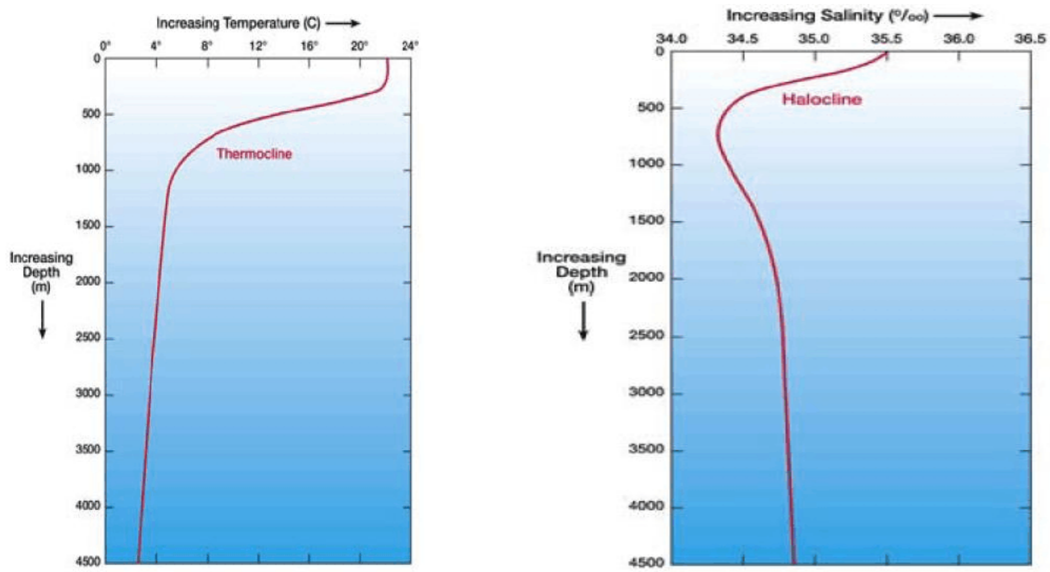

Figure 4: Temperature and Salinity Profile of the Ocean
Sources: http://www.windows.ucar.edu/tour/link=/earth/Water/temp.html&edu=high (accessed July 2005
http://www.windows.ucar.edu/tour/link=/earth/Water/salinity_depth.html&edu=high (accessed July 2005).

3.2.5 Ocean Zones

The ocean can be separated into the following five zones (see Figure 5) relative to the amount of sunlight that penetrates through seawater: (a) epipelagic, (b) mesopelagic, (c) bathypelagic, (d) abyssopelagic, and (e) hadalpelagic. Sunlight is the principle factor of primary production (phytoplankton) in marine ecosystems, and because sunlight diminishes with ocean depth, the amount of sunlight penetrating seawater and its affect on the occurrence and distribution of marine organisms are important. The epipelagic zone extends to nearly 200 meters and is the near extent of visible light in the ocean. The mesopelagic zone occurs between 200 meters and 1,000 meters and is sometimes referred to as the “twilight zone.” Although the light that penetrates to the mesopelagic zone is extremely faint, this zone is home to wide variety of marine species. The bathypelagic zone occurs from 1,000 feet to 4,000 meters, and the only visible light seen is the product of marine organisms producing their own light, which is called “bioluminescence.” The next zone is the abyssopelagic zone (4,000 m–6,000 m), where there is extreme pressure and the water temperature is near freezing. This zone does not provide habitat for very many creatures except small invertebrates such as squid and basket stars. The last zone is the hadalpelagic (6,000 m and below) and occurs in trenches and canyons. Surprisingly, marine life such as tubeworms and starfish are found is this zone, often near hydrothermal vents.

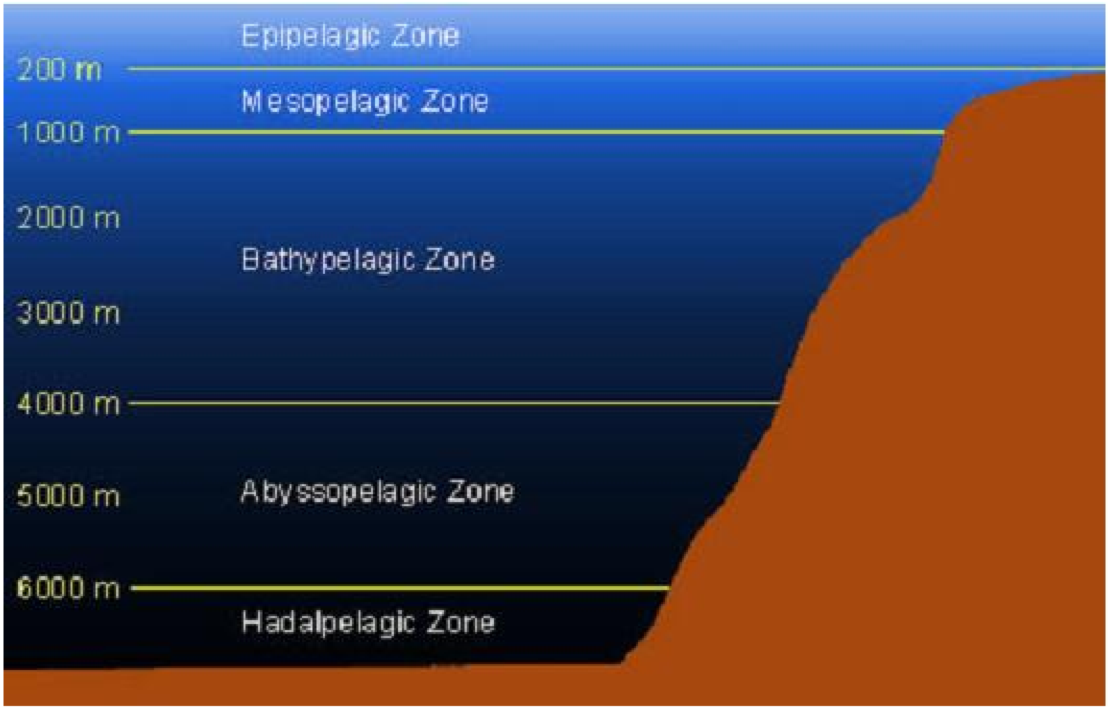

Figure 5: Depth Profile of Ocean Zones
Source: WPRFMC 2005b.

3.2.6 Ocean Water Circulation

The circulation of ocean water is a complex system involving the interaction between the oceans and atmosphere. The system is primarily driven by solar radiation that results in wind being produced from the heating and cooling of ocean water, and the evaporation and precipitation of atmospheric water. Except for the equatorial region, which receives a nearly constant amount of solar radiation, the latitude and seasons affect how much solar radiation is received in a particular region of the ocean. This, in turn, has an affect on sea–surface temperatures and the production of wind through the heating and cooling of the system (Tomczak and Godfrey 2003).

3.2.7 Surface Currents

Ocean currents can be thought of as organized flows of water that exist over a geographic scale and time period in which water is transported from one part of the ocean to another part of the ocean (Levington 1995). In addition to water, ocean currents also transport plankton, fish, heat, momentum, salts, oxygen, and carbon dioxide. Wind is the primary force that drives ocean surface currents; however, Earth's rotation and wind determine the direction of current flow. The sun and moon also influence ocean water movements by creating tidal flow, which is more readily observed in coastal areas rather than in open-ocean environments (Tomczak and Godfrey 2003). Figure 6 shows the major surface currents of the Pacific Ocean.

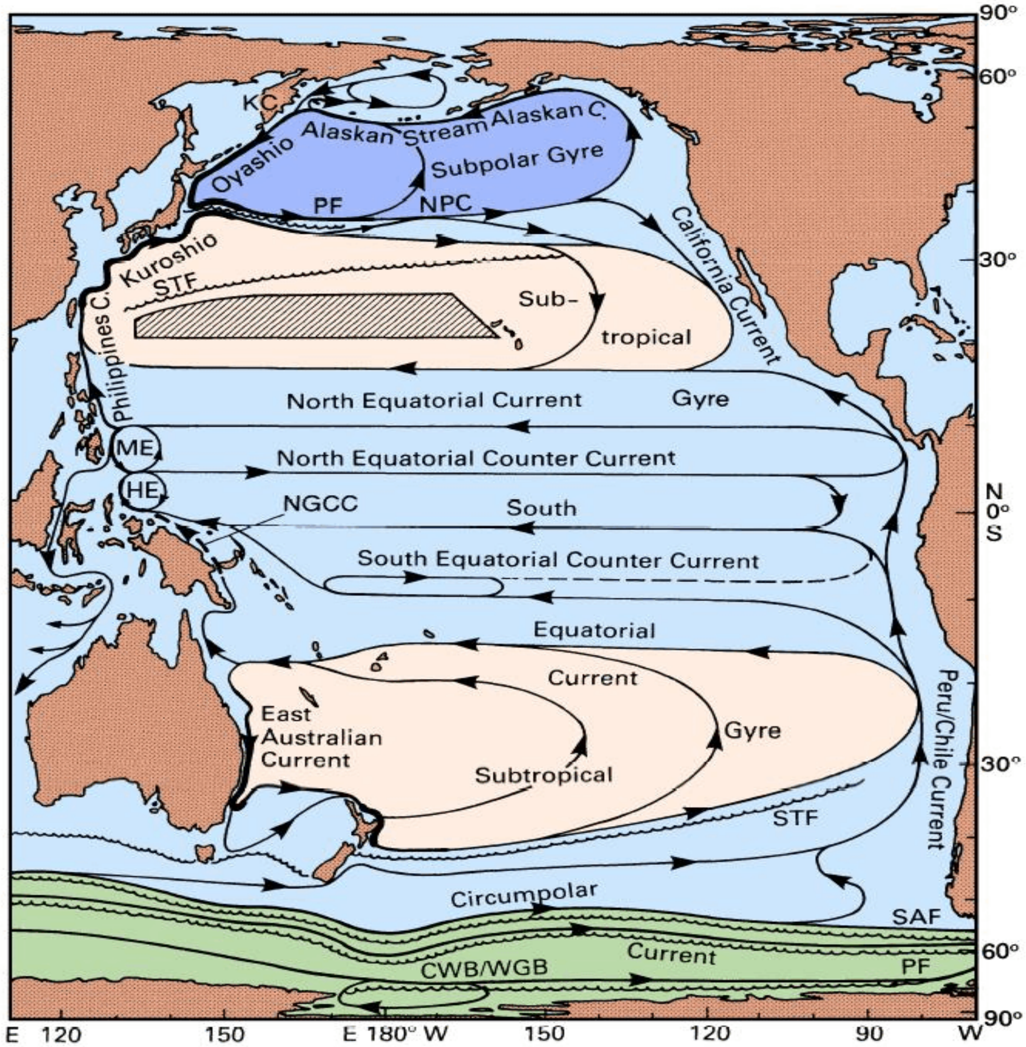

Figure 6: Major Surface Currents of the Pacific Ocean

Source: Tomczak and Godfrey 2003

Note:. Abbreviations are used for the Mindanao Eddy (ME), the Halmahera Eddy (HE), the New Guinea Coastal (NGCC), the North Pacific (NPC), and the Kamchatka Current (KC). Other abbreviations refer to fronts: NPC (North Pacific Current), STF (Subtropical Front), SAF (Subantarctic Front), PF (Polar Front), and CWB/WGB (Continental Water Boundary/Weddell Gyre Boundary). The shaded region indicates banded structure (Subtropical Countercurrents). In the western South Pacific Ocean, the currents are shown for April–November when the dominant winds are the Trades. During December–March, the region is under the influence of the northwest monsoon, flow along the Australian coast north of 18° S and along New Guinea reverses, the Halmahera Eddy changes its sense of rotation, and the South Equatorial Current joins the North Equatorial Countercurrent east of the eddy (Tomczak and Godfrey 2003).

3.2.8 Transition Zones

Transition zones are areas of ocean water bounded to the north and south by large-scale surface currents originating from subartic and subtropical locations (Polovina et al. 2001). Located generally between 32° N and 42° N, the North Pacific Transition Zone is an area between the southern boundary of the Subartic Frontal Zone (SAFZ) and the northern boundary of the Subtropical Frontal Zone (STFZ; see Figure 7). Individual temperature and salinity gradients are observed within each front, but generally the SAFZ is colder (~8° C) and less salty (~33.0 ppm) than the STFZ (18° C, ~35.0 ppm, respectively). The North Pacific Transition Zone (NPTZ) supports a marine food chain that experiences variation in productivity in localized areas due to changes in nutrient levels brought on, for example, by storms or eddies. A common characteristic among some of the most abundant animals found in the Transition Zone such as flying squid, blue sharks, Pacific pomfret, and Pacific saury is that they undergo seasonal migrations from summer feeding grounds in subartic waters to winter spawning grounds in the subtropical waters. Other animals found in the NPTZ include swordfish, tuna, albatross, whales, and sea turtles (Polovina et al. 2001).

3.2.9 Eddies

Eddies are generally short to medium term water movements that spin off of surface currents and can play important roles in regional climate (e.g., heat exchange) as well as the distribution of marine organisms. Large-scale eddies spun off of the major surface currents often blend cold water with warm water, the nutrient rich with the nutrient poor, and the salt laden with fresher waters (Bigg 2003). The edges of eddies, where the mixing is greatest, are often targeted by fishermen as these are areas of high biological productivity.

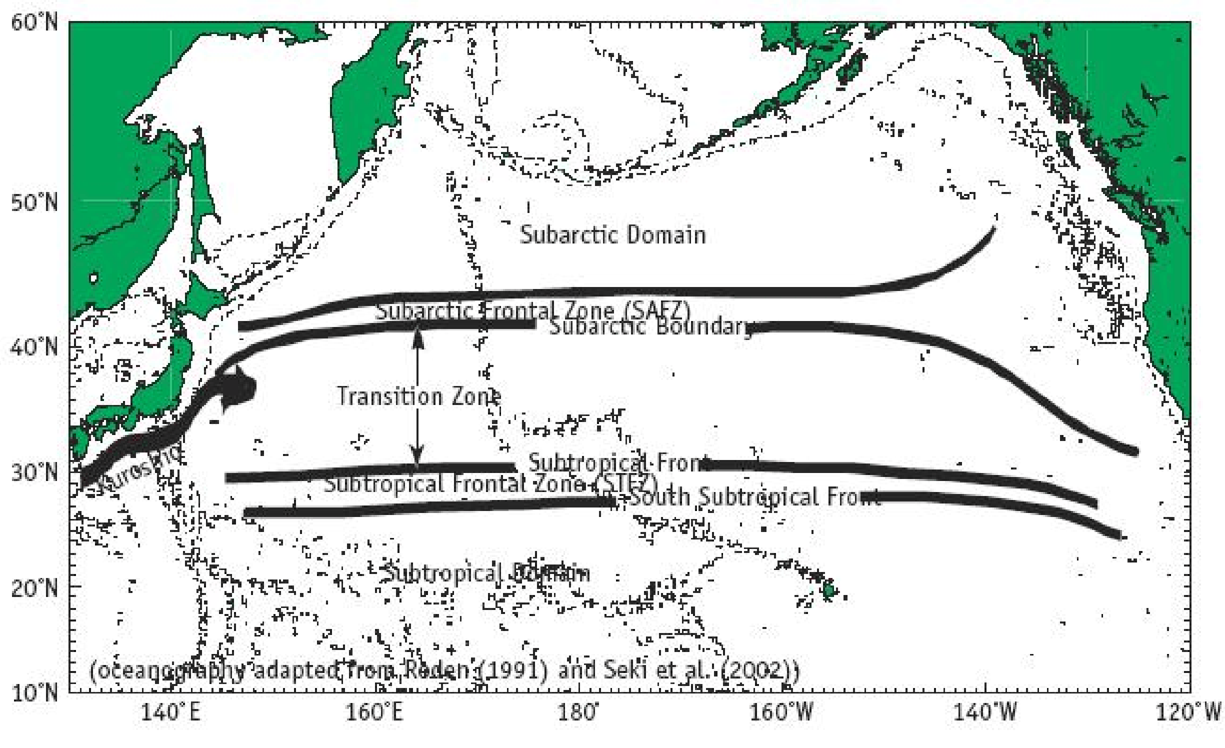

Figure 7: North Pacific Transition Zone
Source: http://www.pices.int/publications/special_publications/NPESR/2005/File_12_pp_201_210.pdf (accessed July 2005).

3.2.10 Deep-ocean Currents

Deep-ocean currents, or thermohaline movements, result from the effects of salinity and temperature on the density of seawater (Tomczak and Godfrey 2003). In the Southern Ocean, for example, water exuded from sea ice is extremely dense due to its high salt content. The dense seawater then sinks to the bottom and flows downhill filling up the deep polar ocean basins. The system delivers water to deep portions of the polar basins as the dense water spills out into oceanic abyssal plains. The movement of the dense water is influenced by bathymetry. For example, the Arctic Ocean does not contribute much of its dense water to the Pacific Ocean due to the narrow shallows of the Bering Strait. Generally, the deep-water currents flow through the Atlantic Basin, around South Africa, into the Indian Ocean, past Australia, and into the Pacific Ocean. This process has been labeled the "ocean conveyor belt"—taking nearly 1,200 years to complete one cycle. The movement of the thermohaline conveyor can affect global weather patterns, and has been the subject of much research as it relates to global climate variability. See Figure 8 for a simplified schematic diagram of the deep-ocean conveyor belt system.

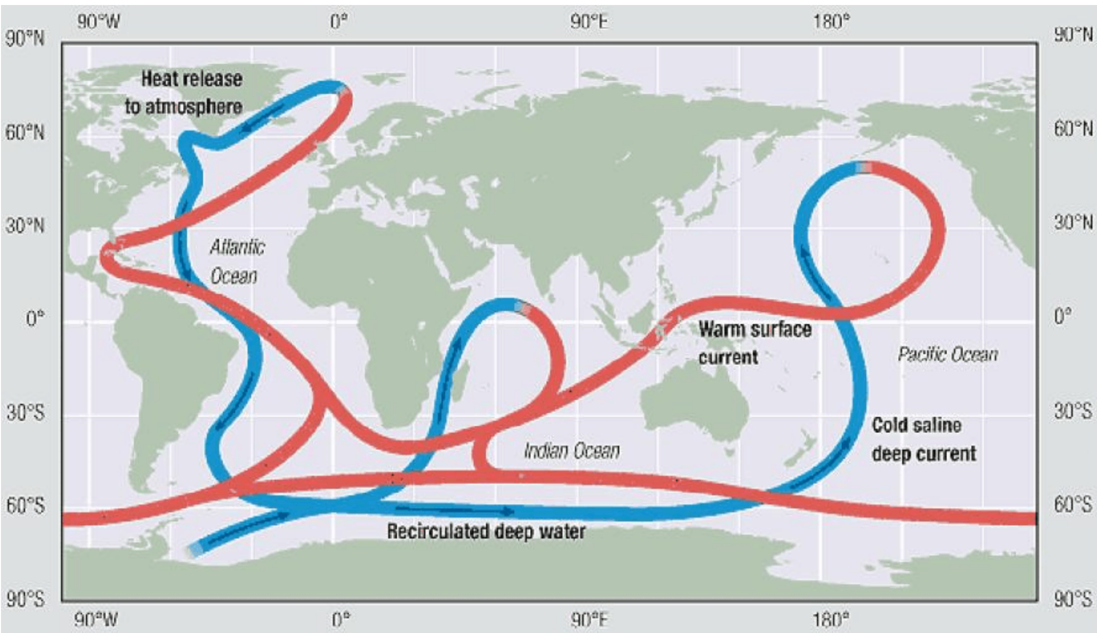

Figure 8: Deep Ocean Water Movement
Source:U.N. GEO Yearbook 2004

3.2.11 Prominent Pacific Ocean Meteorological Features

The air–sea interface is a dynamic relationship in which the ocean and atmosphere exchange energy and matter. This relationship is the basic driver for the circulation of surface water (through wind stress) as well as for atmospheric circulation (through evaporation). The formation of weather systems and atmospheric pressure gradients are linked to exchange of energy (e.g., heat) and water between air and sea (Bigg 2003).

Near the equator, intense solar heating causes air to rise and water to evaporate, thus resulting in areas of low pressure. Air flowing from higher trade wind pressure areas move to the low pressure areas such as the Intertropical Convergence Zone (ITCZ) and the South Pacific Convergence Zone (SPCZ), which are located around 5° N and 30° S, respectively. Converging trade winds in these areas do not produce high winds, but instead often form areas that lack significant wind speeds. These areas of low winds are known as the "doldrums." The convergence zones are associated near ridges of high sea–surface temperatures, with temperatures of 28° C and above, and are areas of cloud accumulation and high rainfall amounts. The high rainfall amounts reduce ocean water salinity levels in these areas (Sturman and McGowan 2003).

The air that has risen in equatorial region fans out into the higher troposphere layer of the atmosphere and settles back toward Earth at middle latitudes. As air settles toward Earth, it creates areas of high pressure known as subtropical high-pressure belts. One of these high-pressure areas in the Pacific is called the "Hawaiian High Pressure Belt," which is responsible for the prevailing trade wind pattern observed in the Hawaiian Islands (Sturman and McGowan 2003).

The Aleutian Low Pressure System is another prominent weather feature in the Pacific Ocean and is caused by dense polar air converging with air from the subtropical high-pressure belt. As these air masses converge around 60° N, air is uplifted, creating an area of low pressure. When the relatively warm surface currents (Figure 8) meet the colder air temperatures of subpolar regions, latent heat is released, which causes precipitation. The Aleutian Low is an area where large storms with high winds are produced. Such large storms and wind speeds have the ability to affect the amount of mixing and upwelling between ocean layers (e.g., mixed layer and thermocline, Polovina et al. 1994).

The Hawaii Archipelago is subject to high wave energy produced from weather systems generated off the Aluetian Islands and other areas of the North Pacific. Such waves can have major effects on the nearshore environment. For example, high wave energies can break off pieces of coral, move underwater boulders, shift large volumes of sand, and erode islands (Grigg 2002).

The dynamics of the air–sea interface do not produce steady states of atmospheric pressure gradients and ocean circulation. As discussed in the previous sections, there are consistent weather patterns (e.g., ITCZ) and surface currents (e.g., north equatorial current); however, variability within the ocean–atmosphere system results in changes in winds, rainfall, currents, water column mixing, and sea-level heights, which can have profound effects on regional climates as well as on the abundance and distribution of marine organisms.

One example of a shift in ocean–atmospheric conditions in the Pacific Ocean is El Niño–Southern Oscillation (ENSO). ENSO is linked to climatic changes in normal prominent weather features of the Pacific and Indian Oceans, such as the location of the ITCZ. ENSO, which can occur every 2–10 years, results in the reduction of normal trade winds, which reduces the intensity of the westward flowing equatorial surface current (Sturman and McGowan 2003). In turn, the eastward flowing countercurrent tends to dominate circulation, bringing warm, low-salinity low-nutrient water to the eastern margins of the Pacific Ocean. As the easterly trade winds are reduced, the normal nutrient-rich upwelling system does not occur, leaving warm surface water pooled in the eastern Pacific Ocean.

The impacts of ENSO events are strongest in the Pacific through disruption of the atmospheric circulation, generalized weather patterns, and fisheries. ENSO affects the ecosystem dynamics in the equatorial and subtropical Pacific by considerable warming of the upper ocean layer, rising of the thermocline in the western Pacific and lowering in the east, strong variations in the intensity of ocean currents, low trade winds with frequent westerlies, high precipitation at the dateline, and drought in the western Pacific (Sturman and McGowan 2003). ENSO events have the ability to significantly influence the abundance and distribution of organisms within marine ecosystems. Human communities also experience a wide range of socioeconomic impacts from ENSO such as changes in weather patterns resulting in catastrophic events (e.g., mudslides in California due to high rainfall amounts) as well as reductions in fisheries harvests (e.g., collapse of anchovy fishery off Peru and Chile; Levington 1995; Polovina 2005).

Changes in the Aleutian Low Pressure System are another example of interannual variation in a prominent Pacific Ocean weather feature profoundly affecting the abundance and distribution of marine organisms. Polovina et al. (1994) found that between 1977 and 1988 the intensification of the Aleutian Low Pressure System in the North Pacific resulted in a deeper mixed-layer depth, which led to higher nutrients levels in the top layer of the euphotic zone. This, in turn, led to an increase in phytoplankton production, which resulted in higher productivity levels (higher abundance levels for some organisms) in the Northwestern Hawaiian Islands. Changes in the Aleutian Low Pressure System and its resulting effects on phytoplankton productivity are thought to occur generally every ten years. The phenomenon is often referred to as the "Pacific Decadal Oscillation" (Polovina 2005; Polovina et al. 1994).

3.2.12 Pacific Island Geography

The following sections briefly describe the island areas of the Western Pacific Region to provide background on the diversity of island nations and the corresponding physical and political geography surrounding the Hawaii Archipelago. The Pacific islands can be generally grouped into three major areas: (a) Micronesia, (b) Melanesia, and (c) Polynesia. However, the islands of Japan and the Aleutian Islands in the North Pacific are generally not included in these three areas, and they are not discussed here as this analysis focuses on the Western Pacific Region and its ecosystems. Information used in this section was obtained from the online version of the U.S.Central Intelligence Agency's World Fact Book. [11]

3.2.12.1 Micronesia

Micronesia, which is primarily located in the western Pacific Ocean, is made up of hundreds of high and low islands within six archipelagos: (a) Caroline Islands, (b) Marshall Islands, (c) Mariana Islands, (d) Gilbert Islands, (e) Line Islands, and (f) Phoenix Islands.

[11] http://www.cia.gov/cia/publications/factbook/index.html

The Caroline Islands (~850 square miles) are composed of many low coral atolls, with a few high islands. Politically, the Caroline Islands are separated into two countries: Palau and the Federated States of Micronesia.

The Marshall Islands (~180 square miles) are made up of 34 low-lying atolls separated by two chains: the southeastern Ratak Chain and the northwestern Ralik Chain. Wake Island is geologically a part of the Marshall Islands archipelago.

Nauru (~21 square miles), located southeast of the Marshall Islands, is a raised coral reef atoll rich in phosphate. The island is governed by the Republic of Nauru, which is the smallest independent nation in the world.

The Mariana Islands (~396 square miles) are composed of 15 volcanic islands that are part of a submerged mountain chain that stretches nearly 1,500 miles from Guam to Japan. Politically, the Mariana Islands are split into the Territory of Guam and the Commonwealth of Northern Mariana Islands (CNMI), both of which are U.S. possessions.

The Gilbert Islands are located south of the Marshall Islands and are made up of 16 low-lying atolls.

The Line Islands, located in the central South Pacific, are made up of ten coral atolls, of which Kirimati is the largest in the world (~609 square miles). The U.S. possessions of Kingman Reef, Palmyra Atoll, and Jarvis Island are located within the Line Islands. Most of the islands and atolls in these three chains, however, are part of the Republic of Kiribati (~ 811 square miles), which has an EEZ of nearly one million square miles.

The Phoenix Islands, located to the southwest of the Gilbert Islands, are composed of eight coral atolls. Howland and Baker Islands (U.S. possessions) are located within the Phoenix archipelago.

3.2.12.2 Melanesia

Melanesia is composed of several archipelagos that include: (a) Fiji Islands, (b) New Caledonia, (c) Solomon Islands, (d) New Guinea, (e) Bismarck Archipelago, (f) Louisiade Islands, (g) Tobriand Islands, (h) Maluku Islands, (i) Torres Strait Islands, and (j) Vanuatu Islands.

Located approximately 3,500 miles northeast of Sydney, Australia, the Fiji archipelago (~18,700 square miles) is composed of nearly 800 islands: the largest islands are volcanic in origin and the smallest islands are coral atolls. The two largest islands, Viti Levu and Vanua Levu, make up nearly 85 percent of the total land area of the Republic of Fiji Islands.

Located nearly 750 miles east–northeast of Australia, is the volcanic island of Grande Terre or New Caledonia (~6,300 square miles). New Caledonia is French Territory and includes the nearby Loyalty Islands and the Chesterfield Islands, which are groups of small coral atolls.

The Solomon Islands (~27,500 square miles) are located northwest of New Caledonia and east of Papua New Guinea. Thirty volcanic islands and several small coral atolls make up this former

British colony, which is now a member of the Commonwealth of Nations. The Solomon Islands are made up of smaller groups of islands such as the New Georgia Islands, the Florida Islands, the Russell Islands, and the Santa Cruz Islands. Approximately 1,500 miles separate the western and eastern island groups of the Solomon Islands.

New Guinea is the world's second largest island and is thought to have separated from Australia around 5000 BC. New Guinea is split between two nations: Indonesia (west) and Papua New Guinea (east). Papua New Guinea (~178,700 square miles) is an independent nation that also governs several hundred small islands within several groups. These groups include the Bismarck Archipelago and the Louisiade Islands, which are located north of New Guinea, and Tobriand Islands, which are southeast of New Guinea. Most of the islands within the Bismarck and Lousiade groups are volcanic in origin, whereas the Tobriand Islands are primarily coral atolls. The Maluku Islands (east of New Guinea) and the Torres Strait Islands (between Australia and New Guniea) are also classified as part of Melanesia. Both of these island groups are volcanic in origin. The Maluku Islands are under Indonesia's governance, while the Torres Strait Islands are governed by Australia.

The Vanuatu Islands (~4,700 square miles) make up an archipelago that is located to the southeast of the Solomon Islands. There are 83 islands in the approximately 500-mile long Vanuatu chain, most of which are volcanic in origin. Before becoming an independent nation in 1980 (Republic of Vanuatu), the Vanuatu Islands were colonies of both France and Great Britain, and known as New Hebrides.

3.2.12.3 Polynesia

Polynesia is composed of several archipelagos and island groups including (a) New Zealand and associated islands, (b) Tonga, (c) Samoa Islands, (d) Tuvalu, (e) Tokelau, (f) Cook Islands, (g) Territory of French Polynesia , (h) Pitcairn Islands (i) Easter Island, and (h) Hawaii.

New Zealand (~103,470 square miles) is composed of two large islands, North Island and South Island, and several small island groups and islands. North Island (~44,035 square miles) and South Island (~58,200 square miles) extend for nearly 1,000 miles on a northeast–southwest axis and have a maximum width of 450 miles. The other small island groups within the former British colony include the Chatham Islands and the Kermadec Islands. The Chatham Islands are a group of ten volcanic islands located 800 kilometers east of South Island. The four emergent islands of the Kermadec Islands are located 1,000 kilometers northeast of North Island and are part of a larger island arc with numerous subsurface volcanoes. The Kermadec Islands are known to be an active volcanic area where the Pacific Plate subducts under the Indo-Australian Plate.

The islands of Tonga (~290 square miles) are located 450 miles east of Fiji and consist of 169 islands of volcanic and raised limestone origin. The largest island, Tongatapu (~260 square miles), is home to two thirds of Tonga's population (~106,000). The people of Tonga are governed under a hereditary constitutional monarchy.

The Samoa archipelago is located northeast of Tonga and consists of seven major volcanic islands, several small islets, and two coral atolls. The largest islands in this chain are Upolu

(~436 square miles) and Savai`i (~660 square miles). Upolu and Savai`i and its surrounding islets and small islands are governed by the Independent State of Samoa with a population of approximately 178,000 people. Tutuila (~55 square miles), the Manua Islands (a group of three volcanic islands with a total land area of less than 20 square miles), and two coral atolls (Rose Atoll and Swains Island) are governed by the U.S. Territory of American Samoa. More than 90 percent of American Samoa's population (~68,000 people) live on Tutuila. The total land mass of American Samoa is about 200 square kilometers, surrounded by an EEZ of approximately 390,000 square kilometers.

Approximately 600 miles northwest of the Samoa Islands is Tuvalu (~10 square miles), an independent nation made up of nine low-lying coral atolls. None of the islands have elevation higher than 14 feet, and the total population of the country is around 11,000 people. Tuvalu's coral island chain extends for nearly 360 miles, and the country has an EEZ of 350,000 square miles.

East of Tuvalu and north of Samoa are the Tokelau Islands (~4 square miles). Three coral atolls make up this territory of New Zealand, and a fourth atoll (Swains Island) is of the same group, but is controlled by the U.S Territory of American Samoa.

To the east of the Samoa archipelago are the Cook Islands (~90 square miles), which are separated into the Northern Group and Southern Group. The Northern Group consists of six sparsely populated coral atolls, and the Southern Group consists of seven volcanic islands and two coral atolls. Rorotonga (~26 square miles), located in the Southern Group, is the largest island in the Cook Islands and also serves as the capitol of this independent island nation. From north to south, the Cook Islands spread nearly 900 miles, and the width between the most distant islands is nearly 450 miles. The Cook Islands EEZ is approximately 850,000 square miles.

The 32 volcanic islands and 180 coral atolls of the Territory of French Polynesia (~ 1,622 square miles) are made up of the following six groups: the Austral Islands, Bass Islands, Gambier Islands, Marquesas Islands, Society Islands, and the Tuamotu Islands. The Austral Islands are a group of six volcanic islands in the southern portion of the territory. The Bass Islands are a group of two islands in the southern-most part of the territory, with their vulcanism appearing to be much more recent than that of the Austral Islands. The Gambier Islands are a small group of volcanic islands in a southeastern portion of the Territory and are often associated with the Tuamotu Islands because of their relative proximity; however, they are a distinct group because they are of volcanic origin rather than being coral atolls. The Tuamotu Islands, of which there are 78, are located in the central portion of the Territory and are the world's largest chain of coral atolls. The Society Islands are group of several volcanic islands that include the island of Tahiti. The island of Tahiti is home to nearly 70 percent of French Polynesia's population of approximately 170,000 people. The Marquesa Islands are an isolated group of islands located in the northeast portion of the territory, and are approximately 1,000 miles northeast of Tahiti. All but one of the 17 Marquesas Islands are volcanic in origin. French Polynesia has one of the largest EEZs in the Pacific Ocean at nearly two million square miles.

The Pitcairn Islands are a group of five islands thought to be an extension of the Tuamotu archipelago. Pitcairn Island is the only volcanic island, with the others being coral atolls or uplifted limestone. Henderson Island is the largest in the group; however, Pitcairn Island is the only one that is inhabited.

Easter Island, a volcanic high island located approximately 2,185 miles west of Chile, is thought to be the eastern extent of the Polynesian expansion. Easter Island, which is governed by Chile, has a total land area of 63 square miles and a population of approximately 3,790 people.

The northern extent of the Polynesian expansion is the Hawaiian Islands, which are made up of 137 islands, islets, and coral atolls. The exposed islands are part of a great undersea mountain range known as the Hawaiian-Emperor Seamount Chain, which was formed by a hot spot within the Pacific Plate. The Hawaiian Islands extend for nearly 1,500 miles from Kure Atoll in the northwest to the Island of Hawaii in the southeast. The Hawaiian Islands are often grouped into the Northwestern Hawaiian Islands (Nihoa to Kure) and the Main Hawaiian Islands (Hawaii to Niihau). The total land area of the 19 primary islands and atolls is approximately 6,423 square miles, and the over 75 percent of the 1.2 million population lives on the island of Oahu.

3.3 Biological Environment

This section contains general descriptions of marine trophic levels, food chains, and food webs, as well as a description of two general marine environments: benthic or demersal (associated with the seafloor) and pelagic (the water column and open ocean). A broad description of the types of marine organisms found within these environments is provided, as well as a description of organisms important to fisheries. Protected species are also described in this section. This section is intended to provide background information on the ecosystems which will be given consideration in managing the fisheries of the Hawaii Archipelago.

3.3.1 Marine Food Chains, Trophic Levels, and Food Webs

Food chains are often thought of as a linear representation of the basic flow of organic matter and energy through a series of organisms. Food chains in marine environments are normally segmented into six trophic levels: primary producers, primary consumers, secondary consumers, tertiary consumers, quaternary consumers, and decomposers.

Generally, primary producers in the marine ecosystems are organisms that fix inorganic carbon into organic carbon compounds using external sources of energy (i.e., sunlight). Such organisms include single-celled phytoplankton, bottom-dwelling algae, macroalgae (e.g., sea weeds), and vascular plants (e.g., kelp). All of these organisms share common cellular structures called “chloroplasts,” which contain chlorophyll. Chlorophyll is a pigment that absorbs the energy of light to drive the biochemical process of photosynthesis. Photosynthesis results in the transformation of inorganic carbon into organic carbon such as carbohydrates, which are used for cellular growth.

Primary consumers in the marine environment are organisms that feed on primary or higher level producers, and depending on the environment (i.e., pelagic vs. benthic) include zooplankton, corals, sponges, many fish, sea turtles, and other herbivorous organisms. Secondary, tertiary, and quaternary consumers in the marine environment are organisms that feed on primary consumers and include fish, mollusks, crustaceans, mammals, and other carnivorous and omnivorous organisms. Decomposers live off dead plants and animals, and are essential in food chains as they break down organic matter and make it available for primary producers (Valiela 2003).

The microbial loop is the trophic pathway in aquatic environments where dissolved organic carbon (DOC) is reintroduced to the food web through the incorporation into bacteria. Bacteria are consumed mostly by protists such as flagellates and ciliates. These protists, in turn, are consumed by larger aquatic organisms (for example small crustaceans like copepods). The DOC is introduced into aquatic environments from several sources, such as the leakage of fixed carbon from algal cells or the excretion of waste products by aquatic animals and microbes. DOC is also produced by the breakdown and dissolution of organic particles. In inland waters and coastal environments, DOC can originate from terrestrial plants and soils. For the most part, this dissolved carbon is unavailable to aquatic organisms other than bacteria. Thus, the reclamation of this organic carbon into food web results in additional energy available to higher trophic levels (e.g., fish). Because microbes are the base of the food web in most aquatic environments, the trophic efficiency of the microbial loop has a profound impact on important aquatic processes. Such processes include the productivity of fisheries and the amount of carbon exported to the ocean floor.

Marine food webs are complex representations of overall patterns of feeding among organisms, but generally they are unable to reflect the true complexity of the relationships between organisms, so they must be thought of as simplified representations. An example of a marine food web applicable to the western Pacific is presented in Figure 9. The openness of marine ecosystems, lack of specialists, long life spans, and large size changes and food preferences across the life histories of many marine species make marine food webs more complex than their terrestrial and freshwater counterparts (Link 2002). Nevertheless, food webs are an important tool in understanding ecological relationships among organisms.

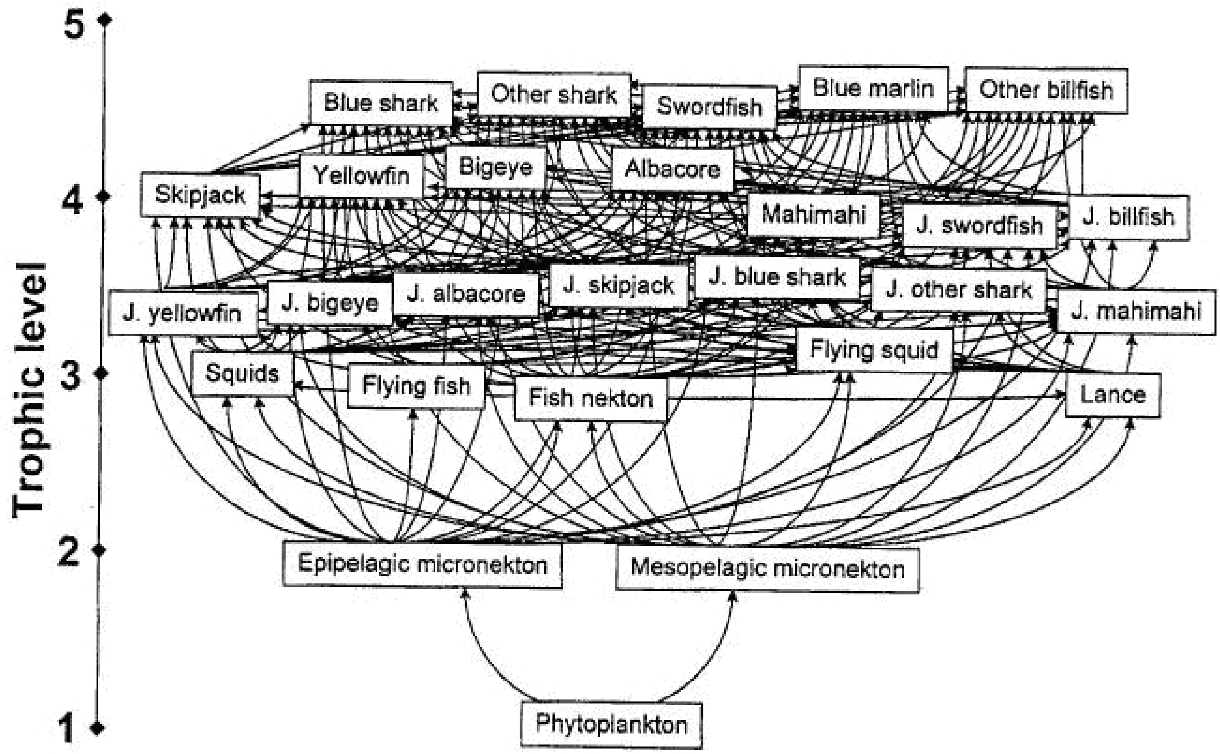

Figure 9: Central Pacific Pelagic Food Web
Source: Kitchell et al. 1999

3.3.2 Benthic Environment

The word *benthic* comes from the Greek work *benthos* or "depths of the sea." The definition of the benthic (or demersal) environment is quite general in that it is regarded as extending from the high-tide mark to the deepest depths of the ocean floor. Benthic habitats are home to a wide range of marine organisms forming complex community structures. This section presents a simple description of the following benthic zones: (a) intertidal, (b) subtidal (e.g., coral reefs), (c) banks and seamounts, (d) deep-reef slope, and (e) deep-ocean bottom (see Figure 10).

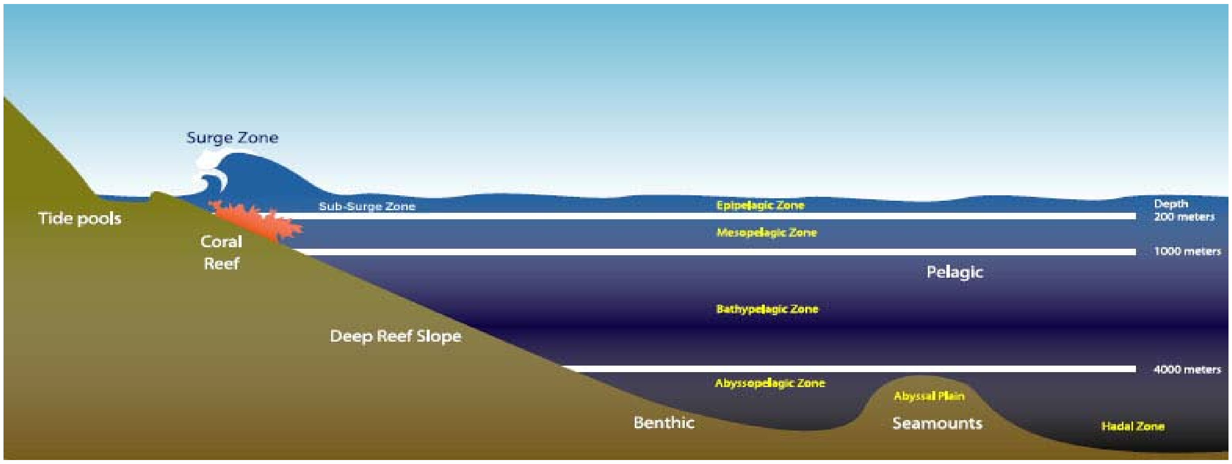

Figure 10: Benthic Environment
Source: WPRFMC 2005b

3.3.2.1 Intertidal Zone

The intertidal zone is a relatively small margin of seabed that exists between the highest and lowest extent of the tides. Because of wave action on unprotected coastlines, the intertidal zone can sometimes extend beyond tidal limits due to the splashing effect of waves. Vertical zonation among organisms is often observed in intertidal zones, where the lower limits of some organisms are determined by the presence of predators or competing species, whereas the upper limit is often controlled by physiological limits and species' tolerance to temperature and drying (Levington 1995). Organisms that inhabit the intertidal zone include algae, seaweeds, mollusks, crustaceans, worms, echinoderms (starfish), and cnidarians (e.g., anemones).

Many organisms in the intertidal zone have adapted strategies to combat the effects of temperature, salinity, and desiccation due to the wide-ranging tides of various locations. Secondary and tertiary consumers in intertidal zones include starfish, anemones, and seabirds. Marine algae are the primary produces in most intertidal areas. Many species' primary consumers such as snails graze on algae growing on rocky substrates in the intertidal zone. Due to the proximity of the intertidal zone to the shoreline, intertidal organisms are important food items to many human communities. In Hawaii, for example, intertidal limpet species (snails) such as `opihi (*Cellana exarata*) were eaten by early Hawaiian communities and are still a popular food item in Hawaii today. In addition to mollusks, intertidal seaweeds are also important food items for Pacific islanders.

3.3.2.2 Seagrass Beds

Seagrasses 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), seagrasses 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. Seagrass beds are the habitat of certain commercially valuable shrimps, and provide food for reef-associated species such as surgeonfishes (Acanthuridae). Seagrasses are also important sources of nutrition for higher vertebrates such as green sea 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 coral reef 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.

3.3.2.3 Mangrove Forests

Mangroves are terrestrial shrubs and trees that are able to live in the salty environment of the intertidal zone. In their native habitat, their prop roots form important substrate on which sessile organisms can grow, and they provide shelter for fishes. Mangroves are believed to also provide important nursery habitat for many juvenile reef fishes. The natural eastern limit of mangroves in the Pacific is American Samoa. Apart from the usefulness of the wood for building, charcoal, and tannin, mangrove forests can stabilize areas where sedimentation is occurring and may be important as nursery grounds for peneaeid shrimps and some inshore fish species. They may also provide a habitat for some commercially valuable crustaceans.

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). Oriental Mangrove (*Bruguiera gymnorrhiza*), another introduction, is known from Oahu and Molokai and rapidly spreading in some areas. Mangroves are invasive species in Hawaii where they have become established on all the major Hawaiian Islands. Chimner et al. (2006) found that mangroves are still expanding at a rapid rate on Oahu and have colonized many different landforms including tidal flats, riverbanks, fishponds, canals, embayments, lagoons, and some reef areas that are protected from strong waves and currents. Mangroves change water quality, alter food chains, and displace vegetation in areas where native waterbirds breed (Enoki 2004). Numerous research and restoration projects are being implemented to monitor and quantify mangrove expansion, and control mangroves through removal and efforts to prevent re-establishment.

3.3.2.4 Coral Reefs

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 in the Pacific Ocean, coral reefs are confined to the warm tropical and subtropical waters lying between 30° N and 30° S. Coral reef ecosystems are some of 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 (Hatcher et al. 1989).

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

The symbiotic relationship between the animal coral polyps and algal cells (dinoflagellates) 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, because of the low nitrogen content of the carbohydrates derived from photosynthesis. Due to reef-building coral's symbiotic relationship with photosynthetic zooxanthellae, reef-building corals do not generally occur at depths greater than 100 meters (~300 feet; Hunter 1995).

Primary production on coral reefs is associated with phytoplankton, algae, seagrasses, and zooxanthellae. Primary consumers include many different species of corals, mollusks, crustaceans, echinoderms, gastropods, sea turtles, and fish (e.g., parrot fish). Secondary consumers include anemones, urchins, crustaceans, and fish. Tertiary consumers include eels, octopus, barracudas, and sharks.

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, which is in common with the distribution of fish and invertebrate species. More than 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 hard coral (about 65 species in 17 genera) and, more important, 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. Furthermore, 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).

Coral Reefs of the Hawaii Archipelago

The total potential coral reef area in Hawaii (MHI and NWHI) is estimated to be 2,826 square kilometers within the 10-fathom curve, and 20,437 square miles within the 100-fathom curve, respectively (Rohmann et al. 2005). The MHI represent the younger portion of the Hawaii Archipelago, and have less well-developed fringing reefs that have not subsided as far below sea level as those in the NWHI (Smith 1993). The potential coral reef area surrounding the MHI is estimated at 1,231 square kilometers within the 10-fathom contour (Rohmann et al. 2005).

NOAA's *The State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2005* (NOAA 2005a) concluded that the condition of coral reef ecosystems around the Hawaii Archipelago ranges from fair to excellent, but many MHI reefs are threatened by continued population growth, overfishing, urbanization, runoff and development. Ocean outfalls, urban growth and coastal developments (i.e., hotels, golf courses etc.) are focal points for coral reef degredation. NOAA also found that coral populations in the Hawaii Archipelago continue to be spared from the epidemic disease outbreaks seen in many other coral reefs around the world, and no major die-off of corals has ever been documented due to disease in Hawaii. However, diseases are present and NOAA's baseline study at 18 sites around Oahu found an average disease prevalence (number of diseased colonies/total number of colonies) of 0.95 percent (range 0-4.4 percent). Diseases found include growth anamolies or "tumors", trematode infection and general coral necroses. Similar studies in the NWHI found evidence of coral disease at very low levels at 68.5 percent of the sites studied. The most common was *Porites trematodiasis* which was found at 57.5 percent of the sites. The overall prevalence of disease was estimated at 0.5 percent (range 0-7.1 percent).

The following description of the impacts of tropical storms and storm related waves on Hawaii's reefs is drawn from NOAA (2005a). Breaking waves from surf generated by Pacific storms is the single most important factor in determining the community structure of exposed reef communities throughout the MHI. The NWHI are only rarely in the path of tropical storms and hurricanes but the impacts of large wave events resulting from extratropical storms passing across the North Pacific each winter are thought to be significant. These extreme wave events subject the shallow water coral reef communities to at least one order of magnitude more energy than the typical winter waves. As such, these extreme wave events are believed to play a fundamental role in forming and maintaining biogeographic (spatial and vertical) distributions of corals, algae, and fishes in the coral reef ecosystems of the NWHI. A good understanding of the response of reef systems to natural stresses is an important aspect in evaluating the effects of human activities because responses of coral reef ecosystems to human-induced stress are superimposed on natural cycles of impact and recovery.

The majority of the following information is drawn from Grigg (1997) who summarized the condition of the reefs on each island and concluded that 90 percent of Hawaii's reefs are healthy. However, he found increasing problems with excessive levels of fishing and environmental degradation associated with a growing human population, urbanization, and development (Friedlander 1996; Grigg 2002; J. Maragos, personal communication). Focal points for coral reef degradation in Hawaii include reefs adjacent to urban areas, coastal recreational developments (e.g., hotels, golf courses), and ocean outfalls (Jokiel and Cox 1996 in Friedlander 1996; J. Maragos personal communication).

Grigg also found that a combination of natural and anthropogenic factors, including wave energy, depth, sedimentation, turbidity, light, nutrient concentration, and other biological factors, control coral reef community structure in Hawaii. Most coastline areas in the state are exposed to the open ocean, and the reefs in these areas are frequently disturbed by wave-induced mortality. As such, the only significant buildup of reefs in the MHI is found in areas that are reasonably sheltered from open-ocean swells and at depths that are not constrained by sea level. Such areas are typically restricted to embayments and areas sheltered from wave exposure by nearby islands. Examples include the Kona Coast of Hawaii, the south coast of west Maui, the north coast of Lanai and Kauai, Kaneohe Bay, Hanauma Bay, and Barber's Point on Oahu (Des Rochers 1992; J. Maragos personal communication). In most places, the modern Holocene reefs consist of only a thin veneer on top of the older Pleistocene reefs, which suggests that no accretion of living corals is taking place. Slow coral growth, low rates of recruitment, and sedimentation have also been proposed as factors that have contributed to the slow rate of coral reef formation in Hawaii (Friedlander 1996).

In general, impacts related to anthropogenic factors such as point and nonpoint pollution tend to be of most significance in wave-sheltered environments or in areas with high residence time such as embayments and lagoons (Freidlander et al. 2005; Grigg 2002). In cases in which the ecology of reefs is under primary or dominant control by wave forces, the potential effects of pollution may be less pronounced, except with respect to aesthetic values or water quality and human health (Grigg 2002). Friedlander (1996) and Grigg (1997) both noted that excessive fishing is a serious problem throughout the MHI. The Council will consider the existing and potential future impacts on coral reefs when managing the coral reef fisheries included in this FEP, as described in Chapter 4. However, impacts on coral reefs within waters not included in the EEZ of the Hawaii Archipelago are not specifically included in management of fisheries by this FEP, as described in Section 1.4. Grigg also found that each of the MHI is characterized by other specific and localized threats to coral reef health as described below.

Oahu: Grigg found that Oahu, being the population center of Hawaii, ranks highest among the MHI in terms of coral reef resource problems and the need for better long-term management. Most of the open coastline of Oahu is fringed by coral reefs with low natural coral cover due to wave action. The best reef development is found in embayments or shelter areas, such as Kaneohe Bay or Hanauma Bay. Reef communities are generally healthy except for local areas where shoreline use is high or in some embayments where water circulation is restricted. Point and nonpoint source pollution has degraded many of these environments. Although, the most serious anthropogenic impact to coral reef ecosystems islandwide is overfishing it should be noted that the "overfishing" determination made in Grigg (1997) is not based on the criteria specified in the Coral Reef Ecosystem FMP or the MSA's National Standard 1.

Grigg reported that many improvements in coastal environments have occurred on Oahu in recent years. All shallow nearshore sewage discharges have been replaced by deep-water outfalls, and better land management practices and the curtailment of dredging and filling activities have greatly reduced sedimentation problems to coral reefs island-wide.

Maui: Most coral reefs on Maui are also under primary control of wave forces. Healthy reefs can be found off Honokowai on the western end and the stretch of coastline between Olowalu and Papawai off the south coast of West Maui. Both of these areas were sheltered from the effects of Hurricane Iniki in 1992, and coral cover ranges from 50–80 percent (depth: 10–20 meters). Other pristine reefs also exist at 30–40 meters in the Auau Channel where they are totally sheltered from wave stress. Exposed areas, some with reefs containing greater than 50 percent coral cover, were devastated by Hurricane Iniki, which resulted in mortality of up to 100 percent (E. Brown, personal communication in Grigg 2002).

The two most significant environmental problems affecting coral reefs on Maui are excessive fishing and increases in various species of invasive algae, which may be related to nutrient loading, periodic natural upwelling, the low abundance of urchins, or high fishing pressure on herbivorous fishes.

Lanai: Virtually all of the reefs on Lanai are in a healthy condition, although those on the northern half experience episodic mortally as the result of sediment runoff (Grigg 2002; J. Maragos, personal communication in Green 1997). None of Lanai's reefs seem to experience pollution, although they all experience fishing pressure.

The reefs of Molokai have been subjected to widespread and high fishing levels as well as sedimentation, although other anthropogenic effects on these reefs appear minimal. There was an outbreak of the starfish *Acanthaster planci* off the southeast coast in 1972, and an attempt was made to eradicate the outbreak (Branham et al. 1972 in Grigg 2002). However, it appears that the starfish returned to their normal abundance level naturally over a period of several years.

Molokai: The south coast of Molokai supports the longest fringing reef in Hawaii (~35 miles long: J. Maragos, personal communication in Green 1997). The condition of this reef varies from poor to excellent; with much of the reef degradation associated with sedimentation due to poor land use practices (J. Maragos, personal communication).

Kahoolawe: Kahoolawe was used as a military target for live firing and bombing for years, which resulted in high rates of sedimentation onto the reefs. The reefs are now in a state of recovery, since the bombing ceased in 1994. Interestingly, little ordinance can be found on any reefs around Kahoolawe today, suggesting rapid overgrowth by coral and/or high accuracy of the military target practice.

Hawaii: The island of Hawaii (the Big Island) is still geologically active. The reefs on this island are dramatically different on the windward and leeward coasts. Reefs on the windward side (except in Hilo Bay) are controlled by wave stress, and are characterized by early successional reef stages (i.e., scattered coral colonies or thin veneers on basalt foundations: Grigg 2002; J. Maragos, personal communication in Green 1997). In contrast, rich coral reef communities exist along the sheltered leeward side of the island (Grigg 2002; J. Maragos, personal communication in Green 1997). However, Grigg noted that the reefs along the leeward shore are subject to severe storms with a periodicity of approximately 40 years, which may explain why fringing reefs are not well developed in this area. Human impacts have also had some effect on the reefs of this island. Reefs on the Hamakua Coast have been degraded by sugarcane waste waters in the past, while excessive fishing, aquarium fish collecting, and ground water intrusion have caused serious human impacts on the reefs on the leeward coast.

Kauai: Kauai is the oldest and wettest island in the MHI, and Grigg suggested that sedimentation may be responsible for the lack of well-developed fringing reefs around most of the island. Grigg noted that the reefs that are most heavily impacted by sediments are those that are in shallow or enclosed areas that have restricted circulation. In contrast, the healthiest reefs were found on the exposed northeast and north coasts where the sediment is washed away by waves and currents (Grigg 2002; J. Maragos, personal communication in Green 1997). Grigg also noted that some of the best reefs on the island exist in deep water (15–25 m deep) in areas with the least exposure to sediment-laden streams (e.g., reefs of Poipu and Makahuena). However, these reefs have been impacted by hurricanes in recent years (Ewa in 1982; Iniki in 1992). In addition to the recent reefs, fossil limestone reefs are present off the southern shore off Kauai (30–70 meters deep), where abundant populations of the black coral *Antipathes dichotoma* can be found. In addition to sedimentation, human impacts that are perceived to be a problem on the reefs off Kauai include high fishing pressure and poor water quality.

Niihau: Little is known about the reefs on the small, privately owned island of Niihau. However, they are believed to be in good condition, especially along the western coast (J. Maragos, personal communication in Green 1997).

Penguin Bank: The reef habitat in federal waters in the MHI is restricted to Penguin Bank and Kaula Rock (Hunter 1995). Very little is known of the condition of the reefs in these locations, although they are presumed to be in good condition because of their remoteness from human population areas. On the basis of interpretations of navigational charts, Hunter (1995) suggested that the Penguin Bank supports areas of coral or coralline algae at a depth of approximately 50 meters. In deeper water (50–100 meters), the reef on Penguin Bank is dominated by coralline algae, Halimeda, bryozoans, and pen shells, and corals are present in low abundances (Agegian and Abbott 1985 in Hunter 1995).

NWHI: The NWHI comprise a multitude of reef areas (Hunter 1995; Maragos and Gulko 2002), including the following: numerous islands or reefs (French Frigate Shoals, Kure, Laysan, Lisianski, Maro Reef, Midway Atoll, Necker Island, Nihoa Island, Pearl and Hermes Atoll, and Gardner Pinnacles); two seamounts (Ladd and Nero); several banks (Brooks, Northhampton, Pioneer, Raita, Saint Rogatien, and Salmon); and eight shoals (Gambia Shoal and seven unnamed shoals, including three between Nihoa and Necker and one north of St. Rogatien). In general, these coral reef areas tend to be in excellent condition with unique biodiversity and high-standing stock of many reef fishes, probably because of their isolation, protected status, and harsh seasonal weather conditions (Friedlander 1996). The "pristine" condition of this resource is likely to continue because they are distant from land-based sources of pollution as well as protected from any large-scale human activities in the region (Friedlander 1996; Maragos and Gulko 2002).

Many reefs in the NWHI are made up of calcareous algae (Green 1997). A peak in coral species diversity occurs in the middle of the Hawaii Archipelago at FFS and Maro Reef (Grigg 1983).In general, fish species diversity appears to be lower in the NWHI than in the MHI. Although the inshore fish assemblages of the two regions are similar, fish size, density, and biomass are higher in the NWHI, and fish communities in the NWHI are dominated by apex predators (sharks and jacks), whereas those in the MHI are not (Friedlander and DeMartini 2002). Some fish species that are common in parts of the NWHI are rare in the MHI (Green 1997).

Coral Reef Productivity

Coral reefs are among the most biologically productive environments 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 with the extent of other marine ecosystems, which collectively produce between 70 and 100 million metric tons per year (Munro 1984; Smith 1978). An apparent paradox of coral reefs, however, is their location in the low-nutrient areas of the tropical oceans. Coral reefs themselves are characterized by the highest gross primary production in the sea, with sand, rubble fields, reef flats, and margins adding to primary production rates. The main primary producers on coral reefs are the benthic microalgae, macroalgae, symbiotic microalgae of corals, and other symbiont-bearing invertebrates (Levington 1995). 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, so their contribution to total coral reef primary productivity is small (WPRFMC 2001).

Although the ocean's surface waters in the tropics generally have low productivity, these waters are continually moving. Coral reefs, therefore, have access to open-water productivity and thus, particularly in inshore waters, shallow benthic habitats such as reefs are not always the dominant sources of nutrients for fisheries. 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, as well as active transport onto reefs via fishes that shelter on reefs but that feed in adjacent habitats. There is, therefore, greater potential for nourishment of inshore reefs than offshore reefs by external sources, and this inshore nourishment is enhanced by large land masses (Birkeland 1997a).

For most of the Pacific Islands, rainfall typically ranges from 2.0 to 3.5 m per year. Low islands, such as atolls, tend to have less rainfall and may suffer prolonged droughts. Furthermore, when rain does fall on coral islands that have no major catchment area, there is little 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 such as Palmyra Atoll and Rose Atoll which receive up to 4.3 m of rain per year. 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. In addition, 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 biodiversity found in such locations.

Coral Reef Communities

A major portion of the primary production of the coral reef ecosystem comes from complex interkingdom relationships of animal/plant photosymbioses hosted by animals of many taxa, most notably stony corals. Most of the geological structure of reefs and habitat are 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—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).

Typically, spawning of coral reef fish 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 an extremely high fecundity. Coral reef species exhibit a wide range of strategies related to larval dispersal and ultimately recruitment into the same or new areas. Some larvae are dispersed as short-lived, yolk-dependent (lecithotrophic) organisms, but the majority of coral reef invertebrate species disperse their larvae into the pelagic environment to feed on various types of plankton (planktotrophic)(Levington 1995). For example, larvae of the coral *Pocillopora damicornis*, which is widespread throughout the Pacific, has been found in the plankton of the open ocean exhibiting a larval life span of more than 100 days (Levington 1995). Because many coral reefs are space limited for settlement, planktotrophic larvae are a likely strategy to increase survival in other areas (Levington 1995). Coral reef fish experience their highest predation mortality in their first few days or weeks, thus rapid growth out of the juvenile stage is a common strategy. The condition of the overall populations of particular species is linked to the variability among subpopulations: the ratio of sources and sinks, their degrees of recruitment connection, and the proportion of the subpopulations with high variability in reproductive capacity. Recruitment to populations of coral reef organisms depends largely on the pathways of larval dispersal and “downstream” links.

Reproduction and Recruitment

The majority of coral reef associated species 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 species 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, multispecies 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 other coral reef fishes. But they still grow relatively slowly compared with 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, but represent notably different habitats. For example, 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 Northwestern Hawaiian Islands (NWHI) are further characterized by (a) high-latitude coral atolls; (b) a mild temperate to subtropical climate, where inshore water temperatures can drop below 18° C in late winter; (c) species that are common on shallow reefs and attain large sizes, which to the southeast occur only rarely or in deep water; and (d) inshore shallow reefs that are largely free of fishing pressure (Maragos and Gulko 2002).

3.3.2.5 Deep Reef Slopes

As most Pacific islands are oceanic islands versus continental islands, they generally lack an extensive shelf area of relatively shallow water extending beyond the shoreline. For example, the average global continental shelf extends 40 miles, with a depth of around 200 feet (Postma and Zijlstra 1988). While lacking a shelf, many oceanic islands have a deep reef slope, which is often angled between 45° and 90° toward the ocean floor. The deep reef slope is home to a wide variety of marine of organisms that are important fisheries target species such as snappers and groupers. Biological zonation does occur on the reef slope, and is related to the limit of light penetration beyond 100 meters. For example, reef-building corals can be observed at depths less than 100 meters, but at greater depths precious corals such as gorgonian and black corals are more readily observed (Colin et al. 1986).

3.3.2.6 Banks and Seamounts

Banks are generally volcanic structures of various sizes and occur both on the continental shelf and in oceanic waters. Coralline structures tend to be associated with shallower parts of the banks as reef-building corals are generally restricted to a maximum depth of 30 meters. Deeper parts of banks may be composed of rock, coral rubble, sand, or shell deposits. Banks thus support a variety of habitats that in turn support a variety of fish species (Levington 1995).

Fish distribution on banks is affected by substrate types and composition. Those suitable for lutjanids, serranids, and lethrinids tend to be patchy, leading to isolated groups of fish with little lateral exchange or adult migration except when patches are close together. These types of assemblages may be regarded as consisting of metapopulations that are associated with specific features or habitats and are interconnected through larval dispersal.

From a genetic perspective, individual patch assemblages may be considered as the same population; however, not enough is known about exchange rates to distinguish discrete populations.

Seamounts are undersea mountains, mostly of volcanic origin, which rise steeply from the sea bottom to below sea level (Rogers 1994). On seamounts and surrounding banks, species composition is closely related to depth. Deep-slope fisheries typically occur in the 100–500 meter depth range. A rapid decrease in species richness typically occurs between 200 and 400 meters deep, and most fishes observed there are associated with hard substrates, holes, ledges, or caves (Chave and Mundy 1994). Territoriality is considered to be less important for deep-water species of serranids, and lutjanids tend to form loose aggregations. Adult deep-water species are believed to not normally migrate between isolated seamounts.

Seamounts have complex effects on ocean circulation. One effect, known as the Taylor column, relates to eddies trapped over seamounts to form quasi-closed circulations. It is hypothesized that this helps retain pelagic larvae around seamounts and maintain the local fish population. Although evidence for retention of larvae over seamounts is sparse (Boehlert and Mundy 1993), endemism has been reported for a number of fish and invertebrate species at seamounts (Rogers 1994). Wilson and Kaufman (1987) concluded that seamount species are dominated by those on nearby shelf areas, and that seamounts act as stepping stones for transoceanic dispersal. Snappers and groupers both produce pelagic eggs and larvae, which tend to be most abundant over deep reef slope waters, while larvae of Etelis snappers are generally found in oceanic waters. It appears that populations of snappers and groupers on seamounts rely on inputs of larvae from external sources.

Within the Hawaii Archipelago, there are numerous banks and seamounts, with more observed in the NWHI rather than in the MHI. In the MHI, the largest bank is Penguin Bank which is located southeast of Oahu.

3.3.2.7 Deep Ocean Floor

At the end of reef slopes lies the dark and cold world of the deep ocean floor. Composed of mostly mud and sand, the deep ocean floor is home to deposit feeders and suspension feeders, as well as certain species of deep-sea fishes. Compared with shallower benthic areas (e.g., coral reefs), benthic seafloor areas are lower in productivity and biomass. Due to the lack of sunlight, primary productivity is low, and many organisms rely on deposition of organic matter that sinks to the bottom. The occurrence of secondary and tertiary consumers decreases the deeper one goes due to the lack of available prey. With increasing depth, suspension feeders become less abundant and deposit feeders become the dominant feeding type (Levington 1995).

Although most of the deep seabed is homogenous and low in productivity, there are hot spots teeming with life. In areas of volcanic activity such as the mid-oceanic ridge, thermal vents exist that spew hot water loaded with various metals and dissolved sulfide. Bacteria found in these areas are able to make energy from the sulfide (chemotrophs) and are thus considered primary producers. A variety of organisms either feed on or contain these bacteria in their bodies within special organs called "trophosomes." Types of organisms found near these thermal vents include crabs, limpets, tubeworms, and bivalves (Levington 1995).

3.3.2.7.1 Benthic Species of Economic Importance

Coral Reef Associated Species

The most commonly harvested species of coral reef associated organisms include the following: surgeonfishes (Acanthuridae), triggerfishes (Balistidae), jacks (Carangidae), parrotfishes (Scaridae), soldierfishes/squirrelfishes (Holocentridae), wrasses (Labridae), octopus (*Octopus cyanea, O. ornatus*), and goatfishes (Mullidae). 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) estimated the average MSY for Pacific reefs to be approximately 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 skepticism about the sustainability of the high yields reported for Pacific and Southeast Asian reefs. Among other examples, he noted that the high values for American Samoa reported by Wass (1982) during the early 1970s were followed by a 70 percent 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 percent in 1979 to between 3 and 13 percent in 1993.

Furthermore, problems still remain in rigorously quantifying the effects of factors on yield estimates such as primary productivity, depth, sampling area, or coral cover. Polunin and Roberts (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, 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, indicates that depleted biomass levels may recover to preexploitation 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 Southeast Asia (Polunin and Roberts 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) cited the example of a pinnacle reef off Guam fished down over a period of six months in 1967 that has still not recovered 30 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 is due to recruitment overfishing because it takes time to rebuild adult spawning biomasses and high fecundities (Polunin and Morton 1992). Furthermore, 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.

Crustaceans

Crustaceans are harvested on small scales throughout the inhabited islands of the Western Pacific Region. The most common harvests include lobster species of the taxonomic groups Palinuridae (spiny lobsters) and Scyllaridae (slipper lobsters). Adult spiny lobsters are typically found on rocky substrate in well-protected areas, in crevices, and under rocks. Unlike many other species of *Panulirus*, the juveniles and adults of *P. marginatus* are not found in separate habitat apart from one another (MacDonald and Stimson 1980; Parrish and Polovina 1994). Juvenile *P. marginatus* recruit directly to adult habitat; they do not utilize separate shallow-water nursery habitat apart from the adults as do many Palinurid lobsters (MacDonald and Stimson 1980; Parrish and Polovina 1994). Juvenile and adult *P. marginatus* do utilize shelter differently from one another (MacDonald and Stimson 1980). Similarly, juvenile and adult *P. penicillatus* also share the same habitat (Pitcher 1993).

Pitcher also observed that, in the southwestern Pacific, spiny lobsters are typically found in association with coral reefs. Coral reefs provide shelter as well as a diverse and abundant supply of food items, he noted. Pitcher also stated that in this region, *P. penicillatus* inhabits the rocky shelters in the windward surf zones of oceanic reefs, an observation also noted by Kanciruk (1980). Other species of *Panulirus* show more general patterns of habitat utilization with. *P. penicillatus* moving onto reef flat to forage at night.

Spiny lobsters are non-clawed decapod crustaceans with slender walking legs of roughly equal size. Spiny lobster have a large spiny carapace with two horns and antennae projecting forward of their eyes and a large abdomen terminating in a flexible tail fan (Uchida et al.1980). Uchida and Uchiyama (1986) provided a detailed description of the morphology of slipper lobsters (*S. squammosus* and *S. haanii)* and noted that the two species are very similar in appearance and are easily confused (Uchida and Uchiyama 1986). The appearance of the slipper lobster is notably different than that of the spiny lobster.

Spiny lobsters (*Panulirus* spp.) are dioecious (i.e., male reproductive organs are in one individual and female in another)(Uchida and Uchiyama 1986). Generally, the different species of the genus *Panulirus* have the same reproductive behavior and life cycle (Pitcher 1993). The male spiny lobster deposits a spermatophore or sperm packet on the female's abdomen (WPRFMC 1983). In *Panulirus* spp., the fertilization of the eggs occurs externally (Uchida et al. 1980). The female lobster scratches and breaks the mass, releasing the spermatozoa (WPRFMC 1983). Simultaneously, ova are released from the female's oviduct and are then fertilized and attach to the setae of the female's pleopods (WPRFMC 1983). At this point, the female lobster is ovigerous, or "berried" (WPRFMC 1983). The fertilized eggs hatch into "leaf-like" larvae (or phyllosoma) larvae after 30–40 days (MacDonald 1986; Uchida and Uchiyama 1986). Spiny lobsters are very fecund (WPRFMC 1983). The release of the phyllosoma larvae appears to be timed to coincide with the full moon, and in some species at dawn (Pitcher 1993). In *Scyllarides* spp. fertilization is internal (Uchida and Uchiyama 1986).

Very little is known about the planktonic phase of the phyllosoma larvae of *Panulirus marginatus* (Uchida et al. 1980). After hatching, the phyllosoma enter a planktonic phase (WPRFMC 1983). The duration of this planktonic phase varies depending on the species and geographic region (WPRFMC 1983). The planktonic larval stage may last from 6 months to 1 year from the time of the hatching of the eggs (WPRFMC 1983, MacDonald 1986). Johnson (1968) suggested that fine-scale oceanographic features, such as eddies and currents, serve to retain lobster larvae within island areas. In the NWHI, for example, lobster's larvae settlement appears to be linked to the north and southward shifts of the North Pacific Central Water type (MacDonald 1986). The relatively long pelagic larval phase for palinurids results in very wide dispersal of spiny lobster larvae; palinurid larvae are transported up to 2,000 miles by prevailing ocean currents (MacDonald 1986).

Reef Slope, Bank, and Seamount Associated Species

Bottomfish

The families of bottomfish and seamount fish that are often targeted by fishermen include snappers (Lutjanidae), groupers (Serranidae), and jacks (Carangidae). Distinct depth associations are reported for certain species of snappers and groupers. Many snappers and some groupers are restricted to feeding in deep water (Parrish 1987). Species of the genus *Pristipomoides* occur at intermediate depths, often schooling around rocky outcrops and promontories (Ralston et al. 1986), while *Eteline* snappers are deep-water species. Groupers (Serranidae) are relatively larger and mostly occur in shallow areas, although some occupy deep-slope habitats. Groupers in general are more sedentary and territorial than snappers or emperors, and are more dependent on hard substrata. In general, groupers may be less dependent on hard-bottom substrates at depth (Parrish 1987). For each family, schooling behavior is reported more frequently for juveniles than for adults. Spawning aggregations may, however, occur even for the solitary species at certain times of the year, especially among groupers.

A commonly reported trend is that juveniles occur in shallow water and adults are found in deeper water (Parrish 1989). Juveniles also tend to feed in different habitats than adults, possibly reflecting a way to reduce predation pressures. Not much is known on the location and characteristics of nursery grounds for juvenile deep-slope snappers and groupers. In Hawaii, juvenile opakapaka (*P. filamentosus)* have been found on flat, featureless shallow banks, as opposed to high-relief areas where the adults occur. Similarly, juveniles of the deep-slope grouper, hāpu`upu`u (*Epinephelus quernus*), are found in shallow water (Moffitt 1993). Ralston and Williams (1988), however, found that for deep-slope species, size is poorly correlated with depth.

The distribution of adult bottomfish is correlated with suitable physical habitat. Because of the volcanic nature of the islands within the region, most bottomfish habitat consists of steep-slope areas on the margins of the islands and banks. The habitat of the major bottomfish species tend to overlap to some degree, as indicated by the depth range where they are caught. Within the overall depth range, however, individual species are more common at specific depth intervals.

Depth alone does not assure satisfactory habitat. Both the quantity and quality of habitat at depth are important. Bottomfish are typically distributed in a non-random patchy pattern, reflecting bottom habitat and oceanographic conditions. Much of the habitat within the depths of occurrence of bottomfish is a mosaic of sandy low-relief areas and rocky high-relief areas. An important component of the habitat for many bottomfish species appears to be the association of high-relief areas with water movement. In the Hawaiian Islands and at Johnston Atoll, bottomfish density is correlated with areas of high relief and current flow (Haight 1989; Haight et al. 1993a; Ralston et al. 1986).

Although the water depths utilized by bottomfish may overlap somewhat, the available resources may be partitioned by species-specific behavioral differences. In a study of the feeding habitats of the commercial bottomfish in the Hawaii Archipelago, Haight et al. (1993b) found that ecological competition between bottomfish species appears to be minimized through species-specific habitat utilization. Species may partition the resource through both the depth and time of feeding activity, as well as through different prey preferences.

Precious Corals

Currently, there are minimal harvests of precious corals in the Western Pacific Region. However, in the 1970s to early 1990s both deep- and shallow-water precious corals were targeted in EEZ waters around Hawaii. The commonly harvested precious corals include pink coral (*Corallium secundum, Corallium regale, Corallium laauense*), gold coral (*Narella* spp., *Gerardia* spp., *Calyptrophora* spp.), bamboo coral (*Lepidisis olapa, Acanella* spp.), and black coral (*Antipathes dichotoma*, *Antipathes grandis*, *Antipathes ulex*).

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

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

Because of the great depths at which they live, precious corals may be insulated from some short-term changes in the physical environment; however, not much is known regarding the long-term effects of changes in environmental conditions, such as water temperature or current velocity, on the reproduction, growth, or other life history characteristics of the precious corals (Grigg 1993).

3.3.3 Pelagic Environment

Connectivity of the different marine environments mandates the importance each has on the others with regards to species diversity and abundance, reproduction, sustainable harvest, habitat needs, and trophic connections. The pelagic or open ocean ecosystem is very large compared with any other marine ecosystem; however, other oceanic communities are vitally important to pelagic species in part because of the food-poor nature of much of the pelagic environment. For example, the mesopelagic boundary area described as being between 200 and 1,000 m depth and bordered by the photic zone above, and the aphotic zone below, provides habitat for a unique community of fishes, crustaceans, mollusks and other invertebrates which become prey for tunas and other pelagic species. Acoustic sampling studies off the coasts of Oahu and Kona were implemented by Benoit-Bird et al. (2001) to assess the spatial heterogeneity, horizontal and vertical migration patterns, relative abundances, and temporal patterns of the mesopelagic community as well as the linkages among this community, the influence of the coastlines, and oceanographic parameters. The Benoit-Bird et al. study showed that the horizontal component of the mesopelagic community migration indicates a clear link between the nearshore and oceanic ecosystems in the Hawaiian Islands, which in turn affects the presence and abundance of the pelagic predator species.

Studies near the Hawaiian Islands indicate that concentrations of spawning tuna near the islands may be due to increased forage species in these areas associated with elevated primary productivity (Itano 2000). Spawning in yellowfin tuna has been correlated to sea surface temperatures (SSTs), mainly above 24 - 26°C and may also be correlated with frontal areas such as the edge of Western Pacific Warm Pool (WPWP). The WPWP is the largest oceanic body of warm water with surface temperatures consistently above 28°C (Yan et al. 1992 *in* Itano 2000). The edge zones of this warm area are convergence zones which bring up nutrient rich waters and create high productivity areas resulting in high densities of tuna forage (i.e., baitfish such as anchovy) and thus large numbers of tuna. Offshore areas of high pelagic catch rates and spawning frequencies were found around several productive seamounts which also exhibit high productivity due to interactions of submarine topography, current gyres and being located in the lee of the main Hawaiian Islands (Itano 2000). Trophic linkages such as those evident in tunas whereby ocean anchovy are a primary forage species [of tuna] which themselves feed primarily on copepods provide a critical link between zooplankton and larger pelagic fishes (Ozawa and Tsukahara 1973 *in* Itano 2000). Understanding these linkages is an essential component of successful ecosystem-based fishery management.

Phytoplanktons contribute to more than 95 percent of primary production in the marine environment (Valiela 2003) and represent several different types of microscopic organisms that require sunlight for photosynthesis. Phytoplankton primarily live in the upper 100 meters of the euphotic zone of the water column and provide primary production in the marine ecosystem as food for zooplankton, which in turn, feeds small organisms such as crustaceans and so forth on up the food chain. For example, large pelagic species are commonly most concentrated near islands and seamounts that create divergences and convergences, which concentrate forage species, and also near upwelling zones along ocean current boundaries and along gradients in temperature, oxygen, and salinity. Swordfish and numerous other pelagic species tend to concentrate along food-rich temperature fronts between cold upwelled plankton-rich water and warmer oceanic water masses (NMFS 2001).

These frontal zones have been identified as likely migratory pathways across the Pacific for loggerhead turtles (Polovina et al. 2000). Loggerhead turtles are opportunistic omnivores that feed on floating prey such as the pelagic cnidarian *Vellela vellela* ("by the wind sailor") and the pelagic gastropod *Janthia* spp., both of which are likely to be concentrated by the weak downwelling associated with frontal zones (Polovina et al. 2000).

Migration patterns of pelagic fish stocks in the Pacific Ocean are not easily understood or categorized, despite extensive tag-and-release projects for many of the species. This is particularly evident for the more tropical tuna species (e.g., yellowfin, skipjack, bigeye) that appear to roam extensively within a broad expanse of the Pacific centered on the equator. Although tagging and genetic studies have shown that some interchange does occur, it appears that short life spans and rapid growth rates restrict large-scale interchange and genetic mixing of eastern, central, and far-western Pacific stocks of yellowfin and skipjack tuna. The movement of the cooler water tuna (e.g., bluefin, albacore) is more predictable and defined, with tagging studies documenting regular, well-defined seasonal movement patterns relating to specific feeding and spawning grounds. The oceanic migrations of billfish are poorly understood, but the results of limited tagging work conclude that most billfish species are capable of transoceanic movement, and some seasonal regularity has been noted (NMFS 2001).

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

The Hawaii Archipelago’s position in the Pacific Ocean lies within the clockwise rotating North Pacific Subtropical Gyre, extending from the northern portion of the North Equatorial Current into the region south of the Subtropical High, where the water moves eastward in the North Pacific Current. At the pass between the MHI and the NWHI, there is often a westward flow from the region of Kauai along the lee side of the lower NWHI. This flow, the North Hawaiian Ridge Current (NHRC), is extremely variable and can also be absent at times. The analysis of 10 years of shipboard acoustic Doppler current-profiler data collected by the NOAA research vessel *Townsend Cromwell* shows the mean flow through the ridge between Oahu and Nihoa, and extending to a depth of 200 meters. (J. Firing, personal communication 2005).

Embedded in the mean east-to-west flow are an abundance of mesoscale eddies created from a mixture of wind, current, and seafloor interactions. These eddies can rotate either clockwise or counterclockwise and have important biological impacts. For example, eddies create vertical fluxes, with regions of divergence (upwelling), where the thermocline shoals and deep nutrients are pumped into surface waters enhancing phytoplankton production, and also regions of convergence (downwelling) where the thermocline deepens. Sea–surface temperatures around the Hawaii Archipelago experience seasonal variability, but generally vary between 18°–28° C (64°–82° F) with the colder waters occurring more often in the NWHI.

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

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

3.3.4 Protected Species

To varying degrees, protected species in the Western Pacific Region face various natural and anthropogenic threats to their continued existence. These threats include regime shifts, habitat degradation, poaching, fisheries interactions, vessel strikes, disease, and behavioral alterations from various disturbances associated with human activities. This section presents available information on the current status of protected species (generally identified as sea turtles, marine mammals, and seabirds) known to occur (perhaps only occasionally) in the Western Pacific Region. Fishery interactions with protected species are routinely evaluated by NMFS through the preparation and issuance of biological opinions (see Section 8.5). In summary, due to the target species and gear types used in the fisheries managed under this FEP, very few interactions with protected species have been reported or observed. These are described in Chapter 4.

3.3.4.1 Sea Turtles

All Pacific sea turtles are designated under the Endangered Species Act as either threatened or endangered. The breeding populations of Mexico's olive ridley sea turtles (*Lepidochelys olivacea*) are currently listed as endangered, while all other ridley populations are listed as threatened. Leatherback sea turtles (*Dermochelys coriacea*) and hawksbill turtles (*Eretmochelys imbricata*) are also classified as endangered. Loggerhead (*Caretta caretta*) and green sea turtles (*Chelonia mydas*) are listed as threatened (the green sea turtle is listed as threatened 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 (NMFS 2001).

Green and hawksbill turtles are known to nest in Hawaii and forage in nearshore waters around Hawaii, and loggerhead, leatherback and olive ridley turtles have been sighted offshore by Hawaii-based pelagic longline vessels as they migrate through EEZ waters around the Hawaii Archipelago (NMFS 2005).

Leatherback Sea Turtles

Leatherback turtles (*Dermochelys coriacea*) are widely distributed throughout the oceans of the world, and are found in waters of the Atlantic, Pacific, and Indian Oceans; the Caribbean Sea; and the Gulf of Mexico (Dutton et al. 1999). Increases in the number of nesting females have been noted at some sites in the Atlantic (Dutton et al. 1999), but these are far outweighed by local extinctions, especially of island populations, and the demise of once-large populations throughout the Pacific, such as in Malaysia (Chan and Liew 1996) and Mexico (Sarti et al. 1996; Spotila et al. 1996). In other leatherback nesting areas, such as Papua New Guinea, Indonesia, and the Solomon Islands, there have been no systematic, consistent nesting surveys, so it is difficult to assess the status and trends of leatherback turtles at these beaches. In all areas where leatherback nesting has been documented, current nesting populations are reported by scientists, government officials, and local observers to be well below abundance levels of several decades ago. The collapse of these nesting populations was most likely precipitated by a tremendous overharvest of eggs coupled with incidental mortality from fishing (Sarti et al. 1996).

Leatherback turtles are the largest of the marine turtles, with a shell length often exceeding 150 centimeters and front flippers that are proportionately larger than in other sea turtles and that may span 270 centimeters in an adult (NMFS and USFWS 1998c). The leatherback is morphologically and physiologically distinct from other sea turtles, and it is thought that its streamlined body, with a smooth dermis-sheathed carapace and dorso-longitudinal ridges may improve laminar flow.

Leatherback turtles lead a completely pelagic existence, foraging widely in temperate waters, except during the nesting season when gravid females return to tropical beaches to lay eggs. Males are rarely observed near nesting areas, and it has been proposed that mating most likely takes place outside of tropical waters, before females move to their nesting beaches (Eckert and Eckert 1988). Leatherbacks are highly migratory, exploiting convergence zones and upwelling areas in the open ocean, along continental margins, and in archipelagic waters (Eckert 1998). In a single year, a leatherback may swim more than 10,000 kilometers (Eckert 1998).

Satellite telemetry studies indicate that adult leatherback turtles follow bathymetric contours over their long pelagic migrations and typically feed on cnidarians (jellyfish and siphonophores) and tunicates (pyrosomas and salps), and their commensals, parasites, and prey (NMFS and USFWS 1998c). Because of the low nutritient value of jellyfish and tunicates, it has been estimated that an adult leatherback would need to eat about 50 large jellyfish (equivalent to approximately 200 liters) per day to maintain its nutritional needs (Duron 1978). Compared with greens and loggerheads, which consume approximately 3–5 percent of their body weight per day, leatherback turtles may consume 20–30 percent of their body weight per day (Davenport and Balazs 1991).

Females are believed to migrate long distances between foraging and breeding grounds, at intervals of typically two or four years (Spotila et al. 2000). The mean renesting interval of females on Playa Grande and Costa Rica was estimated to be 3.7 years, while in Mexico, 3 years was the typical reported interval (L. Sarti, Universidad Naçional Autonoma de Mexico [UNAM], personal communication, 2000 in NMFS 2004). In Mexico, the nesting season generally extends from November to February, although some females arrive as early as August (Sarti et al. 1996). Most of the nesting on Las Baulas takes place from the beginning of October to the end of February (Reina et al. 2002). In the western Pacific, nesting peaks on Jamursba-Medi Beach (Papua, Indonesia) from May to August, on War-Mon Beach (Papua) from November to January (Starbird and Suarez 1994), in peninsular Malaysia during June and July (Chan and Liew 1996), and in Queensland, Australia in December and January (Limpus and Reimer1994).

Migratory routes of leatherback turtles originating from eastern and western Pacific nesting beaches are not entirely known. However, satellite tracking of postnesting females and genetic analyses of leatherback turtles caught in U.S. Pacific fisheries or stranded on the west coast of the U.S. presents some strong insights into at least a portion of their routes and the importance of particular foraging areas. Current data from genetic research suggest that Pacific leatherback stock structure (natal origins) may vary by region. Due to the fact that leatherback turtles are highly migratory and that stocks mix in high-seas foraging areas, and based on genetic analyses of samples collected by both Hawaii-based and west-coast-based longline observers, leatherback turtles inhabiting the northern and central Pacific Ocean comprise individuals originating from nesting assemblages located south of the equator in the western Pacific (e.g., Indonesia, Solomon Islands) and in the eastern Pacific along the Americas (e.g., Mexico, Costa Rica; Dutton et al. 1999).

Recent information on leatherbacks tagged off the west coast of the United States has also revealed an important migratory corridor from central California to south of the Hawaiian Islands, leading to western Pacific nesting beaches. Leatherback turtles originating from western Pacific beaches have also been found along the U.S. mainland. There, leatherback turtles have been sighted and reported stranded as far north as Alaska (60° N) and as far south as San Diego, California (NMFS 1998). Of the stranded leatherback turtles that have been sampled to date from the U.S. mainland, all have been of western Pacific nesting stock origin (P. Dutton NMFS, personal communication 2000 in NMFS 2004).

Loggerhead Sea Turtles

The loggerhead sea turtle (*Caretta caretta*) is characterized by a reddish brown, bony carapace, with a comparatively large head, up to 25 centimeters wide in some adults. Adults typically weigh between 80 and 150 kilograms, with average curved carapace length (CCL) measurements for adult females worldwide between 95-–100 centimeters CCL (Dodd 1988) and adult males in Australia averaging around 97 centimeters CCL (Limpus 1985, in Eckert 1993). Juveniles found off California and Mexico measured between 20 and 80 centimeters (average 60 cm) in length (Bartlett 1989, in Eckert 1993). Skeletochronological age estimates and growth rates were derived from small loggerheads caught in the Pacific high-seas driftnet fishery. Loggerheads less than 20 centimeters were estimated to be 3 years old or less, while those greater than 36 centimeters were estimated to be 6 years old or more. Age-specific growth rates for the first 10 years were estimated to be 4.2 cm/year (Zug et al. 1995).

For their first years of life, loggerheads forage in open-ocean pelagic habitats. Both juvenile and subadult loggerheads feed on pelagic crustaceans, mollusks, fish, and algae. The large aggregations of juveniles off Baja California have been observed foraging on dense concentrations of the pelagic red crab *Pleuronocodes planipes* (Nichols et al. 2000). Data collected from stomach samples of turtles captured in North Pacific driftnets indicate a diet of gastropods (*Janthina* spp.), heteropods (*Carinaria* spp.), gooseneck barnacles (*Lepas* spp.), pelagic purple snails (*Janthina* spp.), medusae (*Vellela* spp.), and pyrosomas (tunicate zooids). Other common components include fish eggs, amphipods, and plastics (Parker et al. 2002).

Loggerheads in the North Pacific are opportunistic feeders that target items floating at or near the surface, and if high densities of prey are present, they will actively forage at depth (Parker et al. 2002). As they age, loggerheads begin to move into shallower waters, where, as adults, they forage over a variety of benthic hard- and soft-bottom habitats (reviewed in Dodd, 1988). Subadults and adults are found in nearshore benthic habitats around southern Japan, as well as in the East China Sea and the South China Sea (e.g., Philippines, Taiwan, Vietnam).

The loggerhead sea turtle is listed as threatened under the ESA throughout its range, primarily due to direct take, incidental capture in various fisheries, and the alteration and destruction of its habitat. In general, during the last 50 years, North Pacific loggerhead nesting populations have declined 50–90 percent (Kamezaki et al. 2003). From nesting data collected by the Sea Turtle Association of Japan since 1990, the latest estimates of the number of nesting females in almost all of the rookeries are as follows: 1998 –2,479 nests, 1999 –2,255 nests, and 2000 –2,589 nests.[12]

In the South Pacific, Limpus (1982) reported an estimated 3,000 loggerheads nesting annually in Queensland, Australia during the late 1970s. However, long-term trend data from Queensland indicate a 50 percent decline in nesting by 1988–89 due to incidental mortality of turtles in the coastal trawl fishery. This decline is corroborated by studies of breeding females at adjacent feeding grounds (Limpus and Reimer 1994). Currently, approximately 300 females nest annually in Queensland, mainly on offshore islands (Capricorn-Bunker Islands, Sandy Cape, Swains Head; Dobbs 2001). In southern Great Barrier Reef waters, nesting loggerheads have declined approximately 8 percent per year since the mid-1980s (Heron Island), while the foraging ground population has declined 3 percent and comprised less than 40 adults by 1992. Researchers attribute the declines to recruitment failure due to fox predation of eggs in the 1960s and mortality of pelagic juveniles from incidental capture in longline fisheries since the 1970s (Chaloupka and Limpus 2001).

Green Sea Turtles

Green turtles (*Chelonia mydas*) are distinguished from other sea turtles by their smooth carapace with four pairs of lateral “scutes,” a single pair of prefrontal scutes, and a lower jaw edge that is coarsely serrated. Adult green turtles have a light to dark brown carapace, sometimes shaded with olive, and can exceed 1 meter in carapace length and 100 kilograms in body mass. Females nesting in Hawaii averaged 92 centimeters in straight carapace length (SCL), while at Olimarao Atoll in Yap, females averaged 104 centimeters in curved carapace length and approximately 140 kilograms in body mass. In the rookeries of Michoacán, Mexico, females averaged 82 centimeters in CCL, while males averaged 77 centimeters in CCL (NMFS and USFWS 1998c). Based on growth rates observed in wild green turtles, skeletochronological studies, and capture–recapture studies, all in Hawaii, it is estimated that an average of at least 25 years would be needed to achieve sexual maturity (Eckert 1993).

Although most adult green turtles appear to have a nearly exclusively herbivorous diet, consisting primarily of seagrass and algae (Wetherall 1993), those along the east Pacific coast

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[12] In the 2001, 2002, and 2003 nesting seasons, a total of 3,122, 4,035 and 4,519 loggerhead nests, respectively, were recorded on Japanese beaches (Matsuzawa, March 2005, final report to the WPRFMC).

seem to have a more carnivorous diet. Analysis of stomach contents of green turtles found off Peru revealed a large percentage of mollusks and polychaetes, while fish and fish eggs, jellyfish, and commensal amphipods made up a smaller percentage (Bjorndal 1997). Seminoff et al. (2000) found that 5.8 percent of gastric samples and 29.3 percent of the fecal samples of east Pacific green turtles foraging in the northern Sea of Cortéz, Mexico, contained the remains of the fleshy sea pen (*Ptilosarcus undulatus*).

Green sea turtles are a circumglobal and highly migratory species, nesting and feeding in tropical/subtropical regions. Their range can be defined by a general preference for water temperature above 20° C. Green sea turtles are known to live in pelagic habitats as posthatchlings/juveniles, feeding at or near the ocean surface. The non-breeding range of this species can lead a pelagic existence many miles from shore while the breeding population lives primarily in bays and estuaries, and are rarely found in the open ocean. Most migration from rookeries to feeding grounds is via coastal waters, with females migrating to breed only once every two years or more (Bjorndal 1997).

Tag returns of eastern Pacific green turtles (often reported as black turtles) establish that these turtles travel long distances between foraging and nesting grounds. In fact, 75 percent of tag recoveries from 1982–1990 were from turtles that had traveled more than 1,000 kilometers from Michoacán, Mexico. Even though these turtles were found in coastal waters, the species is not confined to these areas, as indicated by sightings recorded in 1990 from a NOAA research ship. Observers documented green turtles 1,000–2,000 statute miles from shore (Eckert 1993). The east Pacific green is also the second-most sighted turtle in the east Pacific during tuna cruises; they frequent a north–south band from 15° N to 5° S along 90° W and an area between the Galapagos Islands and the Central American Coast (NMFS and USFWS 1998a).

The non-breeding range of green turtles is generally tropical, and can extend approximately 500–800 miles from shore in certain regions (Eckert 1993). The underwater resting sites include coral recesses, undersides of ledges, and sand bottom areas that are relatively free of strong currents and disturbance from natural predators and humans. In the Pacific, the only major (> 2,000 nesting females) populations of green turtles occur in Australia and Malaysia. Smaller colonies occur in the insular Pacific islands of Polynesia, Micronesia, and Melanesia (Wetherall 1993) and on six small sand islands at French Frigate Shoals, a long atoll situated in the middle of the Hawaii Archipelago (Balazs et al. 1994).

Green turtles were listed as threatened under the ESA on July 28, 1978, except for breeding populations found in Florida and the Pacific coast of Mexico, which were listed as endangered. Using a precautionary estimate, the number of nesting female green turtles has declined by 48 percent to 67 percent over the last three generations (~150 years; Troeng and Rankin 2005). Causes for this decline include harvest of eggs, subadults, and adults; incidental capture by fisheries; loss of habitat; and disease. The degree of population change is not consistent among all index nesting beaches or among all regions. Some nesting populations are stable or increasing (Balazs and Chaloupka 2004; Chaloupka and Limpus 2001; Troeng and Rankin 2005). However, other populations or nesting stocks have markedly declined. Because many of the threats that have led to these declines have not yet ceased, it is evident that green turtles face a measurable risk of extinction (Troeng and Rankin 2005).

Green turtles in Hawaii are considered genetically distinct and geographically isolated, although a nesting population at Islas Revillagigedos in Mexico appears to share the mtDNA haplotype that commonly occurs in Hawaii. In Hawaii, green turtles nest on six small sand islands at French Frigate Shoals, a crescent-shaped atoll situated in the middle of the Hawaii Archipelago (Northwestern Hawaiian Islands; Balazs et al. 1995). Ninety to 95 percent of the nesting and breeding activity occurs at the French Frigate Shoals, and at least 50 percent of that nesting takes place on East Island, a 12-acre island. Long-term monitoring of the population shows that there is strong island fidelity within the regional rookery. Low-level nesting also occurs at Laysan Island, Lisianski Island, and on Pearl and Hermes Reef (NMFS 1998).

Since the establishment of the ESA in 1973, and following years of exploitation, the nesting population of Hawaiian green turtles has shown a gradual but definite increase (Balazs 1996; Balazs and Chaloupka 2004). In three decades, the number of nesting females at East Island increased from 67 nesting females in 1973 to 467 nesting females in 2002. Nester abundance increased rapidly at this rookery during the early 1980s, leveled off during the early 1990s, and again increased rapidly during the late 1990s to the present. This trend is very similar to the underlying trend in the recovery of the much larger green turtle population that nests at Tortuguero Costa Rica (Bjorndal et al. 1999). The stepwise increase of the long-term nester trend since the mid-1980s is suggestive, but not conclusive, of a density-dependent adjustment process affecting sea turtle abundance at the foraging grounds (Balazs and Chaloupka 2004; Bjorndal et al. 2000;). Balazs and Chaloupka (2004) concluded that the Hawaiian green sea turtle stock is well on the way to recovery following 25 years of protection. This increase is attributed to increased female survivorship since the harvesting of turtles was prohibited in addition to the cessation of habitat damage at the nesting beaches since the early 1950s (Balazs and Chaloupka 2004).

Hawksbill Sea Turtles

Hawksbill sea turtles (*Eretmochelys imbricata*) are circumtropical in distribution, generally occurring from latitudes 30° N to 30° S within the Atlantic, Pacific, and Indian Oceans and associated bodies of water (NMFS 1998). While data are somewhat limited on their diet in the Pacific, it is well documented that in the Caribbean hawksbill turtles are selective spongivores, preferring particular sponge species over others (Dam and Diez 1997b). Foraging dive durations are often a function of turtle size, with larger turtles diving deeper and longer. At a study site also in the northern Caribbean, foraging dives were made only during the day and dive durations ranged from 19 to 26 minutes at depths of 8–10 meters. At night, resting dives ranged from 35 to 47 minutes in duration (Dam and Diez 1997a).

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). Within the Great Barrier Reef of Australia, hawksbills move from a pelagic existence to a “neritic” life on the reef at a minimum CCL of 35 centimeters. The maturing turtle establishes foraging territory and will remain in this territory until it is displaced (Limpus 1992). As with other sea turtles, hawksbills will make long reproductive migrations between foraging and nesting areas (Meylan 1999), but otherwise they remain within coastal reef habitats. In Australia, juvenile turtles outnumber adults 100:1. These populations are also sex biased, with females outnumbering males 2.57:1 (Limpus 1992).

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, Papua New Guinea, the Solomon Islands (McKeown 1977), and Australia (Limpus 1982).

The hawksbill turtle is listed as endangered throughout its range. In the Pacific this species is threatened by 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 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 absent in most localities where it was once abundant (Cliffton et al. 1982). Hawksbill turtle populations are benefitting from conservation and recovery programs but have not yet recovered. Hawksbill turtles occur in waters around the Hawaii Archipelago and nest on Maui and the southeast coast of the Big Island.

Olive Ridley Sea Turtles

Olive ridley turtles (*Lepidochelys olivacea*) are olive or grayish green above, with a greenish white underpart, and adults are moderately sexually dimorphic (NMFS and USFWS 1998e). Olive ridleys lead a highly pelagic existence (Plotkin 1994). These sea turtles appear to forage throughout the eastern tropical Pacific Ocean, often in large groups, or flotillas. In a 3-year study of communities associated with floating objects in the eastern tropical Pacific, Arenas et al. (1992) found that 75 percent of sea turtles encountered were olive ridleys and were present in 15 percent of the observations, thus implying that flotsam may provide the turtles with food, shelter, and/or orientation cues in an otherwise featureless landscape. It is possible that young turtles move offshore and occupy areas of surface-current convergences to find food and shelter among aggregated floating objects until they are large enough to recruit to the nearshore benthic feeding grounds of the adults, similar to the juvenile loggerheads mentioned previously.

While it is true that olive ridleys generally have a tropical range, individuals do occasionally venture north, some as far as the Gulf of Alaska (Hodge and Wing 2000). The postnesting migration routes of olive ridleys, tracked via satellite from Costa Rica, traversed thousands of kilometers of deep oceanic waters ranging from Mexico to Peru and more than 3,000 kilometers out into the central Pacific (Plotkin 1994). Stranding records from 1990–1999 indicate that olive ridleys are rarely found off the coast of California, averaging 1.3 strandings annually (J. Cordaro, NMFS, personal communication, NMFS 2004).

The olive ridley turtle is omnivorous, and identified prey include a variety of benthic and pelagic prey items such as shrimp, jellyfish, crabs, snails, and fish, as well as algae and seagrass (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 are likely to attract the turtles. Olive ridley turtles also forage at great depths, as a turtle was sighted foraging for crabs at a depth of 300 meters

(Landis 1965, in Eckert et al. 1986). The average dive lengths for adult females and males are reported to be 54.3 and 28.5 minutes, respectively (Plotkin 1994, in Lutcavage and Lutz 1997).

Declines in olive ridley populations have been documented in Playa Nancite, Costa Rica; however, other nesting populations along the Pacific coast of Mexico and Costa Rica appear to be stable or increasing, after an initial large decline due to harvesting of adults. Historically, an estimated 10-million olive ridleys inhabited the waters in the eastern Pacific off Mexico (Cliffton et al. 1982, in NMFS and USFWS 1998e). However, human-induced mortality led to declines in this population. Beginning in the 1960s, and lasting over the next 15 years, several million adult olive ridleys were harvested by Mexico for commercial trade with Europe and Japan (NMFS and USFWS 1998e). Although olive ridley meat is palatable, it is not widely sought; eggs, however, are considered a delicacy, and egg harvest is considered one of the major causes for its decline. Fisheries for olive ridley turtles were also established in Ecuador during the 1960s and 1970s to supply Europe with leather (Green and Ortiz-Crespo 1982). In the Indian Ocean, Gahirmatha supports perhaps the largest nesting population; however, this population continues to be threatened by nearshore trawl fisheries. Direct harvest of adults and eggs, incidental capture in commercial fisheries, and loss of nesting habits are the main threats to the olive ridley's recovery.

3.3.4.2 Marine Mammals

Cetaceans listed as endangered under the ESA and that have been observed in the Western Pacific Region include the humpback whale (*Megaptera novaeangliae*), sperm whale (*Physeter macrocephalus*), blue whale (*Balaenoptera musculus*), fin whale (*B. physalus*), and sei whale (*B. borealis*). In addition, one endangered pinniped, the Hawaiian monk seal (*Monachus schauinslandi*), occurs in the region.

Humpback Whales

Humpback whales (*Megaptera novaeangliae*) can attain lengths of 16 meters. Humpback whales winter in shallow nearshore waters of usually 100 fathoms or less. Mature females are believed to conceive on the breeding grounds one winter and give birth the following winter. Genetic and photo identification studies indicate that within the U.S. EEZ in the North Pacific, there are at least three relatively separate populations of humpback whales that migrate between their respective summer/fall feeding areas to winter/spring calving and mating areas (Hill and DeMaster 1999). The Central North Pacific stock of humpback whales winters in the waters of the Main Hawaiian Islands (Hill et al. 1997). At least six well-defined breeding stocks of humpback whales occur in the Southern Hemisphere.

There is no precise estimate of the worldwide humpback whale population. The humpback whale population in the North Pacific Ocean basin is estimated to contain 6,000–8,000 individuals (Calambokidis et al. 1997). The Central North Pacific stock appears to have increased in abundance between the early 1980s and early 1990s; however, the status of this stock relative to its optimum sustainable population size is unknown (Hill and DeMaster 1999).

Humpback whales migrate through waters around the NWHI and occur off all eight Hawaiian Islands during the winter breeding season, but particularly within the shallow waters of the "four-island" region (Kaho'olawe, Molokai, Lanai, Maui); the northwestern coast of the island of Hawaii; and the waters around Niihau, Kauai, and Oahu. This population is estimated to total 6,000 – 10,000 individuals and researchers estimate that it is increasing by seven percent per year, putting the species on a track to double in just over a decade.

Sperm Whales

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, making up to 40 percent of its total body length. The current average size for male sperm whales is about 15 meters, with females reaching up to 12 meters. Sperm whales are found in tropical to polar waters throughout the world (Rice 1989). They are among the most abundant large cetaceans in the region. Sperm whales have been sighted around several of the Northwestern Hawaiian Islands (Rice 1960) and off the main islands of Hawaii (Lee 1993). The sounds of sperm whales have been recorded throughout the year off Oahu (Thompson and Freidl 1982).

According to NOAA (www.nmfs.noaa.gov/pr/species/mammals/cetaceans/spermwhale.htm, accessed April 17, 2009) the world's population of sperm whales is estimated to be between 200,000 and 1,500,000 individuals. However, the methods used to make this estimate are in dispute, and there is considerable uncertainty over the number of sperm whales. The status of sperm whales in Hawaii waters relative to the optimum sustainable population is unknown, and there are insufficient data to evaluate trends in abundance (Forney et al. 2000).

Blue Whales

The blue whale (*Balaenoptera musculus*) is the largest living animal. Blue whales can reach lengths of 30 meters and weights of 160 tons (320,000 lbs), with females usually being larger than males of the same age. They occur in all oceans, usually along continental shelves, but can also be found in the shallow inshore waters and on the high seas. No sightings or strandings of blue whales have been reported in Hawaii, but acoustic recordings made off Oahu and Midway Atoll reported blue whales somewhere within the EEZ around Hawaii (Thompson and Freidl 1982). The stock structure of blue whales in the North Pacific is uncertain (Forney et al. 2000). The status of this species in Hawaii waters relative to the optimum sustainable population is unknown, and there are insufficient data to evaluate trends in abundance (Forney et al. 2000). Prior to whaling, the worldwide population of blue whales is believed to have been about 200,000 animals. Only 8,000-12,000 are estimated to be alive today. Blue whales have always been more abundant in the Antarctic than in the northern hemisphere. An estimated 4,900 to 6,000 blue whales are believed to have inhabited the north Pacific prior to whaling. The north Pacific population is now estimated at 1,200 to 1,700 animals.

Fin Whales

Fin whales (*Balaenoptera physalus*) are found throughout all oceans and seas of the world from tropical to polar latitudes (Forney et al. 2000). Although it is generally believed that fin whales make poleward feeding migrations in summer and move toward the equator in winter, few actual observations of fin whales in tropical and subtropical waters have been documented, particularly in the Pacific Ocean away from continental coasts (Reeves et al. 1999). There have only been a few sightings of fin whales in Hawaii waters.

There is insufficient information to accurately determine the population structure of fin whales in the North Pacific, but there is evidence of multiple stocks. The status of fin whales in Hawaii waters relative to the optimum sustainable population is unknown, and there are insufficient data to evaluate trends in abundance (Forney et al. 2000).

Sei Whales

Sei whales (*Balaenoptera borealis*) have a worldwide distribution but are found mainly in cold temperate to subpolar latitudes rather than in the tropics or near the poles (Horwood 1987). They are distributed far out to sea and do not appear to be associated with coastal features. Two sei whales were tagged in the vicinity of the Northern Mariana Islands (Reeves et al. 1999). Sei whales are rare in Hawaii waters. The International Whaling Commission only considers one stock of sei whales in the North Pacific, but some evidence exists for multiple populations (Forney et al. 2000). In the southern Pacific most observations have been south of 30°(Reeves et al. 1999).

There are no data on trends in sei whale abundance in the North Pacific (Forney et al. 2000). It is especially difficult to estimate their numbers because they are easily confused with Bryde's whales, which have an overlapping, but more subtropical, distribution (Reeves et al. 1999).

Hawaiian Monk Seals

The Hawaiian monk seal (*Monachus schauinslandi*) is a tropical seal endemic to the Hawaiian Islands. Today, the entire population of Hawaiian monk seals is about 1,300 to 1,400 and occurs mainly in the NWHI. The six major reproductive sites are French Frigate Shoals, Laysan Island, Lisianski Island, Pearl and Hermes Reef, Midway Atoll, and Kure Atoll. Small populations at Necker Island and Nihoa Island are maintained by both reproduction and immigration, and an increasing number of seals are distributed throughout the MHI where they are also reproducing.

The subpopulation of monk seals on French Frigate Shoals has shown the most change in population, increasing dramatically in the 1960s–70s and declining in the late 1980s–90s. In the 1960s–70s, the other five subpopulations experienced declines. However, during the past decade, the number of monk seals increased at Kure Atoll, Midway Atoll, and Pearl and Hermes Reef while the subpopulations at Laysan Island and Lisianski Island remained relatively stable. The recent subpopulation decline at French Frigate Shoals is thought to have been caused by male aggression, shark attack, entanglement in marine debris, loss of habitat, and decreased prey availability. The Hawaiian monk seal is assumed to be well below its optimum sustainable population, and, since 1985, the overall population has declined approximately 3 percent per year (Forney et al. 2000).

The 2004 U.S. Pacific Marine Mammal Stock Assessment estimates that there are 1,304 monk seals in the Hawaiian Islands, with at least 52 of those occurring in the Main Hawaiian Islands (NOAA 2005). There was an exceptional reporting of a pupping at Johnston Atoll in 1969; however, site visits by biologists have been infrequent and it is not known how regularly monk seals use the atoll.

Aggressive male monk seals in the NWHI are known to mob females and sometimes kill pups. Mobbing behavior is thought to occur due to a skewed sex ratio, and 22 subadult males were translocated from Laysan Island in the NWHI to the Big Island in the MHI in 1994. In 1998, two males were identified as aggressive at French Frigate Shoals. They were translocated to Johnston Atoll in 1999 and were resighted at that location for a few months, although they have not been resighted recently.

At one time it was believed that NWHI lobsters were an important part of the diet of monk seals and this concern may have contributed to the closure of the NWHI lobster fishery. However, an ongoing analysis of fatty acid signatures in monk seal blubber indicates that lobster and crustaceans in general do not appear to be very important to monk seals as there are species of NWHI lobsters in relatively high abundance but monk seals are not eating them (PIFSC Scientist Charles Littnan in the Honolulu Advertiser, December 1, 2006).

Other Marine Mammals

Table 7 lists known non-ESA listed marine mammals that occur in the Western Pacific Region.

Table 7: Non-ESA Listed Marine Mammals of the Western Pacific

Common Name	Scientific Name	Common Name	Scientific Name
Blainsville beaked whale	*Mesoplodon densirostris*	pygmy sperm whale	*Kogia breviceps*
bottlenose dolphin	*Tursiops truncatus*	Risso's dolphin	*Grampus griseus*
Bryde's whale	*Balaenoptera edeni*	rough-toothed dolphin	*Steno bredanensis*
Cuvier's beaked whale	*Ziphius cavirostris*	short-finned pilot whale	*Globicephala macrorhynchus*
dwarf sperm whale	*Kogia simus*	spinner dolphin	*Stenella longirostris*
false killer whale	*Pseudorca crassidens*	spotted dolphin	*Stenella attenuata*
killer whale	*Orcinus orca*	striped dolphin	*Stenella coeruleoalba*
melon-headed whale	*Peponocephala electra*	Pacific white-sided dolphin	*Lagenorhynchus obliquidens*
pygmy killer whale	*Feresa attenuata*	minke whale	*Balaenoptera acutorostrata*

Common Name	Scientific Name	Common Name	Scientific Name
Fraser's dolphin	*Lagenodelphis hosei*	Dall's porpoise	*Phocoenoides dalli*
Longman's beaked whale	*Indopacetus pacificus*	common dolphin	*Delphinus delphis*
minke whale	*Balaenoptera acutorostrata*	Fraser's dolphin	*Lagenodelphis hosei*

3.3.4.3 Seabirds

Seabirds listed as threatened or endangered under the ESA are managed by the USFWS. The short-tailed albatross, which is listed as "endangered" under the ESA, is a migratory seabird that is known to be occasionally present in the NWHI.

Short-Tailed Albatross

The short-tailed albatross (*Phoebastria immutabilis*) is the largest seabird in the North Pacific, with a wingspan of more than 3 meters (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 its 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 U.S. (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 unsuccessfully, 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 2000, the breeding population of the short-tailed albatross was estimated at approximately 600 breeding age birds, with an additional 600 immature birds, yielding a total population estimate of 1,200 individuals (65 FR 46643, July 31, 2000). At that time, short-tailed albatrosses were estimated to have an overall annual survival rate of 96 percent and a population growth rate of 7.8 percent (65 FR 46643, July 31, 2000). More recently, NMFS estimated the global population to consist of approximately 1,900 individuals (P. Sievert, personal communication; in NMFS 2005), and the Torishima population was estimated to have increased by 9 percent between the 2003–04 and 2004–05 seasons (Harrison 2005).

The short-tailed albatross was first listed under the Endangered Foreign Wildlife Act in June 1970. On July 31, 2000, the United States Fish and Wildlife Service 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 landslides, reduced genetic variability, limited breeding distribution, plastics ingestion, contaminants, airplane strikes, and incidental capture in longline fisheries in the western and far northern Pacific.

The short-tailed albatross population is growing annually, likely the result of effective habitat protection and management. Active breeding colonies are found on Torishima, south of Honshu Island, Japan and Minami-kojima in the Senkaku islands north of Taiwan. An estimated 80-85% of the breeding short-tailed albatrosses occur in a single colony on Torishima. The current worldwide population is estimate at 2,771 individuals (G. Blogh, USFWS pers comm. to L. Van Fossen, NMFS, 2008). Based on breeding pair counts, the short-tailed albatross population appears to be increasing by seven percent annually (Naughton et al. 2008). In 2006, there were 341 breeding pairs counted at Torishima (Hasegawa 2007a), and 382 breeding pairs were counted there in 2007 (Hasegawa 2007b). No critical habitat has been established for the short-tailed albatross and none of the fisheries evaluated in this FEP are likely to interact with the endangered short-tailed albatross.

Newell's Shearwater

The Newell's shearwater (*Puffinus auricularis newelli*) is listed as threatened under the ESA. Generally, the at-sea distribution of the Newell's shearwater is restricted to the waters surrounding the Hawaii Archipelago, with preference given to the area east and south of the main Hawaiian Islands. The Newell's shearwater has been listed as threatened because of its small population, 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) of their nesting burrows (Harrison 1990). Shearwaters also tend to be gregarious at sea, and 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 enhance the bird's sense of smell, assisting them to locate food while foraging (Ainley et al. 1997).

Other Seabirds

Other seabirds found in the region include the black-footed albatross (*Phoebastria nigripes*), Laysan albatross (*Phoebastria immutabilis*), masked booby (*Sula dactylatra*), brown booby (*Sula leucogaster*), red-footed booby (*Sula sula*), wedge-tailed shearwater (*Puffinus pacificus*), Christmas shearwater (*Puffinus nativitatis*), petrels (*Pseudobulweria* spp., *Pterodroma* spp.), tropicbirds (*Phaethon* spp.), frigatebirds (*Fregata* spp.), and noddies (*Anous* spp.).

Seabirds known to occur around Hawaii include short-tailed, black-footed, and Laysan albatrosses; Christmas, Newell's, flesh-footed, wedge-tailed, and sooty shearwaters; and masked, brown, and red-footed boobies. The world's largest Laysan albatross colony is located on Hawaii's Midway Atoll where lead paint is reported to be flaking off of deteriorating buildings. Paint chips are consumed by albatross chicks as they wait for their parents to return with food and the American Bird Conservancy has stated that these chicks have shockingly high lead concentrations. The organization estimates that 10,000 chicks die each year as a result. The USFWS has stated that they plan to clean up as many buildings as possible over the next two to four years and will also excavate chip-contaminated soil from around the buildings and six inches down. The soil will be replaced with clean beach sand (TenBruggencate 2006).

3.4 Social Environment[13]

Hawaii's economy is dominated by tourism and defense, with tourism by far the leading industry in terms of employment and expenditures. The two represent approximately one quarter of Gross State Product without consideration of ancillary services and also comprise the largest shares of "export" earnings (Tables 8 and 9).

Table 8: Hawaii's Gross State Product

Year	Gross State Product (million $)	Per Capita State Product	Resident Population
2005	53,710	$42,119	1,275,194

Source: DBEDT 2005. Table 13.02

[13] Unless otherwise noted, all data in this section are taken from the 2005 STATE OF HAWAII DATA BOOK, on-line edition, hereafter referenced DBEDT, 2005. [http://www.hawaii.gov/dbedt/ accessed April 7, 2007.]

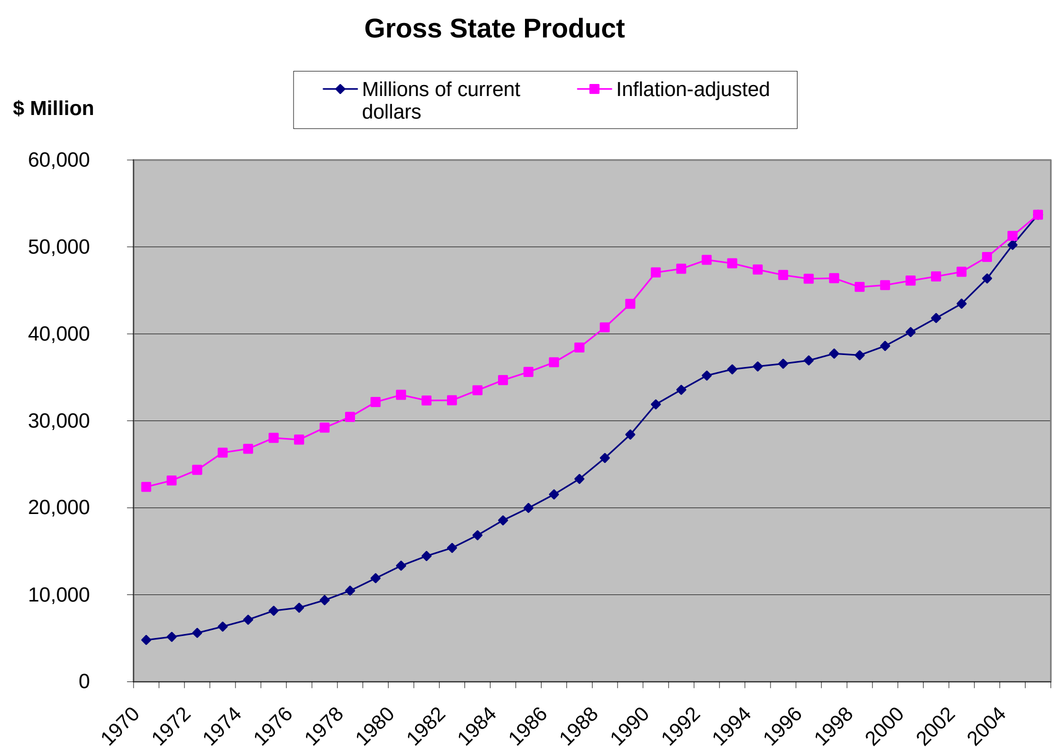
Table 9: Hawaii's "Export" Industries

Year	Sugar (million $)	Pineapple (million $)	U.S. Military (million $)	Tourism (million $)
2004[14]	94	123	4,772	10,862

Source: DBEDT 2006

Natural resource production remains important in Hawaii, although nothing compared to the period of the sugar and pineapple plantations from throughout the first 60 or 70 years of the Twentieth century. Crop and livestock sales were $516.1 million in 2004, with the primary diversified agriculture crops being flower and nursery products, $94.5 million; macadamia nuts, $40.1 million; coffee, $19.8 million; cattle, $22.1 million; milk, $20.2 million (DBEDT 2006). Aquaculture production was $28.1 million in 2004 (DBEDT 2006), although much of aquaculture's value to Hawaii comes from development of technology. Commercial fishing ex-vessel value was $57.5 million, not including value added by the seafood processing sector (WPacFIN 2007), lower than some earlier years due to the closure of the longline fishery for swordfish from 2000-2004.

Hawaii's commercial economy was particularly vibrant between 2000 and 2005, with a 7.5 percent growth in Gross State Product in 2005 and an average of 5.8 percent annual growth rate since 2000. Figure 11 indicates the long-term trend in Gross State Product (1970-2005), with the inflation-adjusted figures clearly showing the downturns in the early 1980s and the mid-1990s, followed by recent growth.



[14] 2004 is the most recent year when complete industry statistics are available.

Figure 11: Gross State Product, 1970-2005

The current unemployment rate (2006, see Table 10) of 2.6% (DBEDT 2007) is the lowest in the United States by far, and close to half the U.S. average rate. This marks a major turn-around from the 1990s when Asian economies declined, the U.S. military down-sized due to the end of the Cold War, and Hawaii plantation agriculture was battered by the cost effects of global trade. Construction, manufacturing and agriculture account for only 9% of wage and salary jobs. About 30% of civilian workers are professional or managerial. Federal, state and local government accounts for 20% of wage and salary jobs (DBEDT 2006).

Table 10: Hawaii Employment Statistics

	2006
Civilian labor force	651,850
Employed	635,100
Unemployment rate	2.6%
Payroll jobs	624,650
Real personal income ($ million)	46,766

Tourism arrivals increased almost monotonically from 1970-1990, but growth was slower in the 1990s until the past three years. There were 7.4 million tourists in Hawaii in 2005. This represents a daily rate of 185,445 tourists, 13% of the “de facto” population (resident, tourist, and military combined), indicating the weight of tourism in many sectors of Hawaii’s economy and society (DBEDT 2005). Tourism arrivals have become more evenly distributed across source locations, with the continental U.S. and Japan being the mainstays, but with arrivals increasing from Europe and China. Nonetheless, Hawaii’s economy remains subject to national and international economic factors.

Total federal expenditures were $12.2 billion in 2004, with 85,900 military personnel and dependents and 31,300 federal civilian workers (not all of whom work on military bases, DBEDT 2006). Research and development spending by the federal government (2003) was $349.6 million representing the importance of the University of Hawaii and a number of other public and private research entities in particular.

Despite these successes, at some individual and community levels Hawaii’s commercial economy has been less successful. For example, per capita disposable income in Hawaii ($29,174) has fallen to below the national average despite a cost of living nearly double the national average (Table 11).

Table 11: Hawaii Cost of Living Comparison

Cost of Living Analysis: Ratio of Honolulu living costs compared to U.S. Average at four income levels				
	Income level 1	Income level 2	Income level 3	Income level 4
Honolulu cost of living indexed to U.S. average	192.9	171.6	161.9	155.1
Rent, utilities	241.4	235.4	230.3	229.0

Source: DBEDT 2005. Table 14.11

Indeed, per capita Gross State Product is the same today as it was in 1990. Hawaii per capita income has fallen from 122.5% of the U.S. average in 1970 to 99% in 2005 (Figure 12). Much of this is attributable to housing costs, with the average single family house selling for $744,174 in 2005, with the median being $590,000, the latter discrepancy also indicating the uneven nature of the housing industry in Hawaii over the past several years.

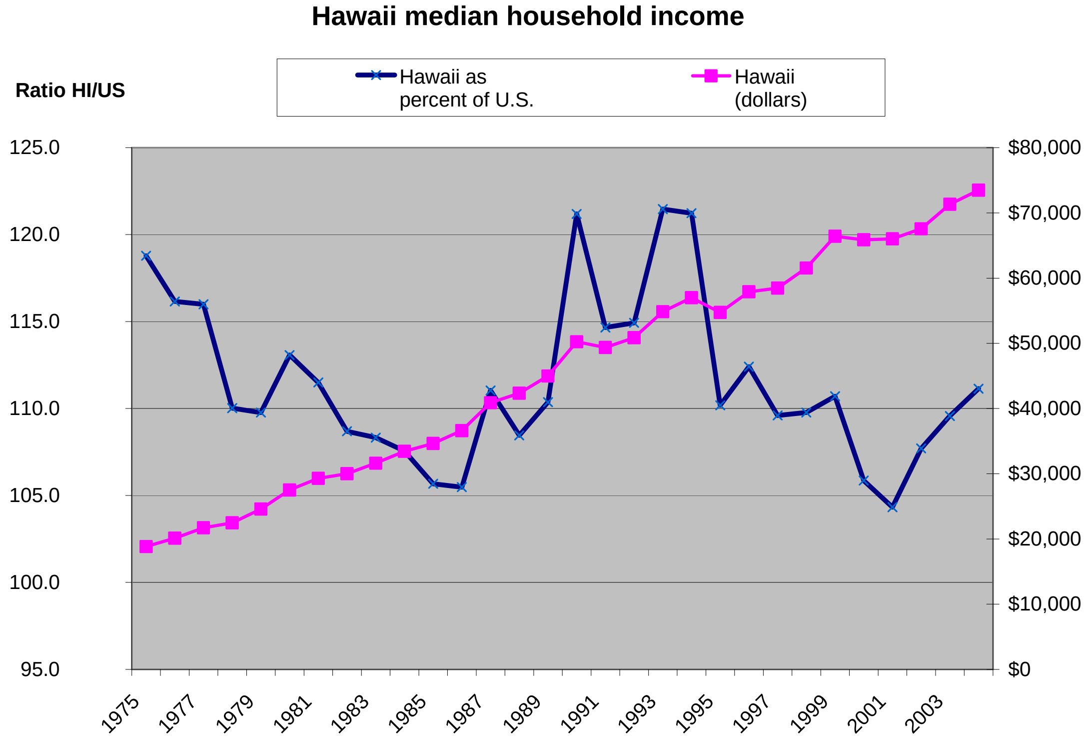


Figure 12: Hawaii Median Household Income, 1975-2005

Tourism is a service industry, and as such, tends to have lower wage levels than manufacturing, for example. So the dominance of tourism means that many workers in Hawaii hold more than one job, with 16% of the workforce reporting they work 49 or more hours per week (DBEDT 2005. Table 12.38). Similarly, the benefits of the commercial economy are not spread evenly across either islands or ethnic groups in Hawaii. In 2004, 8.4% of Hawaii's population was below the poverty line (DBEDT 2005. Table 13.23). The effect of these conditions is that the value of common use resources, such as shorelines, forests, and the ocean, is important for both subsistence and recreational reasons.

The State of Hawaii has been attempting to diversify its economy for many years. Industries encouraged are science and technology, film and television production, sports, ocean research and development, health and education tourism, diversified agriculture and floral and specialty food products. (DBEDT, 2006) However, these remain small percentage of the Hawaii commercial economy.

Bank of Hawaii summarized the recent general trends as of August, 2008. At midyear, 2008, Hawaii's economic growth had slowed to a crawl due to higher oil prices, falling tourism, and falling residential investment. The decrease in tourism is fueled by both decreased domestic demand and a reduction in the number of trans-Pacific flights resulting from the shutdown of Aloha Airlines and ATA, which previously represented 15-20 percent of the available seats to Hawaii. Hawaii's unemployment rate rose to 3.5 percent in June 2008 on a seasonally-adjusted basis, while job growth slowed to a few tenths of one percent, well below the rate necessary to generate enough labor force absorption to prevent the unemployment rate from rising. Since then, Hawaii's unemployment rate has continued to rise and as of September 2008, hit 4.5%. Honolulu's inflation rate was 4.9 percent in first half 2008, up slightly from the 4.8 percent for all of 2007. While shelter costs began to moderate, energy costs rose significantly. Household fuels and utilities costs rose 36.4 percent, year-over-year.

The most recent estimate of the ex-vessel value of fish sold by the fisheries regulated by this FEP is $ 4.2 million. This amounts to a small percentage of Gross State Product, in fact, less than 1 percent. On the other hand, the seafood industry is an important component of local and tourist consumption, and recreational and subsistence fishing represents a substantial proportion of the local population (estimated at 109,000 participants, 8.6% of Hawaii's population).[15] An additional 41,000 tourists are also reported to go fishing while in Hawaii, and total fishing expenditures (resident and tourist combined) were estimated at $125 million.

The most recent estimate of the total economic contribution of the dermsal and pelagic commercial, charter, and recreational fishing sectors to the state economy indicated that in 1992, these sectors contributed $118.79 million of output (production) and $34.29 million of household income, employing 1,469 people (Sharma et al. 1999). These contributions accounted for 0.25 percent of total state output ($47.4 billion), 0.17 percent of household income ($20.2 billion), and 0.19 percent of employment (757,132 jobs). Recreational, subsistence and sport (e.g., charter) fisheries provide additional but unquantified economic benefits in terms of angler satisfaction, protein sources, and tourism revenues.

Although not a focus of this FEP, Hawaii's pelagic fisheries are responsible for the largest share of annual commercial landings and ex-vessel revenue, with 28.2 million pounds of pelagic fish landed in 2005 at an ex-vessel value of $66.7 million. The domestic longline fishery for tuna, swordfish, and other pelagic species is the largest component of the fishery, landing 23 million pounds in 2005 with an ex-vessel value of $58 million. Among the demersal fisheries, commercial harvests of CRE MUS dominate, with MHI and NWHI bottomfish relatively close behind (Table 12). The remainder of Hawaii's commercial fisheries are relatively small, with

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[15] DBEDT, 2005. Table 7.56.

annual fishery ex-vessel revenues of less than $150,000. Chapter 4 provides further information on each of these fisheries.

Table 12: Ex-vessel Revenues from Hawaii's Demersal Fisheries

	Pounds Sold	**Ex-vessel Revenue**
Coral reef species (2005)	701,624	$1,796,764
MHI bottomfish (2003)	272,569	$1,460,000
NWHI bottomfish (2003)	222,000	$851,219
MHI crustaceans (2005)	10,091	$110,927
Precious corals (1997)	415	$10,394
Total	1,206,699	$4,229,304

CHAPTER 4: DESCRIPTION OF HAWAII ARCHIPELAGO FISHERIES

4.1 Introduction

Chapter 4 describes the fisheries of the Hawaii Archipelago and provides background on the history of fishing by the residents of the area, including information on catches, landings, and bycatch for each fishery managed under this FEP. For more information, please see the Council's FMP, FMP amendments and associated annual reports. Additional information is available in a 2008 environmental assessment for the Crustaceans FMP, a 2001 Final EIS for the Coral Reef Ecosystems FMP, 2007 and 2008 environmental assessments for the Precious Corals FMP, a 2005 Final EIS to the Bottomfish FMP, and a 2007 Final Supplemental EIS to the Bottomfish FMP. The information presented in this chapter represents a summary of all the available information relative to the fisheries covered by this FEP. Although this FEP will apply only to Federal waters around the Hawaii Archipelago, fisheries in nearshore (i.e., State of Hawaii) waters are also discussed so as to provide a comprehensive examination of fishing impacts on the area's demersal ecosystem.

4.2 Hawaii Archipelago Bottomfish Fisheries

4.2.1 History and Patterns of Use

Bottomfish fishing was a part of the economy and culture of the indigenous people of Hawaii long before European explorers first visited the islands. Descriptions of traditional fishing practices indicate that Native Hawaiians harvested the same deep-sea bottomfish species as the modern fishery and used some of the same specialized gear and techniques employed today.

The deep-slope bottomfish fishery in Hawaii concentrates on species of eteline snappers (e.g., opakapaka), carangids (e.g., jacks), and a single species of grouper (hapuupuu) concentrated at depths of 30–150 fathoms. The fishery can be divided into two geographical areas: (a) the inhabited MHI with their surrounding reefs and offshore banks and the (b) NWHI, a 1,200-nautical mile chain of largely uninhabited islets, reefs, and shoals. In the MHI, approximately 47 percent of the bottomfish habitat lies in state waters (Parke, 2007) Bottomfish fishing grounds within federal waters around the MHI include Middle Bank, most of Penguin Bank, and approximately 45 nautical miles of 100-fathom bottomfish habitat in the Maui–Lanai–Molokai complex. For management purposes, the NWHI fishery has been separated into the closer Mau Zone between 165° W and 161°20' W, and the more northwestern Hoomalu Zone to the west of 165° W. The entire NWHI bottomfish fishery occurs within Federal waters as fishing is prohibited in State waters and all vessels are required to carry active vessel monitoring systems.

In the small-boat bottomfish fishery that is active around the MHI, the distinction between recreational and commercial fishermen is extremely tenuous, with many otherwise recreational fishermen selling small amounts of fish to cover trip expenses. With the exception of non-commercial fishing participants fishing in federal waters,the MHI bottomfish fishery is not subject to federal permit or reporting requirements but commercial fishermen (those who sell one fish during the year) are required to obtain commercial marine licenses (CML) and to submit

State catch reports reporting their monthly fishing activity including all catches and bycatch (discards). It is difficult to separate catches originating from State (0-3 miles from shore) vs. Federal (3-200 miles from shore) waters as HDAR uses catch reporting forms which do not differentiate these areas. As a result, information on MHI catches is not spatially separated and, unless otherwise noted, represents catches from both State and Federal waters around the MHI.

The number of fishermen engaged in commercial bottomfish fishing in the MHI increased dramatically in the 1970s and peaked at 583 vessels in 1985. Participation declined in the early 1990s, rebounded somewhat in the late 1990s, and in 2003 reached its lowest level since 1977 with only 325 active vessels (WPRMC 2004). Data from various surveys indicate that the importance of the MHI bottomfish fishery varies significantly among fishermen of different islands. According to a 1987 survey of boat fishing club members, bottomfish represented roughly 13 percent of the catch of Hawaii fishermen, 25 percent of the catch of Oahu and Kauai fishermen, and 75 percent of the catch of Maui fishermen (Meyer Resources 1987). A survey of licensed commercial fishermen conducted about the same time indicated that the percentage of respondents who used bottomfish fishing methods was 25 percent on Hawaii, 28 percent on Kauai, 29 percent on Oahu, 33 percent on Lanai, 50 percent on Molokai, and 51 percent on Maui (Harman and Katekaru 1988). Presumably, the differences among islands relate to the proximity of productive bottomfish fishing grounds.

Oahu landings account for roughly 30 percent of the MHI commercial landings of deepwater bottomfish species from 1998 to 2004. Maui landings from the same time period represent 36 percent of total MHI deepwater bottomfish landings, with Hawaii, Kauai and Molokai/Lanai representing 18, 10 and 5 percent, respectively (Kawamoto and Tao 2005). Specific bottomfish fishing locales favored by fishermen vary seasonally according to sea conditions and the availability and price of target species. Historically, Penguin Bank is one of the most important bottomfish fishing grounds in the MHI, as it is the most extensive shallow shelf area in the MHI and within easy reach of major population centers. Penguin Bank is particularly important for the MHI catch of uku, one of the few bottomfish species available in substantial quantities to Hawaii consumers during summer months.

Table 13. Summary of Unique CML numbers by Area Fished

Zone Name	2000	2001	2002	2003
Hawaii (island) State water (0–2)	76	62	64	57
Hawaii (island) Federal water	116	98	84	44
Hawaii (island) both	178	153	131	89
MMLK State water (0–2)	81	63	61	59
MMLK Federal water	102	91	80	66
MMLK both	146	120	112	99
Penguin Bank Federal water	77	58	59	50
MMLK plus 331 Federal water	209	168	163	145
Oahu State water (0–2)	56	41	51	53
Oahu Federal water	76	51	52	46
Oahu both	120	81	91	89
Kauai State water (0–2)	32	35	40	37

Kauai Federal water	61	46	42	16
Kauai both	85	71	66	44
Middle Bank Federal water	5	4	NA	NA

Source: Kawamoto and Tao 2005.

Note: MMLK (Maui, Molokai, Lanai, Kahoolawe) does not include Penguin Banks, unless mentioned otherwise. Trip/License by areas may not be additive because the fisherman may have fished in more than one area during a single trip. A trip to more than one area may be divided into State and Federal or multiple areas within each broad destination. Trip = 1 day fished

Bottomfish gear and fishing strategies are highly selective for desired species and sizes. Bottomfishers use a hook-and-line method of fishing in which weighted and baited lines are lowered and raised with electric, hydraulic, or hand-powered reels. The main line is typically 400–450 pounds test, with hook leaders of 80–120 pound test monofilament. The hooks are circle hooks, and a typical rig uses six to eight hooks branching off the main line. The weight is typically 5–6 pounds. The hook leaders are typically 2–3 feet long and separated by about 6 feet along the main line. Squid is the bait typically used. It is sometimes supplemented with a chum bag containing chopped fish or squid suspended above the highest hook. The use of bottom trawls, bottom gillnets, exposives, and poisons are prohibited.

Bottomfish fishing in the NWHI is conducted solely by commercial fishermen, and the vessels used tend to be larger than those fishing around the MHI, as the distance to fishing grounds is greater. Participation in the NWHI bottomfish fishery is controlled through limited access programs in each of the two management zones (Mau and Hoomalu). These zones were established to reduce the risk of biological overfishing and to improve the economic health and stability of the bottomfish fishery in the NWHI. The programs provide for a limited number of federal fishing permits to be issued each calendar year. Permits may not be sold, leased, or chartered. Based on the biological, economic, and social characteristics of the bottomfish fisheries in the two zones, the long-term target fleet sizes for the Hoomalu and Mau Zones have been determined to be seven and ten vessels, respectively. In 2006, four vessels fished in the Hoomalu Zone, and four fished in the Mau Zone. All of these vessels are independent, owner-operated fishing operations. The NWHI Bottomfish fishery will close on June 15, 2011, in accordance with the provisions of the Papahanaumokuakea Marine National Monument, which was established in the NWHI through Presidential Proclamation No. 8031 on June 15, 2006.

Based on 1998–2002 data commercial bottomfish catches in the MHI fishery represent approximately 60 percent of the total commercial bottomfish harvest in Hawaii (WPRFMC 2004). Preliminary data for 2003 indicate that a total of 272,569 pounds of commercial landings were made by 325 vessels in the MHI, with a total ex-vessel value of $1,460,000 (Figures 13 and 14). Mau Zone landings for 2003 were estimated to total 77,000 pounds, with a total ex-vessel value of $356,769, while Ho'omalu Zone landings were 145,000 pounds, with a total ex-vessel value of $494,450 (WPRFMC 2005a).

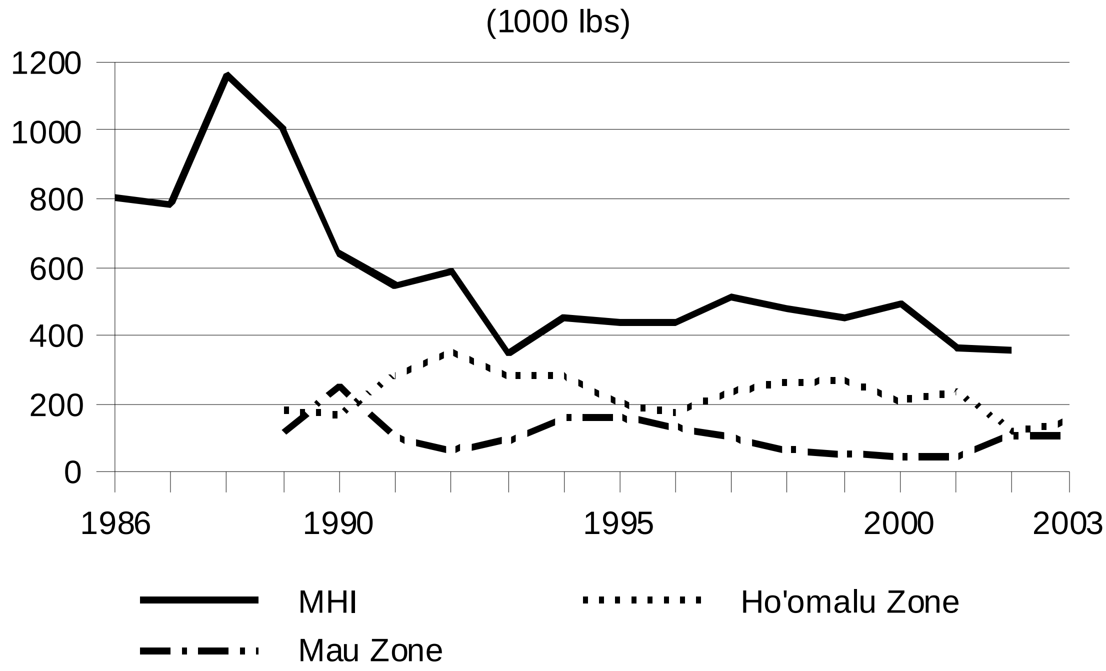

Figure 13: MHI and NWHI Bottomfish Landings 1986–2003
Source: WPRFMC 2005a

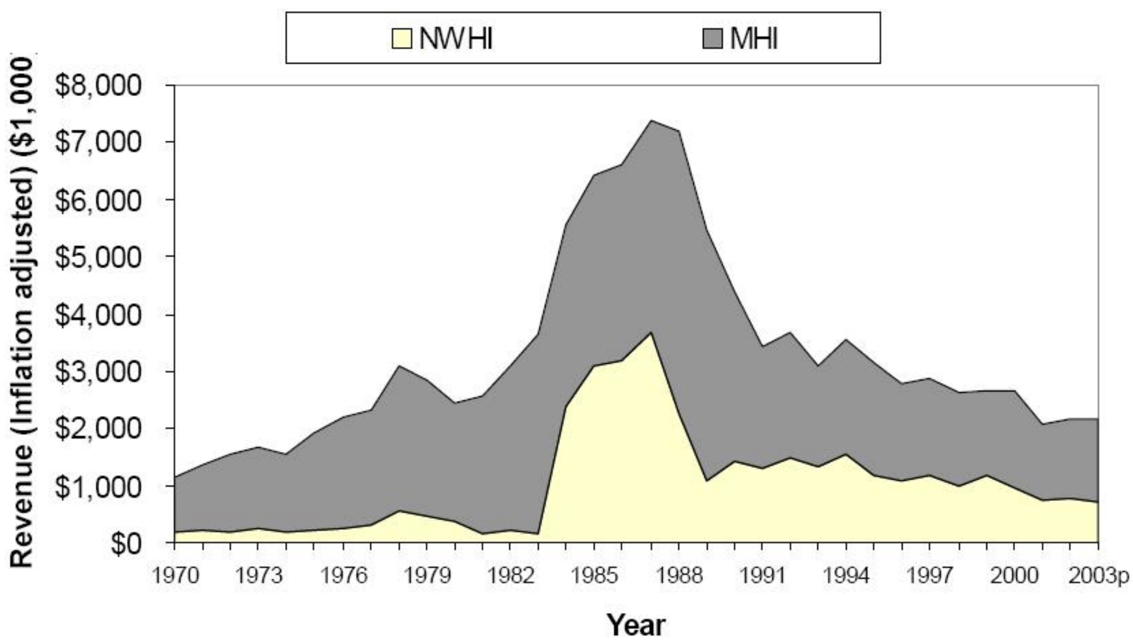

Figure 14: Hawaii Bottomfish Revenue (Inflation Adjusted) by Area 1970–2003
Source: WPRFMC 2005a

Nearly all bottomfish caught in the NWHI fishery is sold through the Honolulu fish auction (United Fishing Agency, Ltd.). Bottomfish caught in the MHI fishery are sold in a wide variety of market outlets (Haight et al. 1993b). Some are marketed through the fish auction and intermediary buyers on all islands. Sales of MHI bottomfish also occur through less formal market channels such as local restaurants, hotels, grocery stores, and to individual consumers. Unsold fish are consumed by fishermen and their families, given to friends and relatives as gifts, and bartered in exchange for various goods and services.

Onaga and opakapaka make up the largest valued landings in each area for most years (ignoring the highly fluctuating landings of uku). NWHI ex-vessel prices were $4.53 and $4.79 per pound, respectively, in 2003 while MHI were $5.89 and $5.01, respectively. However, the NWHI landings are comprised of a higher percentage of these higher priced species compared with the MHI, so the difference in price for individual species by area is ironed out by the different species compositions between the two areas (see Figure 15).

According to U.S. Customs data for the Port of Honolulu, 801,000 pounds of snapper were imported in 2003 worth $2.26 million ($2.82 per pound). This exceeded the domestic supply and thus was a significant factor in ex-vessel prices (WPRFMC 2004). Not only has the quantity of foreign-caught fresh fish increased during the past few years, but the number of countries exporting fresh fish to Hawaii has also increased. A decade ago, for example, fresh snapper was exported to Hawaii mainly from within the South Pacific region. In recent years, Tonga and Australia were the largest sources of imported fresh snapper, with Fiji and New Zealand also being major sources, and Viet Nam, Chad (freshwater), and Madagascar as minor sources.

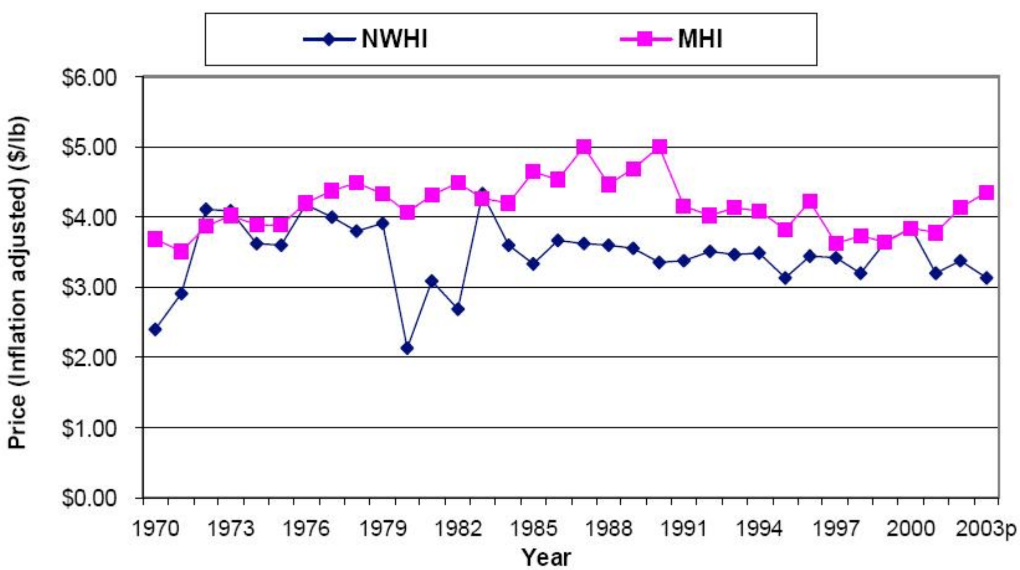

Figure 15: Average Prices for NWHI and MHI BMUS Landings 1970–2003
Source: WPRFMC 2004

4.2.2 Review of Bycatch

Economic Discards
The largest federally managed bottomfish fishery in Hawaii occurs in the NWHI. Two data

sources have been used to assess bycatch rates in this fishery. Logbook data compiled by the Hawaii Division of Aquatic Resources (HDAR) indicate the reported disposition of the catch from all trips. Data were also compiled from 26 NWHI fishing trips that carried observers between October 1990 and December 1993 (Nitta 1999). The observer coverage represented 12 percent of the 209 trips made during that period. In Table 9 is a summary of the 1990–1993 observer data and the logbook data for the 1997–2001 period. The logbook figures are annual averages, while the observer figures are aggregates of all data collected during the 3-year program.[16] The two datasets indicate the same general discard patterns. Two species, kahala (*Seriola dumerili*) and butaguchi (*Pseudocaranx dentex*), made up the majority of the bycatch. Less than 5 percent of the catch of kahala was retained, and between about 50 and 75 percent of the catch of butaguchi was retained. Relatively large percentages of the catch of certain other species, including white ulua (*Caranx ignobilis*), were discarded, but these species' contribution to the catch was relatively small, so their contribution to absolute discards was relatively small. Non-BMUS that had relatively high-percentage discard rates (but relatively low absolute discard rates) in the observer data included opelu (*Decapturus* spp.), sharks, and a number of reef-associated species.

Target species are often discarded if they are damaged by predators. Sharks are responsible for most damage, but Hawaiian monk seals and bottlenose dolphins also cause damage. The carangids tend to be discarded because of their short shelf life and low market value. Butaguchi, for example, is palatable but of generally low value. Kahala, once a major component of commercial and recreational landings, is now seldom retained because it has been implicated in incidents of ciguatera poisoning (Kasaoka 1989).

Although the logbook and observer data represent two different time periods and cannot be strictly compared, substantial differences between the two indicate probable shortcomings in the logbook data. The average overall discard rate indicated by the logbook data is 13 percent, compared with 25 percent for the observer data (Table 14). The differences suggest that the logbook data—at least for some species—probably do not reliably reflect actual bycatch rates. The biggest differences were for the two most commonly discarded species: butaguchi and kahala.The two datasets indicated similar percentage discard rates for kahala, but the logbook data indicated a substantially lower contribution of kahala to the total catch. The same was true for butaguchi, but the percentage bycatch rates indicated in the two datasets were also substantially different. Thus, as is common in many fisheries, underreporting of commonly discarded species appears to be a shortcoming of the logbook data. In 2003, NMFS redeployed observers to the NWHI bottomfish fishery, in part, to collect additional bycatch observations and to calibrate the shortfall in discard reporting.

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[16] HDAR logbook data report "number released" and "number damaged." Assuming that all damaged fish were discarded, these two categories were combined to estimate total bycatch. The observer data report the number discarded and unknown disposition.Assuming that the discard rate where the disposition was unknown equaled the rate where the disposition was known, the values in the unknown category were reduced by the proportion of known discards to retained-plus-known discards. NWHI bottomfishing vessels often engage in pelagic trolling in addition to bottomfishing. The logbook data presented here include only fish recorded as being captured with bottom handline gear; the observer data include relatively small numbers of troll-caught fish.

Regulatory Discards
There are no finfish or invertebrate species captured in the bottomfish fisheries whose capture or retention is prohibited by law. Sea turtle species, which are protected under the ESA, are the only fish (as defined by the MSA) that, if captured in the bottomfish fishery, would be considered regulatory discards.

Table 14. Catch and Bycatch in the NWHI Bottomfish Fishery

		Logbook Data (1997–2001 annual averages)					Observer Data (1990–1993 aggregated)		
Species		Number caught	Number discarded	Percent of total catch	Percent discarded	Percent of all discards	Percent of catch	Percent discarded	Percent of all discards
BMUS		46,684	5,492	98.02	11.76	94.28	95.3	23.7	89.0
Opakapaka	*Pristipomoides filamentosus*	10,653	99	22.37	0.93	1.70	25.9	2.1	2.2
Onaga	*Etelis coruscans*	9,836	70	20.65	0.71	1.20	5.8	0.7	0.2
Ehu	*Etelis carbunculus*	5,171	32	10.86	0.62	0.55	6.0	1.7	0.4
Uku	*Aprion virescens*	4,226	56	8.87	1.33	0.96	11.2	1.7	0.7
Butaguchi	*Pseudocaranx dentex*	3,851	1,090	8.09	28.30	18.71	17.5	48.3	33.2
Kalekale	*Pristipomoides sieboldii*	3,799	361	7.98	9.50	6.20	4.4	6.1	1.1
Hapuupuu	*Epinephelus quernus*	3,517	26	7.38	0.74	0.45	8.1	1.2	0.4
Kahala	*Seriola dumerili*	3,266	3,182	6.86	97.43	54.63	12.4	97.3	47.5
Gindai	*Pristipomoides zonatus*	1,391	22	2.92	1.58	0.38	2.3	0.7	0.1
White ulua	*Caranx ignobilis*	720	552	1.51	76.67	9.48	0.6	68.1	1.7
Taape	*Lutjanus kasmira*	132	0	0.28	0.00	0.00	0.6	36.7	0.8
Lehi	*Aphareus rutilans*	83	1	0.17	1.20	0.02	0.0	0.0	0.0
Black ulua	*Caranx lugubris*	32	0	0.07	0.00	0.00	0.1	50.0	0.2
Yellowtail kalekale	*Pristipomoides auricilla*	3	0	0.01	0.00	0.00	0.2	56.4	0.5
Armorhead	*Pseudopentaceros wheeleri*	3	1	0.01	33.33	0.02	0.0	0.0	0.0
Alfonsin	*Beryx splendens*	0	0	0.00	0.00	0.00	0.0	50.0	0.0
Non-BMUS		943	334	1.98	35.42	5.73	4.7	59.9	11.0
ALL SPECIES		47,627	5,825	100.0	12.5	100.0	100.0	25.4	100.0

Protected Species Interactions

The 1990–1993, NMFS' observer program for the NWHI bottomfish fishery reported a moderate level of interactions between seabirds and the bottomfish fishery, with Laysan and black-footed albatrosses described as aggressively stealing bait from hooks during deployment and retrieval of bottomfish gear, causing lost fishing time (Nitta 1999). Birds were reported as being easily scared away from handlines by waving a pole or gaff. No seabird injuries or mortalities were observed while fishermen were fishing for bottomfish.[17] Although there is a possibility of accidental hooking, the circle hooks used in the bottomfish fishery do not lend easily to incidental hooking of seabirds. One interaction involving a Laysan albatross occurred while a bottomfish fishing vessel was trolling for pelagic species. The bird became hooked, but was subsequently released.

Fishermen have reported that other species of birds, particularly juvenile boobies (*Sula* spp.), dive on trolling lures (Nitta and Henderson 1993). The potential for the bottomfish fishery to cause adverse impacts on seabirds due to competition for prey is negligible, as seabirds do not prey on bottomfish species. The potential for other ecosystem links between the bottomfish fishery and seabirds is unknown; however the level of fishery interactions with seabirds is expected to have no effect on seabird distribution, survival, or population structure (WPRFMC 2001b).

There have been no reported or observed physical interactions with any species of sea turtle and whales in any of the bottomfish fisheries, including during the NMFS 1990–1993 NWHI bottomfish vessel observer program[18] (Nitta 1999).

During the vessel observer program conducted in the NWHI bottomfish fishery from 1990 through 1993, monk seals were observed taking and damaging hooked fish, with an average of one such interaction every 67 hours of fishing (Nitta 1999). A total of 23 monk seal interaction events were recorded during the program. Interactions occurred during 10 out of the 26 observed trips, and were estimated to have involved a maximum of 26 seals. No entanglements or hookings of monk seals were observed (Nitta 1999). An average of 2.67 dolphin-damaged fish per 1,000 fish caught was also observed (Kobayashi and Kawamoto 1995). The impact of the bottomfish fishery on the behavior or foraging success of bottlenose dolphins is unknown, but is not believed to be adverse.

The NWHI vessel observer program was renewed in October 2003, with observer coverage averaging 22 percent during 2004-2005. During the 2004-2005 time period a total of 26 trips carried observers. No interactions with sea turtles, monk seals or endangered seabirds were observed. Eight interactions with seabirds were observed across six trips. Six of the interactions occurred during trolling operations and two during bottomfishing operations. Seven of the eight interactions were with boobies, the remainder was with a Laysan albatross during trolling

[17] Although Nitta (1999) defined an interaction to mean instances in which an animal is "caught or entangled," the report's statement that "many interactions" with albatrosses were observed appears to refer to instances in which the seabirds were not actually caught or entangled (as none were injured).

[18] Nitta (1999) defined "interaction" to mean "instances in which fish caught during bottomfishing operations were stolen or damaged by marine mammals or marine mammals [sic] and/or other protected species were caught or entangled in bottomfishing gear".

operations (PIRO Observer Program webpage accessed March 2007). It is believed that all eight interactions were non-lethal and the seabirds were released alive.

NMFS has received a number of reports from various sources of monk seals with hooks embedded in their mouths or other body parts. Positively attributing a given hooking event to a particular fishery is difficult. A review of the reports led NMFS (2002b) to conclude that seven instances of hookings since 1982 may have been attributable to direct interactions with the bottomfish fishery. There has been one report by fishery participants of a hooking of a monk seal. In 1994, a bottomfish fisherman reported that a seal had stolen the catch and become hooked. The fisherman cut the leader line 12–18 inches from the seal. None of the hookings documented in the MHI since 1989 can be confirmed as originating from the bottomfish fishery (NMFS 2008).

The MHI bottomfish fishery catches some species that may be food resources for monk seals. Recent research on monk seal diets suggests that deepwater bottomfish are part of the monk seal diet (unpublished report, NMFS PIFSC, Honolulu). However, under current levels of fishing pressure in the MHI, the monk seal population is growing, pupping is increasing, and the pups appear to be foraging successfully. Considering that monk seal foraging success appears to be high in the MHI despite fishing pressure, competition for forage with the MHI bottomfish fishery does not appear to adversely impact monk seals in the MHI at this time.

Green turtles are sometimes killed by vessel collisions around the MHI, and it has been estimated that the current MHI bottomfish fishery is likely responsible for killing up to two green sea turtles per year due to vessel collisions. The resulting mortality is not believed to be likely to jeopardize the species because green sea turtles have been rapidly increasing in numbers in recent years while bottomfishing was occurring at a higher level of effort than the current fishery, and they are extremely unlikely to be hooked or entangled by bottomfishing gear.

Following consultations under section 7 of the ESA, NMFS has determined that the bottomfish fisheries will not adversely affect any ESA-listed species or critical habitat in the Hawaii Archipelago.

This FEP continues the existing federal regulations regarding fishery interactions with protected species.

Unlisted Species Interactions
Species of marine mammals that are not listed under the ESA but are protected under the Marine Mammal Protection Act (MMPA; see Section 8.6) and occur in the areas of the Hawaii Archipelago where bottomfish fisheries operate are as follows:

Whales

- Blainsville beaked whale (*Mesoplodon densirostris*)
- Bryde's whale (*Balaenoptera edeni*)
- Cuvier's beaked whale (*Ziphius cavirostris*)
- Dwarf sperm whale (*Kogia simus*)
- False killer whale (*Pseudorca crassidens*)

- Killer whale (*Orcinus orca*)
- Longman's beaked whale (*Indopacetus pacificus*)
- Melon-headed whale (*Peponocephala electra*)
- Minke whale (*Balaenoptera acutorostrata*)
- Pygmy killer whale (*Feresa attenuata*)
- Pygmy sperm whale (*Kogia breviceps*)
- Short-finned pilot whale (*Globicephala macrorhynchus*)

Dolphins

- Bottlenose dolphin (*Tursiops truncatus*)
- Dall's porpoise (*Phocoenoides dalli*)
- Fraser's dolphin (*Lagenodelphis hosei*)
- Risso's dolphin (*Grampus griseus*)
- Rough-toothed dolphin (*Steno bredanensis*)
- Spinner dolphin (*Stenella longirostris*)
- Spotted dolphin (*Stenella attenuata*)
- Striped dolphin (*Stenella coeruleoalba*)

Of the above species, bottomfish fisheries in Federal waters around the Hawaii Archipelago have been documented to interact with only one, the bottlenose dolphin. In the NWHI, the only area in which a vessel observer program has been conducted for the bottomfish fishery, bottlenose dolphins were observed taking fish from hooks, with an average of one bottlenose dolphin interaction observed for every 38 fishing hours (Nitta 1999). No hookings were observed during the 26 trips observed during the 1990-1993 observer program. Several sightings of spinner dolphins were also made but no fishery interactions were observed (Nitta 1999). More recently the NWHI observer program was reactivated between October 2003 and December 2005. On the 26 trips observed (22 percent of all trips taken), there were no reported or observed physical interactions with any species of marine mammals.

The other species listed above may be found within Federal waters around the Hawaii Archipelago and could interact with Federal bottomfish fisheries; however, no reported or observed incidental takes of these species have occurred in these fisheries.

NMFS has concluded that the Hawaii Archipelago commercial bottomfish fisheries will not affect marine mammals in any manner not considered or authorized under the Marine Mammal Protection Act.

4.2.3 Status of Bottomfish Fishery

On May 27, 2005, NMFS informed the Council that the Hawaii Archipelagic bottomfish stock complex, which occurs in both Federal and State waters, was determined to be experiencing overfishing, with the primary problem being excess fishing mortality in the MHI.

The Council prepared and transmitted to NMFS in May, 2006, Amendment 14 to the Bottomfish FMP, which proposed to close waters of Penguin and Middle Banks to fishing for deepwater bottomfish in order to end overfishing.

The Council originally recommended an annual summer closure from May 1 to August 31 of each year for the entire MHI bottomfish fishery (both commercial and recreational vessels). Targeting, possessing, landing, or selling MHI deepwater bottomfish species would be prohibited during the closed season. The Council could not fully implement this alternative, however, without a commitment from the State of Hawaii to adopt parallel regulations in State waters.

The Council received a letter from the State's Department of Land and Natural Resources on April 5, 2006, stating that they would not support a corresponding seasonal closure. Therefore, the Council recommended its secondarily preferred alternative which would close Penguin and Middle Banks, as these areas are entirely within federal waters and their closure does not require support from the State of Hawaii.

Before Amendment 14 was finalized and processed by NMFS, several notable events or changes occurred which indicated a need to re-examine the prudent course of action with regards to ending overfishing of bottomfish in the MHI. The most significant factors are as follows:

- A phase-out of the bottomfish fishery by 2011 in the NWHI was mandated through the Presidential Monument designation. This may be significant because Hawaii's bottomfish are assessed as a stock complex combining the MHI and the NWHI, and because larval transport may allow for one area to serve as a source of immigration to other areas such that management action in one may affect fish stocks in the other. This permanent closure will also result in the elimination of one of the major sources of locally-caught bottomfish for use in the local market/restaurants. After the phase-out vessel operators will have to begin fishing in the MHI or discontinue fishing for bottomfish.

- A late 2006 stock assessment by NMFS' PIFSC concluded that the required reduction in fishing mortality based on 2004 data would be 24 percent in order to end overfishing (Moffitt et al. 2006). Using a dynamic production model and assuming management measures would be applied only to the MHI, this assessment concluded fishing effort would need to be reduced from the 2004 level by 24 percent to bring archipelago-wide fishing mortality down to the MFMT ratio of 1.0.

  The prior stock assessment which was based on 2003 data determined a 15 percent reduction in fishing effort was needed to end overfishing. Amendment 14 was designed to reduce fishing mortality by 15 percent in the MHI based on the 2003 assessment; however, to adequately end overfishing the precautionary approach calls for a 24 percent reduction.

- Congress passed the newly reauthorized Magnuson-Stevens Act which contains several new provisions that may affect management of the bottomfish fishery. These include a requirement to move towards management incorporating total allowable catch (TAC) levels for all fisheries, and a provision requiring State consistency with federal fishery management plans for Hawaii's bottomfish fisheries.

- Updated bottomfish habitat mapping undertaken by PIFSC with resulting estimates of bottomfish habitat in federal waters, as opposed to state, being greatly increased. Current estimates place 53 percent of habitat in federal waters with 47 percent in state waters (Parke 2007)

- The State of Hawaii changed its bottomfish closed areas since the Council took its original final action on Amendment 14. The changes have resulted in reduced benefits (a net gain of 2 percent) to be gained by these closed areas as compared to those originally analyzed as part of Amendment 14.

- The State of Hawaii's current data collection system for the recreational fishery does not result in an adequate estimation of the recreational catch. However, the State is prohibited from amending its rules to require adequate data collection, such as vessel trip reports, without legislative action, whereas, the Council and the Federal managers can do this with the MSA as the statutory basis. In addition, the State's commercial fishery data system provides extremely generalized spatial information which is of little use to fishery scientists and managers.

At its 137th meeting (March 13-16, 2007 in Honolulu) the Council reviewed a range of alternatives and their anticipated environmental impacts and took the following actions:

Relating to MHI bottomfish overfishing:

1. Recommended that a 5 month seasonal closure be implemented through State and Federal emergency rule making in federal and state waters for onaga, ehu, gindai, opakapaka, kalekale, lehi and hapuupuu (the deep-7 bottomfish species) harvested around the Main Hawaiian Islands from May 1 through September 30, 2007.
2. Directed Council staff to begin analysis of the management measures detailed below for Council consideration at the June meeting.

Relating to coordination and information collection:

(1) That the State of Hawaii Division of Aquatic Resources (DAR) commercial marine license and reporting system be used as the primary tool for capturing commercial bottomfish catch and effort information, with the following changes implemented by October 1, 2007:

   a. A bottomfish reporting form be developed to allow reporting of longitude and latitude position information to the nearest minute or one (1) nautical mile. Catch location data will be held confidential and not used for enforcement action.
   b. Reporting form be filed on a per trip basis, not on a monthly basis.

(2) That the DAR seek to implement a seafood dealer licensing program to supplement the seafood dealer reporting program. In addition, the dealer reporting program should be modified to allow for tracking bottomfish from origin/source to retailer.

(3) That NMFS implement a federal permit and reporting program to capture catch and effort information for all bottomfish management unit species harvested in recreational fisheries and landed in Hawaii. Recreational trip report forms will be created consistent (lat/long, per trip basis) with commercial catch reporting forms and filed after each trip.

(4) That the Council, State, NMFS and USCG conduct a comprehensive education and outreach program in coordination with the implementation of the new permit and reporting programs and fishing restrictions and in anticipation of total allowable catch limits.

(5) That Council staff reconvene the bottomfish working group to facilitate coordination of the above as well as scientific monitoring and enforcement activities.

Relating to establishing State and Federal regulatory programs by 2007:

(1) That the Council and NMFS develop and implement a Federal recreational permit program by October 1, 2007 followed by trip reporting program no later than February 15, 2008 (see 3 above).

(2) That the DAR seek to implement an improved State commercial license and trip reporting and seafood dealer licensing program (see 1 and 2 above).

(3) That a 5 month seasonal closure be implemented through State and Federal emergency rule making in federal and state waters for onaga, ehu, gindai, opakapaka, kalekale, lehi and hapuupuu (deep-7 bottomfish species) harvested around the Main Hawaiian Islands from May 1 through September 30, 2007.

(4) That a Total Allowable Catch limit based on commercial catch data be implemented in 2007 (with the fishing year to start on October 1, 2007) based on reducing commercial fishing mortality by 24 precent relative to 2004 commercial fishing mortality. The Pacific Islands Fisheries Science Center, in consultation with Council advisory bodies, will calculate a commercial TAC for consideration at the June 2007 Council meeting. The TAC will apply to MHI deep-7 bottomfish species. Once the commercial TAC is reached, both commercial and recreational fisheries in the MHI will be closed. Recreational TAC will be developed in the future based on information collected through the new recreational permit and reporting program.

(5) That DAR seek to modify its recreational bag limits to include all of the deep-7 species (currently only for onaga and ehu).

Relating to establishing State and Federal regulatory programs by 2008 and beyond:

(1) That a 4 month seasonal closure be implemented in federal and state waters for onaga, ehu, gindai, opakapaka, kalekale, lehi and hapuupuu (deep-7 bottomfish species) harvested around the Main Hawaiian Islands from May 1 through August 31 in 2008.

(2) That a Total Allowable Catch limit (based on commercial and recreational catch data) be established annually beginning in 2008 (with the fishing year to start on September 1

annually) to meet the FMP's overfishing control rule, and based on the best available scientific information.

(3) The Pacific Islands Fisheries Science Center, in consultation with Council advisory bodies, will calculate a TAC for consideration by May 30 each year for Council consideration. The TAC will apply to MHI deep-7 bottomfish species. Once the TAC is reached, all fishing for deep-7 bottomfish species will cease.

(4) Once the recreational bottomfish fishery is managed under a TAC, the recreational catch limits will be removed.

Amendment 14 to Hawaii's Bottomfish FMP became effective April 1, 2008 (73 FR 18450), with the permit and reporting requirements effective as of August 18, 2008 (73 FR 41296). Amendment 14 implemented the following requirements for vessel-based bottomfish fishing in the MHI:

(1) Federal bottomfish permits are required for vessel owners and fishermen to conduct vessel-based non-commercial fishing for any bottomfish management unit species (BMUS), not just deep-7 species, in Federal waters around the MHI (except customers of charter fishing trips).

(2) Operators of non-commercial fishing vessels are required to submit daily Federal logbooks that document bottomfish fishing effort and catch for each fishing trip, and vessel owners share the responsibility for submitting the logbooks in a timely manner. The data from these logbooks will be the basis for calculating non-commercial fishing effort and harvest of BMUS, bycatch, and interactions with protected species.

(3) A closed season was implemented between May and August of 2008. During this closure, fishing for deep-7 species was prohibited in Federal waters. Fishing for bottomfish species other than deep-7 species was not prohibited during the closed season.

(4) An annual total allowable catch (TAC) management system was established for the MHI commercial bottomfish fishery. The TAC will be determined each fishing year using the best available scientific information, commercial and non-commercial fishing data, and other information, and will consider the associated risk of overfishing. NMFS will publish in the Federal Register by August 31 the TAC for the upcoming fishing year, and will use other means to notify permit holders of the TAC. When the TAC is projected to be reached, NMFS will publish notification in the Federal Register and use other means to notify permit holders that the fishery will be closed on a specified date, providing a minimum of 14 days advance notice of the closure. The TAC for the 2007-08 fishing year (October 2007 through April 2008) was set at 178,000lbs (80,740 kg) of Deep 7 species. Progress toward the TAC is determined by the catch reported by holders of Hawaii commercial marine license (CML). When the TAC is projected to be reached, the commercial and non-commercial fisheries for deep-7 bottomfish are closed. There is no prohibition on fishing for other bottomfish species throughout the year. NMFS intends to repeal the Federal non-commercial bag limits once the data collected from the non-

commercial bottomfish fishery are determined to be adequate to include in the annual TAC calculation.

(5) Non-commercial fishermen are allowed to catch, possess, and land as many as five deep - 7 fish combined, per person, per fishing trip in Federal waters. The State of Hawaii also has a similar bag limit for non-commercial fishing.

At the Council's request, NMFS issued a final notice of specifications for the MHI Deep 7 bottomfish fishery (74 FR 6998) which implemented a Total Allowable Catch of 241,000 lbs of deep 7 species caught by commercial fishermen in waters around the Main Hawaiian Islands during the 2008-2009 fishing year.

Impact of NWHI Monument Designation and Regulations

During the phase-out and closure of the NWHI fishery mandated through the NWHI monument designation, fishing effort may shift from the NWHI to the MHI. This effort shift may exacerbate the fishing pressures on the MHI. To estimate the shift in fishing effort from the NWHI, it is essential to examine the current fishing activity of the eight vessels operating there. In 2003, fishermen made 76 trips into NWHI fishing areas and those trips resulted in 220,000 lbs of bottomfish landings (for more information see the 2007 Bottomfish Fishery SEIS). This amount falls well within the imposed landing limit (350,000 lbs annually) for the next five years. Bottomfish landings (by pounds) also fall within zone-specific maximum sustainable yields. In 2003, fishermen landed 77,000 lbs in the Mau Zone and 145,000 lbs in the Hoomalu Zone, less than the areas' maximum sustainable yields of 100,399 lbs and 348,385 lbs, respectively. It appears the landing limit imposed for the next five years will have limited effect on current fishing operations in the NWHI, and it is expected that the NWHI landings will be relatively stable, unless affected by outside factors such as a buyout.

If all of the vessels that currently operate in the NWHI shift their bottomfish fishing effort to the MHI (once the NWHI fishery is closed on June 15, 2011), similar landings could theoretically be made. However, recent effort control measures including 2007 and 2008 seasonal closures, an annual commercial TAC and reduced recreational bag limits may prevent overfishing of MHI bottomfish. It remains to be seen how fishermen will actually react to the NWHI fishery closure; reactions may include shifting to the MHI bottomfish fishery, shifting fishery or gear type (likely to pelagics, longline or troll), or ceasing fishing operations altogether. It also possible that a buyout program will be established for the current NWHI bottomfish fishermen. If structured appropriately, a buyout could limit or eliminate fishing effort shift by scrapping the vessel outright or removing the USCG fishing endorsement from the vessel. The Council recommended a control date of June 2, 2005, for the MHI bottomfish fishery which could be used by the Council and NMFS as criteria to limit fishing effort or participation in a future limited entry program (70 FR 40305, July 13, 2005).

NMFS will continue to monitor the fishery and will periodically assess the status of the Hawaii Archipelago bottomfish stocks complex. State and Federal programs are in place to monitor shifts in effort from the NWHI to the MHI and other fisheries.

4.2.4 Bottomfish MSY

A 2009 report by PIFSC (Brodziak et al. 2009) provides the most recent estimates of MSY for Hawaii's bottomfish complex. Although the report's stock assessment considers the Hawaiian bottomfish stocks to be a single, archipelago-wide multispecies complex, annual MSY estimates for each of the three management zones are also provided as follows: MHI 456,000 lbs; Mau Zone 126,000 lbs; Ho'omalu Zone 437,800 lbs; Total 1,020,100 lbs.

4.2.5 Bottomfish Optimum Yield

Optimum yield for Hawaii's bottomfish fishery is defined as the amount of fish that will be caught by fishermen fishing in accordance with applicable fishery regulations in this plan, in the EEZ and adjacent waters around the Hawaii Archipelago.

4.2.6 Bottomfish Domestic Processing Capacity

Bottomfish harvested in Hawaii are marketed as fresh product with each vessel processing its catch at sea. Therefore the domestic processing capacity and domestic processing levels will equal or exceed the harvest for the foreseeable future.

4.2.7 Bottomfish Total Allowable Level of Foreign Fishing

Domestic vessels have sufficient harvesting capacity to take the entire OY. Therefore the level of Total Allowable Foreign Fishing (TALFF) appears to be zero.

4.3 Hawaii Archipelago Crustacean Fisheries

4.3.1 History and Patterns of Use

Ula (lobster) was a traditional source of food for Native Hawaiians and was sometimes used in early religious ceremonies (Titcomb 1978). After the arrival of Europeans in Hawaii, the lobster fishery became by far the most productive of Hawaii's commercial shellfish fisheries. It was reported that the MHI commercial lobster catch in 1901 was 131,200 pounds (Cobb 1902).By the early 1950s, the commercial catch of spiny lobsters (*P. penicillatus*) around the MHI had dropped by 75 percent to 85 percent (Shomura 1987). A statewide analysis of MHI commercial lobster catch data by Kelly and Messer (2005) found that 185,263 pounds of lobster were caught between 1984 and 2004 with annual landings ranging between 7,000 and 12,000 pounds.

In the late 1970s NMFS, the U.S. Fish and Wildlife Service, Hawaii's Division of Aquatic Resources, and the University of Hawaii's Sea Grant Program joined in a cooperative agreement to conduct a 5-year assessment of the biotic resources of the NWHI. The survey reported that Necker Island and Maro Reef had sufficiently large stocks of lobsters to support some commercial exploitation (Uchida and Tagami 1984).

Shortly after, several commercial vessels began lobster-trapping operations in the NWHI. A period of low catches was followed by a rapid increase in landings as more vessels entered the fishery and markets were developed (Polovina 1993). In the mid-1980s, the NWHI lobster fishery was Hawaii's most lucrative fishery (Pooley 1993b).

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

During the first years of the fishery the turnover of participants was relatively high (Table 15) due to the profit seeking entry-exit behavior by vessel owners who were flexible in the choice of fishing activities (Samples and Sproul 1988). The high turnover continued after 1992, the first year of the limited access program and harvest quota. The quota announced prior to the start of the fishing season weighed heavily in the participation decision as did the annual start-up costs of participating in the lobster fishery and the potential earnings in alternative fisheries (Kawamoto and Pooley 2000). In addition, during the first five years of the limited access program there were a total of 20 permit transfers. By 1997, less than half of the permits that were issued in 1991 were still held by the original recipients. By 1999 37 limited access permits to participate in the NWHI lobster fishery have been issued, but only 19 of the permits have been actually used.

Table 15: NWHI Lobster Permit Holder Entry/Exit Pattern

PERMIT HOLDER	1992	1993 (closed)	1994	1995 (closed)	1996	1997	1998	1999
1	X		X		X	X		X
2			X		X	X		X
3	X		X		X	X		X
4	X		X					
5			X			X		
6	X							
7	X				X			
8	X							
9	X							
10	X							
11	X				X			
12	X							
13							X	
14						X		X

PERMIT HOLDER	1992	1993 (closed)	1994	1995 (closed)	1996	1997	1998	1999
15						X	X	X
16							X	
17						X	X	
18						X		X
19						X	X	

Note: An "x" appears in those years in which the permit holder participated in the NWHI lobster fishery.
Source: A. Katekaru, pers. comm. 2000. NMFS-PIRO.

In 1990 NWHI lobster catch rates fell dramatically, although overfishing is not thought to be responsible for the decline (Polovina and Mitchum 1992). Rather, the decrease was found to be likely due to a climate-induced change in oceanic productivity (Polovina et al. 1994).

Nevertheless, the 1990 season showed that there was excessive fishing capacity in the industry given the reduced population size (Polovina and Haight 1999). Responding to this concern, the Council established a limited access program and a fleet-wide seasonal harvest guideline or quota in 1991 that significantly altered fishing operations as illustrated in Figure 16 (Kawamoto and Pooley 2000).

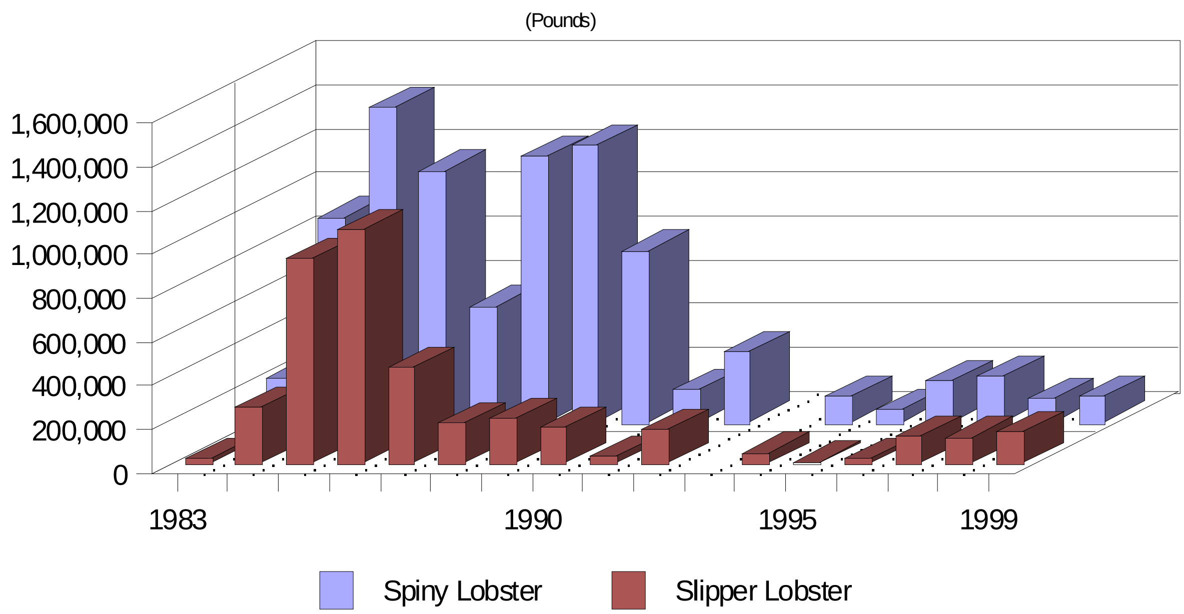

Figure 16: NWHI Lobster Fishery Landings 1983–1999 (top)
Source: Kawamoto and Pooley 2000

The total gross revenue of the NWHI lobster fishery followed the trend in landings (Figure 17).

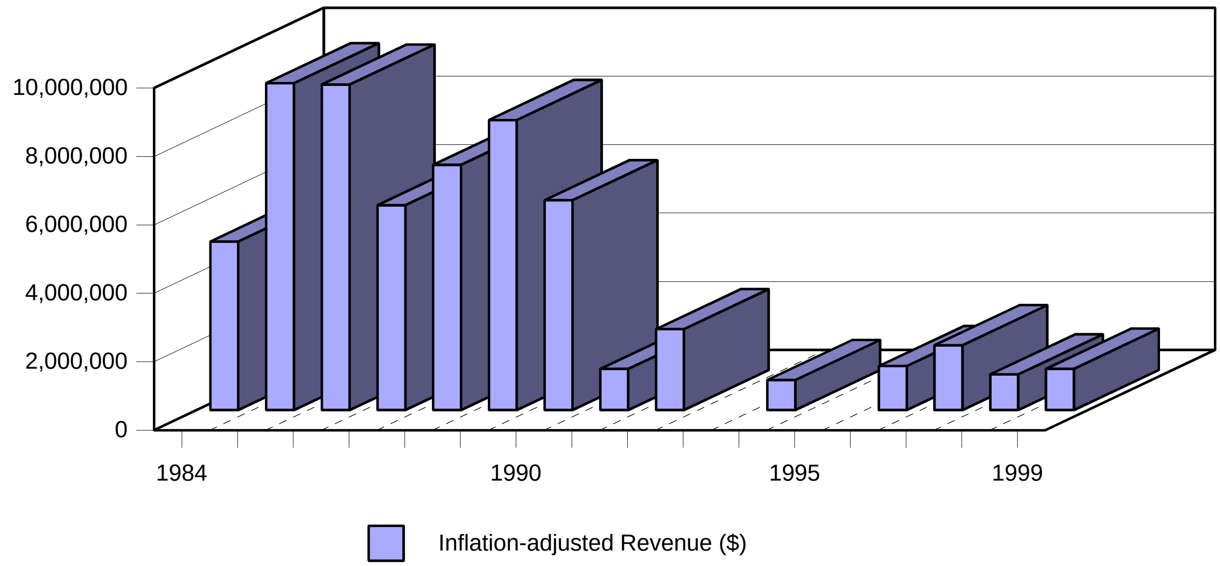

Figure 17: NWHI Lobster Fishery Inflation-adjusted Ex-vessel Revenue, 1984-1999

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

A cost-earnings study of the NWHI lobster fleet was conducted by Clarke and Pooley (1988) based on economic data collected in 1985 and 1986. The study found that despite record revenues in the fishery in 1986, fishermen as a group earned little or no economic profit. Low fleet net returns appeared to be tied to high fishing costs and diminished average catch rates. However, that study did not reflect the later operational characteristics of the fleet, as the fishery in the mid-1980s was essentially a year-round fishery.

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

At least some of the permit holders were able to adapt to these changing economic conditions. Fishery participants during the 1998 season realized a positive return on operations (gross revenues less operating costs) and were able to cover a portion of their fixed costs. In addition, the market value of the freely transferable limited access permits indicated that both economic and financial profits could still be earned in the fishery. Although the price of transferred permits is not recorded by NMFS, dockside reports in 1998 indicated that a permit was worth $40,000 to $100,000 (Pooley and Kawamoto 1998).

As an internationally traded commodity, supply and demand circumstances for lobsters tend to be volatile, resulting in frequent price adjustments (Samples and Gates 1987). In addition, the Hawaii fishery changed over the years in terms of target species and product form. In the early years of the fishery (1977-1984) landings consisted mainly of spiny lobsters. However, for a three-year period from 1985 to 1987 the fishery targeted a previously lightly exploited population of slipper lobsters (Polovina 1993). Between 1988 and 1997 the target was again spiny lobsters, but the catch in 1998 and 1999 consisted mainly of slipper lobsters. Almost all lobsters harvested from the NWHI were sold as a frozen tails; however, from 1996 to 1998, the fleet also landed a significant quantity of live lobsters.

The proportion of fishing effort and reported catch at each bank within the NWHI varied both spatially and temporally. While as many as 16 banks within the NWHI were fished on an annual basis, the majority of fishing effort was been directed at Maro Reef, Gardner Pinnacles, St. Rogatien, and Necker Island. Between 1984 and 1989 most of the fishing effort was directed at Maro Reef. After 1989, fishing effort decreased at Maro Reef and increased significantly at Gardner Pinnacles and Necker Island. In 1997, most of the fishing effort was directed at Necker Island (64%), followed by Maro Reef (23%), Gardner Pinnacles (13%), and St. Rogatien (<l%) (DiNardo et al. 1998).

In 1998, separate harvest guidelines were calculated for each of four fishing areas (Necker Island Lobster Grounds, Gardner Pinnacles Lobster Grounds, Maro Reef Lobster Grounds, and General NWHI Lobster Grounds) to prevent localized depletion. Since 2000, NMFS has not issued harvest guidelines for the NWHI lobster fishery due to uncertainty in their lobster stock assessment model and resultant concerns about the potential for overfishing.

By 1999, all participants in the NWHI lobster fishery used plastic dome-shaped, single-chambered traps with two entrance funnels located on opposite sides. By regulation, all traps must have escape vents to allow unwanted organisms to exit. The traps are typically fished in strings of several hundred that are set before sunset in depths from 20 to 70 meters, and retrieved the next day. Both spiny and slipper lobsters may be caught in the same trap, but fishermen can affect the proportion of each species by selecting the trapping area and depth (Polovina 1993).

Catch information regarding crustaceans in state and federal waters around the MHI is limited to commercial catches as there are no federal or state reporting requirements for recreational fishery participants. As for bottomfish, due to the nature of HDAR’s catch data, HDAR’s catch data are not spatially separated by origin regarding State vs. Federal waters. According to NMFS’ WPacFin Program which works with HDAR to compile state catch data, MHI commercial landings of spiny lobsters were 10,209 lbs in 2000 (with $96,526 in ex-vessel revenues), 8,797 lbs in 2001 ($96,909), 10,843 lbs in 2002 ($121,535), 7,383 lbs in 2003 ($68,289), 8,468 lbs in 2004 ($88,315) and 11,864 lbs in 2005 ($110,927). Annual slipper lobster landings were less than 100 lbs in each year and Kona crabs were not separated from other crabs in the data.

In contrast, HDAR's Commercial Marine Landings Summary Trend Reports indicate 2002 MHI commercial landings of 10,157 lbs of lobsters and 14,149 lbs of Kona crabs. This report series also lists 2003 landings of 7,377 lbs of lobsters and 12,279 lbs of Kona crabs. HDAR's 2004 report indicates that no lobsters were caught commercially in the MHI in 2004; however 12,120 lbs of Kona crabs were reported. Information on the number of participants is unavailable.

NMFS' regional office has issued two 2007 MHI lobster fishing permits for EEZ waters around the MHI. All crustacean permit holders are required to submit federal logbooks of their fishing activities.

Impact of NWHI Monument Designation and Regulations

In 2006 the designation of the NWHI monument essentially closed the NWHI fishery as under the monument's regulations the annual harvest guideline was set at 0 lbs until 2011, at which point commercial fishing will be prohibited in the monument.

Eight species of deepwater shrimp in the genus *Heterocarpus* have been reported throughout the tropical Pacific (*Heterocarpus ensifer, H. laevigatus, H. sibogae, H. gibbosus, H. lepidus, H. dorsalis, H. tricarinatus and H. longirostris*). These shrimp are generally found at depths of 200 to 1,200 meters on the outer reef slopes that surround islands and deepwater banks. Species distribution tends to be stratified by depth with some overlap. The deepwater trap fisheries have primarily targeted *Heterocarpus ensifer* and *H. laevigatus*. Western Pacific commercial trap fisheries for deepwater shrimp are intermittent. There have been sporadic operations in Hawaii since the 1960s, small-scale fisheries in Guam during the 1970s, and some activity in the CNMI during the mid-1990s. The fisheries have been unregulated, and there has been no comprehensive collection of information about the fisheries. Most of these fishing ventures have been short-lived, probably as a result of sometimes-frequent loss of traps, a shrimp product with a short shelf life and history of inconsistent quality, and the rapid localized depletion of deepwater shrimp stocks leading to low catch rates.

While fishing for deepwater shrimp has been highly sporadic over the last several decades, in 1984, a total of 17 vessels reported catching approximately 159 tons of deepwater shrimp worth an estimated ex-vessel value of $780,000 across all western Pacific fisheries for Heterocarpus.

4.3.2 Review of Bycatch

Nontargeted species account for a small percentage of the total catch in the NWHI lobster fishery, as the traps are designed for high selectivity. Using data from 1976–1991 (wire traps) and 1986–2003 (plastic traps) from research cruises in the NWHI, Moffitt et al. (2005) examined the diversity of catch composition. The traps used for the research were more conservative than commercial traps as they did not have escape vents, but otherwise they conformed to fishery regulations. Both wire and plastic traps were found to be highly selective; that is, they primarily caught lobsters. Wire traps caught a total of 82 species over the study period, of which the two target species of lobsters accounted for 90.5 percent by number. Plastic traps caught a total of 258 species over the study period, of which 73.1 percent by number were the two target species. Because lobsters are one of the larger organisms captured, they would be a much higher percentage of the total catch if measured by weight. Of the organisms that were caught incidentally, hermit crabs made up the largest component followed by moray eels and small reef fish.

Octopus abundance was also evaluated due to its potential as a prey species for the Hawaiian monk seal. A total of 83 individuals were captured during the entire 1986–2003 study period, and examination of the data showed no significant decline or increase in their capture rate over time. Based on the data, the study found that it is unlikely that lobster-trapping activities have lowered octopus abundance to such a degree that monk seal populations would be negatively impacted (Moffitt et al. 2005).

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

Currently, there is little information about bycatch associated with the Heterocarpus fishery and what is known comes primarily from research sampling.

Protected Species Interactions

Since 1986, there have been no reports of direct interactions between the NWHI lobster fishery and Hawaiian monk seals. However, in 1986 near Necker Island, one Hawaiian monk seal died as a result of entanglement with a bridle rope from a lobster trap. Modifications to bridle ropes were subsequently made and the Council implemented regulations to improve the ability to respond to any future reports of interactions between monk seals and lobster fishing gear (see Chapter 5). Observer reports show no Hawaiian monk seal entanglements or other interactions since 1987.[14] As described in Chapter 3, at one time it was believed that NWHI lobsters were an important part of the diet of monk seals. However, an ongoing analysis of fatty acid signatures in NWHI monk seal blubber indicates that lobster and crustaceans in general don’t appear to be very important to monk seals as there are species of NWHI lobsters in relatively high abundance but monk seals are not eating them (PIFSC Scientist Charles Littnan in the Honolulu Advertiser, December 1, 2006).

There have been no observed or reported interactions between commercial lobster or Heterocarpus fisheries and any other protected species in Federal waters around the Hawaii Archipelago. Based on the limited potential for entanglement with float lines, on the low likelihood of protected species encountering a deployed Heterocarpu*s* trap, and on the small trap openings practically eliminating the likelihood that a seal could get stuck in a trap should one be

[14]The lobster fishery was observed on a voluntary basis starting in 1997. NMFS scientific data collectors were dispatched on each of the lobster trips during 1997 through 1999.

encountered, the risk of adverse affects on protected species from entanglement or entrapment in fishing gear related to this fishery is discountable.

Following consultations under section 7 of the ESA, NMFS has determined that the crustacean fisheries will not adversely affect any ESA-listed species or critical habitat in the Hawaii Archipelago.

This FEP continues the existing federal regulations regarding fishery interactions with protected species.

Unlisted Species Interactions

Species of marine mammals that are not listed under the ESA but are protected under the Marine Mammal Protection Act (MMPA; see Section 8.6) and occur in Federal waters of the Hawaii Archipelago where crustacean fisheries may operate are as follows:

Whales

- Blainsville beaked whale (*Mesoplodon densirostris*)
- Bryde's whale (*Balaenoptera edeni*)
- Cuvier's beaked whale (*Ziphius cavirostris*)
- Dwarf sperm whale (*Kogia simus*)
- False killer whale (*Pseudorca crassidens*)
- Killer whale (*Orcinus orca*)
- Longman's beaked whale (*Indopacetus pacificus*)
- Melon-headed whale (*Peponocephala electra*)
- Minke whale (*Balaenoptera acutorostrata*)
- Pygmy killer whale (*Feresa attenuata*)
- Pygmy sperm whale (*Kogia breviceps*)
- Short-finned pilot whale (*Globicephala macrorhynchus*)

Dolphins

- Bottlenose dolphin (*Tursiops truncatus*)
- Dall's porpoise (*Phocoenoides dalli*)
- Fraser's dolphin (*Lagenodelphis hosei*)
- Risso's dolphin (*Grampus griseus*)
- Rough-toothed dolphin (*Steno bredanensis*)
- Spinner dolphin (*Stenella longirostris*)
- Spotted dolphin (*Stenella attenuata*)
- Striped dolphin (*Stenella coeruleoalba*)

The species listed above may be found in Federal waters around the Hawaii Archipelago and could interact with Federal crustacean fisheries; however, no reported or observed incidental takes of these species have occurred in these fisheries and NMFS has concluded that the Hawaii Archipelago commercial crustacean fisheries will not affect marine mammals in any manner not considered or authorized under the Marine Mammal Protection Act.

4.3.3 Status of Crustaceans Fishery

The NWHI lobster fishery was closed in 2000 because of growing uncertainty in the population models used to assess stock status (DeMartini et al 2003). It has remained closed since that time, in part due to the uncertainty in the population models and, more recently, due to the June, 2006 imposition of the NWHI Marine National Monument which stipulates that any commercial lobster fishing permit shall be subject to a zero annual harvest limit within the monument. The MHI fishery has not been determined to be overfished or subject to overfishing.

In Hawaii, an intermittent deepwater shrimp fishery began in 1967 (Tagami and Ralston 1988) and continues to be vary from year to year with an average of three vessels reporting the catch of deepwater shrimp to the state of Hawaii. Vessels ranged in size from 7.5 to 40 m in length, though the number of smaller vessels increased as larger vessels left the fishery (Tagami and Barrows 1988). To date, the highest landings (~275,000 lbs) of deepwater shrimp in Hawaii occurred in 1984; however, in 1989 nearly 270,000 lbs were landed, with an estimated ex-vessel value of more than $1 million. In 2005, vessels from the Pacific Northwest fished for *Heterocarpus* spp. in Hawaii and landed over 100,000 lbs. Between 1982 and 2005, the cumulative landings of *H. laevigatus* amounted to over 1.5 million lbs, while during the same time period, *H. ensifer* landings totaled over 20,000 lbs.

4.3.4 Crustaceans MSY

The most recent estimates of MSY for the NWHI fishery are found in Polovina et al. (1987). These researchers estimated the annual MSY for NWHI spiny lobsters to be 900,000 lobsters and estimated an annual MSY of 600,000 NWHI slipper lobsters.

In the absence of more complete and accurate data, the MSY for the spiny lobster stock around the MHI can be provisionally estimated as approximately 15,000 – 30,000 lobsters per year of 8.26 cm carapace length or longer. There are insufficient data to estimate MSY values for MHI slipper lobsters or Kona crabs, The MSY for the deepwater shrimp has been estimated for the Hawaiian Islands at 40 kg/nmi^2 (Tagami and Ralston 1988 in King 1993).

4.3.5 Crustaceans Optimum Yield

OY for the NWHI spiny and slipper lobster fishery is defined as the fishing mortality rate associated with a 10 percent risk of recruitment overfishing.

OY for the MHI spiny lobster fishery is defined as the greatest amount of non-berried spiny lobster with a carapace length of 31/4 in. (8.26 cm) that can be taken each year from EEZ waters around the MHI by vessels fishing in accordance with the measures in this plan. No OY estimates for MHI slipper lobsters or Kona crabs are available.

OY for *Heterocarpus* in the MHI has not been determined. Improved catch reports have been recommended to enhance information available to fishery managers about deepwater shrimp in the MHI and allow for improved fishery management in the future.

4.3.6 Crustaceans Domestic Processing Capacity

Lobsters harvested in the Hawaii Archipelago are marketed as fresh product or as frozen lobster tails, with each vessel processing its catch at sea. In general, shrimp are considered luxury food items; therefore care in handling is practiced. Smaller vessels normally wash the shrimp and store them in iced sea-water for transportation to protect the shrimp from enzyme-induced reactions (King 1993). Larger vessels have the space on board to process the shrimp by quick freezing them, which preserves their quality and allows them to be easily exported. Different processing methods are acceptable for different uses of deepwater shrimp. Local markets, restaurants, and hotels use whole, fresh, chilled shrimp. Shrimp tails are less likely to be used because of low meat recovery rates which is not commercially attractive (Oishi 1983).The domestic processing capacity and domestic processing levels will equal or exceed the harvest for the foreseeable future.

4.3.7 Crustaceans TALFF

Domestic vessels have the capability to harvest the entire optimum yield from the fishery. Therefore the TALFF appears to be zero.

4.4 Hawaii Archipelago Precious Coral Fisheries

4.4.1 History of Patterns and Use

The ongoing collection of black coral from depths of 30–100 meters 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 by hand from a bed located in the Auau Channel. Most of the harvest has come from State of Hawaii waters; however, a portion of the black coral bed in the Auau Channel is located in the EEZ. In 1999, concern about the potential for greater harvesting pressure on the black coral resources led the State of Hawaii to prohibit the harvest of black coral with a base diameter of less than 3/4 inches from state waters.

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 used two one-man submersibles to survey and harvest pink and gold corals at depths between 400–500 meters during 1999 and 2001. However, they did not continue their operations after that time, and the actual harvests cannot be reported here because of data confidentiality policies that prohibit the publication of proprietary information unless there are at least three separate operations included in the dataset.

In 1988, the domestic fishing vessel *Kilauea* used a tangle net dredge (now prohibited) to harvest beds at Hancock Seamount in the NWHI. Their catch, however, consisted mostly of dead or low-quality pink coral, and the operation was soon discontinued. In the mid-1980s, a company experimented with manned submersibles equipped with spotlights, cameras, and a variety of maneuverable tools to harvest individual colonies, chosen by size and quality prior to cutting, in a highly controlled and efficient manner (Carleton 1987).

Between 1990 and 1997, the annual harvest of black coral in Hawaii varied from a low of 864 pounds to a high of 6,017 pounds, with a yearly average of 3,084 pounds (Table 16). Landings and ex-vessel revenues of the black corals recently harvested in Hawaii cannot be presented due to the low number of active harvesting operations (less than three); however, current precious coral harvest is below MSY. There is no known recreational component to this fishery.

Table 16: Volume and Value of Black Coral Landings in Hawaii 1990-1997
Source: Hawaii Division of Aquatic Resources

Year	Harvested (lb)	Sold (lb)	Value ($)
1990	2,349	2,169	31,575
1991	2,305	2,250	35,080
1992	2,398	2,328	46,560
1993	864	769	15,380
1994	4,354	4,209	84,180
1995	6,017	5,912	122,765
1996	4,865	1,703	41,325
1997	1,520	415	10,394

4.4.2 Review of Bycatch

Because the Precious Corals FMP allows harvest only by selective gear (i.e., with submersibles or by hand), Federal precious coral fisheries in Hawaii have no bycatch.

Protected Species Interactions

There have been no reported or observed interactions between marine mammals and Federal precious corals fisheries in the region. The potential impacts on the Hawaiian monk seal are discussed below. There could be some impact on marine mammals from routine fishing vessel operations (e.g., behavioral or physiological reactions to noise, collisions, or releases of pollutants), however such impacts would be extremely rare and therefore constitute a low-level risk to marine mammals. With implementation of this FEP, this extremely low-level risk to marine mammals would remain.

Monk seals have been observed diving to depths where gold corals and other deep-water organisms occur (> 100 m); however there is no evidence that any precious corals are important to monk seal foraging. Coral and fish inhabit the same type of high relief and high flow habitats; however, it is unknown if any impact occurs to monk seals or other protected species as a result of coral harvest (Parrish 2006). There could be some impact from routine fishing vessel operations (e.g., behavioral or physiological reactions to noise, collisions, or releases of pollutants), however such impacts would be rare posing a very low-level risk to monk seals. The coral harvest uses extremely selective gear and operates on a small scale; therefore, it seems prudent to expect little to no impact is occurring. There have been no reported or observed interactions between sea turtles and Hawaii's precious corals fishery. With implementation of this FEP, this extremely low-level risk to monk seals would remain.

There have been no reported or observed interactions between sea turtles and precious corals fisheries in the region. There could be some impact on sea turtles from routine fishing vessel operations (e.g., behavioral or physiological reactions to noise, collisions, or releases of pollutants). Such impacts, however, would be rare, and therefore constitute a very low-level risk to sea turtles. With implementation of this FEP, this extremely low-level risk to sea turtles would remain.

The precious corals fishery relies on selective harvesting gear (hand harvest and submersibles) which is not likely to result in any interactions with seabirds, and no such interactions have been reported or observed. Following consultations under section 7 of the ESA, NMFS has determined that the precious corals fisheries will not adversely affect any ESA-listed species or critical habitat in the Hawaii Archipelago.

This FEP continues the existing federal regulations regarding fishery interactions with protected species.

Unlisted Species Interactions

Species of marine mammals that are not listed under the ESA but are protected under the Marine Mammal Protection Act (MMPA; see Section 8.6) and occur in Federal waters of the Hawaii Archipelago where the precious corals fishery may operate are as follows:

Whales

- Blainsville beaked whale (*Mesoplodon densirostris*)
- Bryde's whale (*Balaenoptera edeni*)
- Cuvier's beaked whale (*Ziphius cavirostris*)
- Dwarf sperm whale (*Kogia simus*)
- False killer whale (*Pseudorca crassidens*)
- Killer whale (*Orcinus orca*)
- Longman's beaked whale (*Indopacetus pacificus*)
- Melon-headed whale (*Peponocephala electra*)
- Minke whale (*Balaenoptera acutorostrata*)
- Pygmy killer whale (*Feresa attenuata*)
- Pygmy sperm whale (*Kogia breviceps*)
- Short-finned pilot whale (*Globicephala macrorhynchus*)

Dolphins

- Bottlenose dolphin (*Tursiops truncatus*)

- Dall's porpoise (*Phocoenoides dalli*)
- Fraser's dolphin (*Lagenodelphis hosei*)
- Risso's dolphin (*Grampus griseus*)
- Rough-toothed dolphin (*Steno bredanensis*)
- Spinner dolphin (*Stenella longirostris*)
- Spotted dolphin (*Stenella attenuata*)
- Striped dolphin (*Stenella coeruleoalba*)

The species listed above may be found in Federal waters around the Hawaii Archipelago and could interact with Federal precious coral fisheries; however, no reported or observed incidental takes of these species have occurred in these fisheries and NMFS has concluded that the Hawaii Archipelago commercial precious corals fisheries will not affect marine mammals in any manner not considered or authorized under the Marine Mammal Protection Act.

4.4.3 Status of Precious Corals Fishery

To date Hawaii's precious corals fishery has not been determined to be overfished or subject to overfishing. Several conservation and management measures have been recently recommended by the Council and implemented by NMFS in response to biological concerns.

The first measure was in response to the presence of an invasive soft coral *Carijoa riisei* or snowflake coral, on black coral, as well as an observed decline in black coral biomass in Hawaii's Auau Channel. Research revealed that the biomass of the Auau Channel black coral population had decreased by at least 25 percent in the last 30 years. Data collected in late 2001 during Pisces V dives showed a decline in recruitment, as well as a decrease in the relative abundance of legal sized colonies. The decline in recruitment may be related to an increase in abundance of *Carijoa riisei*. This highly invasive soft coral was found to be overgrowing large areas of black coral habitat particularly in deep water between 80-110 meters. Harvests of shallower populations have also been increasing, additionally stressing these populations. As of November 2007, all black coral harvested from waters of the Hawaii Archipelago must have either a one inch base diameter or a 48 inch height and a limited exemption from the size requirement was revoked to allow for a longer period of recruitment of black corals in the Auau Channel.

The second measure was in response to a recent study indicating that the growth rate of gold coral may be far lower than that previously believed. The best available data on gold coral cited in the current Precious Corals FMP indicates that the linear growth rate of gold coral is approximately 6.6 centimeters per year, suggesting a relatively young age for large trees. These estimates are based on the assumption that growth rings are laid down annually as in other precious corals such as black coral and pink coral (*Corallium rubrum* and *C. secundum*). Recent research done on the aging of gold corals using radiometric dating on three samples collected from the Makapuu Bed and off of the island of Hawaii found that gold coral may grow at a much slower rate of 0.004 to 0.0014 cmper year aging those samples at 450-2,740 years old (Roark et al. 2006). Research conducted on *Gerardia* species in the Atlantic have estimated the age of large gold coral trees to be 1,800 years old (Druffel et al. 1995).

The Western Pacific Region's gold coral fishery is currently dormant, although research on gold coral remains active. Recent research has called into question current assumptions about the correlation between linear and axial growth rates of gold coral. Based on recommendations from fishery scientists and as a precautionary measure, at its December 21, 2006 meeting, the Council took final action to recommend a five-year moratorium to fish for, take, or retain any gold coral in any precious coral permit area. This moratorium includes all waters of the U.S. Exclusive Economic Zone of the Western Pacific Region and is currently in effect through June 30, 2013 (73 FR 47098). During the moratorium, an associated research program will collect data on the age structure, growth rate, and correlations between length and age. Additional information will be considered by the Council before lifting the moratorium.

The third recent measure was the 2008 designation of the Auau Channel bed as an Established Bed with an annual harvest quota of 5,000 kg every 2 years (11,023.11 lbs every 2 years). This quota applies to black corals in both State and Federal waters, and existing gear and size requirements continue to apply (Table 18).

4.4.4 Precious Corals Fishery MSY

To date, beds of pink, gold and/or bamboo corals have been found at various locations in EEZ waters around the Hawaii Archipealgo (see Table 18). Within the EEZ, the Makapuu Established Bed has experienced the greatest level of documented exploitation and scientific research, and thus is the source of much of the available information about Hawaii's precious corals. Density of occurrence estimates for precious corals colonies in their habitat, based on *in situ* observations made at the Makapuu Bed, reveal a fairly dense habit of growth. This bed was surveyed in the 1970s, and again in 1997.

In 1971, densities of commercial species were determined in an unexploited section of the bed, and the size frequency distribution of pink coral was determined (Grigg 1976). The average density of pink coral in the Makapuu Bed was 0.022 colonies per square meter. Extrapolation of this figure to the entire bed (3.6 million m^2) results in a standing crop of 79,200 colonies. The 95 percent confidence limits of the standing crop are 47,200 to 111,700 colonies. Conversion of standing crop colonies to biomass produced an estimate of 43,500 kg for *C. secundum* in the Makapuu Bed.

The estimates of density for gold coral (*Gerardia* spp.) and bamboo coral (*Lepidisis olapa*) in the Makapuu Bed were 0.003 colonies/m^2 and 0.01 colonies/m^2 respectively. However, the distributional patterns of both of these species were found to be very patchy, much more so than *C. secundum*, and the area where they occurred was only about half that for pink coral, or 1.8 million m^2. The corresponding estimates of unfished abundance for gold and bamboo colonies are 5,400 and 18,000 colonies respectively. Data for the mean weight of colonies in the populations of gold and bamboo coral in the Makapuu Bed are lacking, but rough estimates were 2.2 kg for gold coral and 0.6 kg for bamboo coral. Multiplying mean weights by densities leads to rough estimates of standing crop of about 11,800 kg for *Gerardia* spp. and 10,800 for *Lepidisis* spp. A 1997 resurvey which used a newer technology enabling deeper dives, found the Makapuu bed to be about 15 percent larger than previously estimated (Grigg 2002).

MSYs for the Makapuu Established Bed have been estimated using a Beverton and Holt cohort production model (Beverton and Holt 1957) where data are available for *Corallium secundum*, and the Gulland Model (MSY = 0.4 MBo, where M=natural mortality and Bo is virgin biomass) for *Gerardia* and *Lepidisis* (Gulland 1970). The Gulland (1969) method to estimate MSY was used for gold and bamboo corals at the Makapuu Bed, where information on population dynamics is lacking. MSY is 40 percent of the natural mortality rate times virgin stock biomass (estimated from the product of area of the bed, average colony density and weighted average weight of a virgin colony; MSY = 0.4 x M x B). The mortality rate for pink coral (M=0.066) is used as a proxy for other species.

Table 17: MSY Estimates for Precious Corals in the Makapuu Bed

Species (common name)	MSY (kg/yr)	Method of calculation
Corallium secundum (pink)	1,185	Beverton and Holt Cohort production model
Corallium secundum (pink)	1,148	Gulland model
Gerardia spp. (gold)	313	Gulland model
Lepidisis olapa (bamboo)	285	Gulland model

Harvest quotas for Hawaii's four Conditional Beds have been extrapolated, based on bed size, by comparison with that of the Makapuu Established Bed using the following formula for Conditional Beds for which detailed data are unavailable (see Table 18).

$$\frac{\text{MSY for Makapuu Bed}}{\text{Area of Makapuu Bed}} = \frac{\text{MSY for Conditional Bed}}{\text{Area of Conditional Bed}}$$

As discussed in Section 4.4.5, the harvest quotas represent OY values and are based on extrapolations from "rounded down MSY values" for the Makapuu Bed.

Commercial harvests of black coral have occurred in waters around Hawaii for more than three decades. Significant harvests have been made from the Auau Channel and around Kauai. In 1976, Grigg estimated black coral MSYs of 6,174 kg/yr for the Auau Channel and 1,480 kg/year for the area around Kauai using a Beverton and Holt yield production model (Grigg 1976). More recently, Grigg discovered a greater impact to the black coral resource from an invasive soft coral, *Carijoa riisei*, and based on that, coupled with harvesting impacts, estimated a reduced MSY of 3,750 kg/yr (Grigg 2004) for this area.

No MSY estimates are available for the Exploratory Areas; however harvest quotas have been implemented based on available information (see Section 4.4.5).

4.4.5 Precious Corals Optimum Yield

As discussed above, optimum yield (OY) values for the six Established and Conditional beds are based on MSY estimates for the Makapuu Bed, which were rounded downward for ecological reasons. The rounded down MSY values were then extrapolated to the Conditional Beds based on relative bed size. The OY for the Makapuu Bed is expressed as a two-year harvest quota because it is economically disadvantageous to utilize the expensive specialized equipment required for selective harvesting of precious coral for only part of each year on only one coral bed. The more flexible biannual schedule makes it easier for harvesters to deploy in other areas once the two-year Makapuu Bed quota is taken.

The OY values are used as the harvest quotas for all species except black coral (Table 18). The harvest quota for the Hawaii Exploratory Area comprises 1,000 kg/year of all species of precious corals combined (except black coral). This harvest quota was set when non-selective gear was allowed to be used and today is considered to be conservative as selective gear has very low bycatch rates and does not damage nearby colonies during the harvesting process.

Table 18: OY values (Harvest Quotas) for Hawaii Precious Corals

Type of coral bed	Name of coral bed	Harvest quota in kilograms	Number of years
Established Beds	Auau Channel	Black: 5,000	2
	Makapuʻu	Pink: 2,000 Gold: 0 (zero) Bamboo: 500	2 -- 2
Conditional Beds	180 Fathom Bank	Pink: 222 Gold: 67 Bamboo: 56	1 1 1
	Brooks Bank	Pink: 17 Gold: 133 Bamboo: 111	1 1 1
	Kaena Point	Pink: 67 Gold: 20 Bamboo: 17	1 1 1
	Keahole Point	Pink: 67 Gold: 20 Bamboo: 17	1 1 1
Refugia	Westpac	All: 0 (zero)	--
Exploratory Areas	Hawaii, American Samoa, Guam, CNMI, U.S. Pacific Remote Island Areas	1,000 per area (all species combined except black corals)	1

Notes:
1. The final rule implementing the FMP lists the harvest quota for pink coral at Brooks Bank as 17 kg. This is a typographical error; the correct harvest quota is 444 kg.
2. No fishing for coral is authorized in refugia.

3. A moratorium on gold coral harvesting is in effect through June 30, 2013.

4.4.6 Precious Corals Domestic Processing Capacity

There is sufficient domestic processing capacity to accommodate increased harvests. The U.S. imports semi-processed coral for finishing into jewelry. Under the FEP, domestic production could replace these imports. It is anticipated that domestic processing capacity and domestic processing levels will equal or exceed the domestic harvest for the foreseeable future.

4.4.7 Precious Corals TALFF

Based on available information domestic vessels can harvest the Precious Coral OY from the Established and Conditional Beds. Therefore the TALFF for these beds appears to be zero. The TALFF for each Exploratory Area shall be its quota minus two times of the amount harvested by domestic vessels between July 1 and December 31 of the proceeding year. The TALFF may be made available for foreign fishing under a scientific research plan approved by NMFS in consultation with the Council and State agencies.

4.5 Hawaii Archipelago Coral Reef Fisheries

4.5.1 History and Patterns of Use

Archaeological evidence reveals that seafood, particularly coral reef species, was part of the customary diet of the earliest human inhabitants of the Hawaiian Islands (Goto 1986). Fishing and related activities in traditional Hawaii were also often highly ritualized and important in religious beliefs and practices. The *Kumulipo*, or Hawaiian creation legend, says that fish were created after corals and mollusks, but before insects and birds (Beckwith 1951). Certain species of fish were venerated as personal, family, or professional gods, called *aumakua*. Like the Native Hawaiians, nineteenth-century Asian immigrants imbued fish with symbolic meaning, extending their cultural significance beyond their value as a dietary staple.

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

Commercial fisheries saw a rise and subsequent fall in both participation and landings during the first half of the twentieth century. There were 2,000 to 2,500 commercial fishermen in 1900 (Cobb 1902). In 1947, the number was about 3,500 (Hida and Skillman 1983), but by 1985 the number fell to about 2,600 (Shomura 1987).

There is a long history of coral reef fishing in the NWHI. Iverson et al. (1990) found ample evidence of fishing by the ancient Hawaiians as far north 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). From the late 1940s to the late 1950s, there was a large commercial 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 fishing is now prohibited throughout the archipelago.
In recent decades, there has been a notable decline in nearshore fishery resources in the MHI (Shomura 1987). Excessive fishing is considered to be one of the major causes of this decline (Grigg 2002; Harman and Katekaru 1988), coastal construction, sedimentation, and other effects of urbanization have also caused extensive damage to coral reefs and benthic habitat near the populated islands.

The majority of the total commercial catch of inshore fishes, invertebrates, and seaweed comes from nearshore reef areas around the MHI; however harvests of some coral reef species also occur in federal waters (e.g., around Penguin Bank).

As illustrated in Figure 18 and Table 19 total catches of coral reef ecosystems species are dominated by bigeye scad and mackerel scad, and variations in their harvests have largely driven the downward trend observed in the 2000-2005 time period. Other species reported by commercial fishermen include surgeonfishes, goatfishes, squirrelfishes and parrotfishes. As described above, because HDAR's catch forms use reporting grids that do not differentiate between State and Federal waters, these data are for all (State and Federal) waters surrounding the Hawaii Archipelago. Information on the number of fishery participants is unavailable.

Coral reef taxa are currently harvested primarily in Hawaii's state waters. No permits for coral reef fisheries in Federal waters have yet been issued. MHI catches of the ten most commonly reported coral reef species are presented in Table 19, and their five year average is illustrated in Figure 19. Currently, there are no active coral reef fisheries in the NWHI.

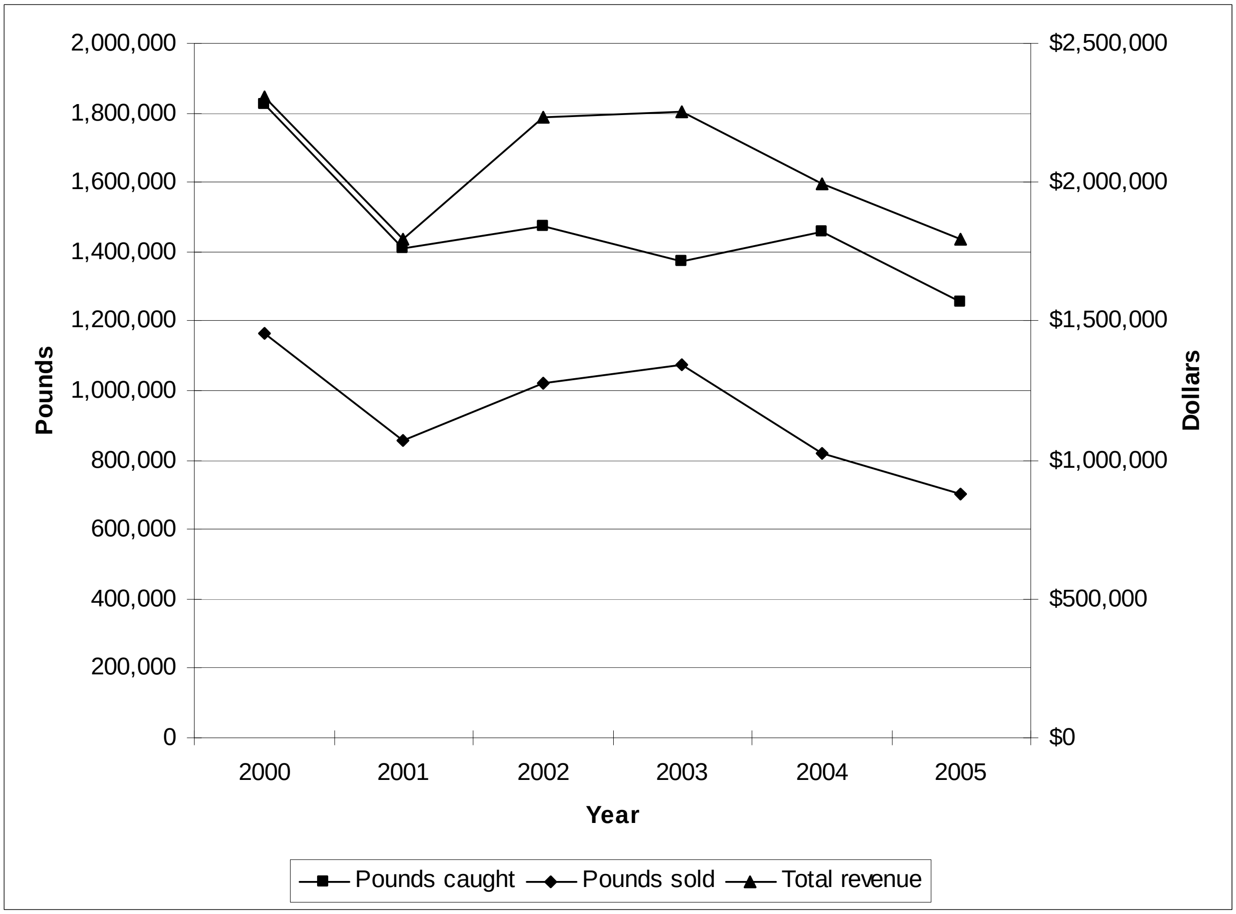

Figure 18: MHI Coral Reef Associated Catches, Sales, and Ex-vessel Revenue, 2000-2005
Source: WPacFin, accessed March 2007

Table 19: MHI Top Ten Catches of Coral Reef Associated Species 2000-2005

	2000	20001	2002	2003	2004	2005	AVG
Bigeye scad (akule)	1,105,273	729,985	614,306	501,220	743,052	656,434	725,045
Mackerel scad	269,799	215,010	331,939	365,707	260,362	232,714	279,255
Surgeon/tangs	98,625	118,841	133,517	124,251	95,138	94,495	110,811
Goatfish	40,220	43,122	68,061	64,239	69,556	42,034	54,539
Squirrelfish	38,548	52,235	53,650	47,154	41,059	37,928	45,096
Parrotfish	29,084	26,656	50,174	70,363	35,374	33,111	40,794
Octopus	23,736	28,985	27,698	26,336	23,115	24,244	25,686
Rudderfish	14,004	16,313	32,102	24,214	23,573	20,417	21,771
Pig-lipped ulua	43,900	36,204	35,836	27,454	29,092	14,959	31,241
Invertebrates	12,780	19,050	11,813	7,697	15,149	11,668	13,026
Algae	10,680	16,882	9,570	13,410	16,864	10,399	12,968

Source: WPacFin, accessed March 2007

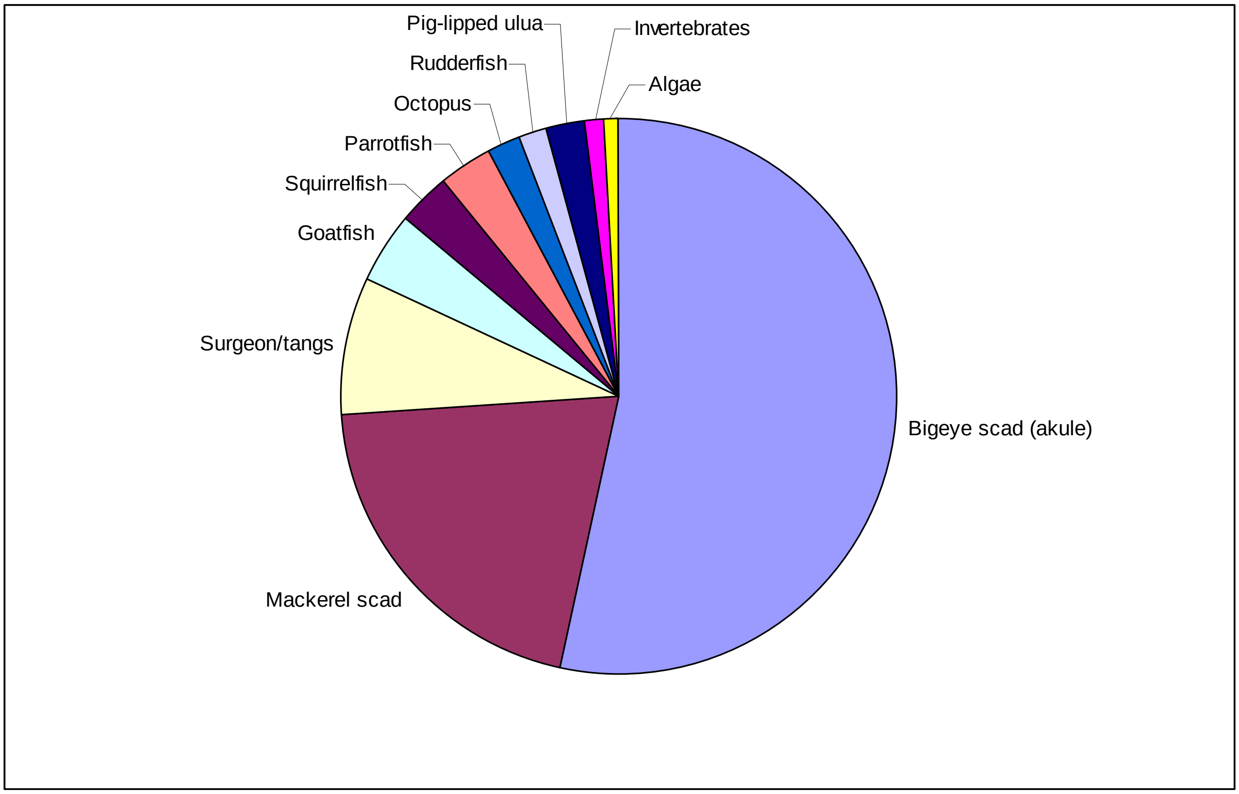

Figure 19: MHI Top 10 Coral Reef-associated Species Catch Composition, 2000-2005 Avg.
Source: WPacFIN, accessed March 2007

With the exception of the FEP's special permit requirement (see Chapter 5) there are no reporting requirements for recreational and other non-commercial catches from waters around the Hawaii Archipelago, but creel surveys at Kaneohe, Hanalei, and Hilo Bays suggest that these catches are at least equivalent to the reported commercial catch, and may be two or three times greater (Friedlander 1996). The majority of these catches are believed to be from State waters and would thus not be managed by this FEP; however, the ecosystem approach would warrant consideration of inshore fisheries and stocks as they interrelate with those in Federal waters.

4.5.2 Review of Bycatch

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

In the Pacific Islands, discards, where they occur, are usually due to cultural or practical reasons. In some cultures, customary taboos may still adhere. For example, people may avoid nearshore copraphageous scavengers, such as surf perches (Theraponidae) for this reason. Taboos may also stem from the association between a species and gender, as is the case with moorish idols (Zanclidae). Some reef fish in Hawaii state waters are also subject to minimum size and weight restrictions for sale or for capture by spearfishing. These include species of parrotfish, goatfish, jacks, surgeonfish, mullet, milkfish, and threadfins.

In other cases, fish may be avoided due to toxicity. Puffers, toad fish, and porcupine fish (Tetraodontidae, Diodontidae) carry ichthyotoxins, while ichthyosarcotoxicity (a type of poison) due to ciguatoxins and related toxins cause people to avoid a wide range of species, including some surgeon fishes (*Ctenochaetus* spp.), moray eels (Muraenidae), groupers (Serranidae), amberjack (*Seriola dumerilli*), and barracuda (Sphyraenidae). Ciguatera toxin is a concern for several coral reef fishes caught in Hawaii

People in the Western Pacific Region consume a wide range of invertebrates. Titcomb (1972) cataloged an extensive list of invertebrates used by Native Hawaiians, including many types of crustaceans, sea cucumbers, sea urchins sponges, corals, and various marine worms. Some traditionally consumed marine invertebrates may be avoided by some people in the western Pacific, particularly as dietary habits become more westernized. Also, some religions, like the Seventh Day Adventist faith, follow dietary rules similar to the kosher dietary restrictions and avoid pork and shellfish. Inadvertent catches of shellfish would likely be discarded by Adventists and may be included as bycatch.

Four fishing gears predominate in Hawaii Archipelago coral reefs and lagoons: hook and line (including handline), spearguns, fish traps, and gillnets. The bycatch characteristics of each of the gear types are summarized below.

Hook-and-Line Catches

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

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

Spearfishing

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

Hawaiian spearfish catches are dominated by parrotfish, surgeonfish, octopus, and squirrelfish. Other common families—such as emperors, snappers, and jacks—also contribute to catches.

Fish Traps

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

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

Nets

In Hawaii, gillnets are used to catch a variety of species including surgeonfish, snappers, goatfish, and rudderfish (DeMello 2004). Gillnets are also often used to target bigeye scad or akule. For smooth fusiform—or cigar-shaped—fish, gillnets tend to select a normally distributed size range, with the lower and upper size limits dependent on mesh size. Spiny fishes may be very vulnerable to gillnet catches, regardless of mesh size, because of tangling. Seasonality can also influence gillnet catches. Fish become more vulnerable during spawning season because gonad development increases their girth and spawning changes behavior (Ehrhardt and Die 1988). The selection effects of gillnets are further complicated by the type of material used, the hanging ratio or measure of meshes per unit of length, the way the net is deployed on a reef, the time of day set, and length of soak. If gillnets are not checked regularly, bycatch may increase. Entangled fish build up in the net; if they are not removed, they are either preyed on or rot and become unsaleable. Gillnets are primarily used in State waters in Hawaii, where their use is increasingly being regulated. Currently gillnets must generally have a minimum stretched mesh size of two inches. They must be checked at least once every two hours and cannot be left in place for more than four hours in any 24 hour period.

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

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

The State of Hawaii regulates the use of seine nets with the same regulations as are in place for gillnets.

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

Protected Species Interactions

There have been no reported or observed interactions between protected species and coral reef fisheries in Federal waters around the Hawaii Archipelago. There is some potential for interactions between monk seals and sea turtles and the coral reef fishery in waters around the Hawaii Archipelago. For example, two monk seal deaths occurred in State waters, after State laws were violoated, due to entanglement in gill nets during 2006-2007[19]. It is surmised that these mortalities were a result of gillnets being left unchecked for extended periods of time such as overnight. Under this FEP allowable gear types in Federal waters include: (1) hand harvest; (2) spear; (3) slurp gun; (4) hand/dip net; (5) hoop net for Kona crab; (6) throw net; (7) barrier net; (8) surround/purse net that is attended at all times; (9) hook-and-line (powered and unpowered handlines, rod and reel, and trolling); (10) crab and fish traps; and (11) remote operating vehicles/submersibles. These allowable gear types are not left unattended which greatly minimizes the potential for any lethal interactions. In addition, some anecdotal information exists indicating that some monk seal hookings may have occurred in near shore coral reef fisheries.

[19] http://the.honoluluadvertiser.com/article/2007/Jun/07/br/br4325609817.html

Following consultations under section 7 of the ESA, NMFS has determined that the coral reef fisheries will not adversely affect any ESA-listed species or critical habitat in the Hawaii Archipelago

This FEP continues the existing federal regulations regarding fishery interactions with protected species.

Unlisted Species Interactions
Species of marine mammals that are not listed under the ESA but are protected under the Marine Mammal Protection Act (MMPA; see Section 8.6) and occur in Federal waters of the Hawaii Archipelago where coral reef fisheries may operate are as follows:

Whales

- Blainsville beaked whale (*Mesoplodon densirostris*)
- Bryde's whale (*Balaenoptera edeni*)
- Cuvier's beaked whale (*Ziphius cavirostris*)
- Dwarf sperm whale (*Kogia simus*)
- False killer whale (*Pseudorca crassidens*)
- Killer whale (*Orcinus orca*)
- Longman's beaked whale (*Indopacetus pacificus*)
- Melon-headed whale (*Peponocephala electra*)
- Minke whale (*Balaenoptera acutorostrata*)
- Pygmy killer whale (*Feresa attenuata*)
- Pygmy sperm whale (*Kogia breviceps*)
- Short-finned pilot whale (*Globicephala macrorhynchus*)

Dolphins

- Bottlenose dolphin (*Tursiops truncatus*)
- Dall's porpoise (*Phocoenoides dalli*)
- Fraser's dolphin (*Lagenodelphis hosei*)
- Risso's dolphin (*Grampus griseus*)
- Rough-toothed dolphin (*Steno bredanensis*)
- Spinner dolphin (*Stenella longirostris*)
- Spotted dolphin (*Stenella attenuata*)
- Striped dolphin (*Stenella coeruleoalba*)

The species listed above may be found in Federal waters around the Hawaii Archipelago and could interact with Federal coral reef fisheries; however, no reported or observed incidental takes of these species have occurred in these fisheries. There could be some impact on marine mammals from routine fishing vessel operations (e.g., behavioral or physiological reactions to noise, collisions, or releases of pollutants); however such impacts would be extremely rare and therefore constitute a low-level risk to marine mammals. NMFS has concluded that the Hawaii Archipelago commercial coral reef fisheries will not affect marine mammals in any manner not considered or authorized under the Marine Mammal Protection Act.

4.5.3 Status of Coral Reef Fisheries

To date Hawaii's coral reef fisheries have not been determined to be overfished or subject to overfishing.

4.5.4 Coral Reef Fisheries MSY

There are no available estimates of MSY values for coral reef ecosystem management unit species in the Hawaii Archipelago.

4.5.5 Coral Reef Fisheries Optimum Yield

OY for coral reef ecosystem associated species is defined as 75 percent of their MSY.

4.5.6 Coral Reef Fisheries Domestic Processing Capacity

Available information indicates that U.S. processors have sufficient capacity to process the entire OY.

4.5.7 Coral Reef Fisheries TALFF

Available information indicates that U.S. vessels currently have the capacity to harvest the OY on an annual basis and therefore no part of OY appears to be available for a TALFF.

4.6 Description of Hawaii Archipelago Fishing Communities

The community setting of the fisheries of the Hawaii Archipelago is a complex one. While the region shares some features with domestic fishing community settings elsewhere, it is unlike any other area of the U.S. or its territories and affiliates in terms of its geographic span, the relative role of U.S. EEZ versus foreign EEZ versus high-seas area dependency, and its general social and cultural history. Furthermore, the identification of specific, geographically identical and bounded communities in these small insular areas is often problematic, at least for the purpose of social impact analysis. Participants in some fisheries may reside in one area on an island, moor or launch their vessels in another area, fish offshore of a different area, and land their fish in yet another area. In these cases, an island or group of islands is the most logical unit of analysis for describing the community setting and assessing community-level impacts. On the other hand, in cases such as the Hawaii-based longline fishery, the influence of and dependency on the fishery appear to be concentrated in certain areas of a particular island. Unfortunately, in most instances, there is a paucity of socioeconomic data on fishery participants at a subisland level with which to illustrate these points.

4.6.1 Identification of Fishing Communities

In Hawaii the residential distribution of individuals who are substantially dependent on or substantially engaged in the harvest or processing of fishery resources approximates the total population distribution. These individuals are not set apart—physically, socially, or economically—from island populations as a whole.

Key findings with respect to the identification of fishing communities in Hawaii include the following: (a) Fishery resources have played a central role in shaping the social, cultural, and economic fabric of Hawaii society. A large number of Hawaii's residents are substantially dependent on or substantially engaged in fishing or fishing-related activities and industries to meet social and economic needs. (b) Fishery participants tend to shift often among gear types and fisheries. Participation in multiple fisheries and the ability to switch gear types and fisheries are fundamental aspects of fisheries in Hawaii and are important to the viability of fishing operations and industries. (c) Fishery participants often reside in one area, moor or launch their vessels in other areas, fish offshore of other areas, and land their fish in yet other areas, and they tend to move among these areas according to the gear types used, weather conditions, and fishing conditions. (d) The shore-side activities associated with the large-vessel fisheries, particularly the longline fishery, are mostly concentrated in the vicinity of Honolulu. Although many people participate in those fisheries and related activities, Honolulu is a large city with a large economy, so its dependency on those fisheries is relatively small. Activities associated with the small-vessel fisheries, in contrast, are fairly widely dispersed within and among islands. Participants in these fisheries do not, generally, stand out geographically from the population as a whole, but there are certain locations in each of the seven inhabited islands in which relatively large concentrations of fishery participants reside or where there are relatively large concentrations of fishing activities or related services. (e) Because of the geographical barriers between Hawaii's islands, social and economic interactions among fishery participants occur primarily at the island level. For the same reason, fishery participants' engagement in fisheries management, such as through public meetings and outreach programs of state and federal agencies, occurs primarily at the island level. (e) The lowest level of government in Hawaii is the county. Each of Hawaii's major four counties includes one, two, or three inhabited islands.

Given the economic importance of fishery resources to the island areas within the Western Pacific Region and taking into account these islands' distinctive geographic, demographic, and cultural attributes, the Council concluded that it is appropriate to characterize each of the inhabited Hawaiian Islands (Kauai, Niihau, Oahu, Maui, Molokai, Lanai, and Hawaii) as a separate fishing community. Defining the boundaries of the fishing communities broadly helps to ensure that fishery impact statements analyze the economic and social impacts on all segments of island populations that are substantially dependent on or engaged in fishing-related activities.

4.6.2 Social Importance of Fisheries

As is the case for most Pacific islands, fishing has been an essential part of Hawaii's culture and society since its first inhabitants settled in the archipelago. As waves of immigrants have arrived, Hawaii has been changed from a self-sufficient subsistence economy to a multi-ethnic cash and wage society largely dependent on imports, tourism and federal spending. As described in Section 3.4, commercial fishing comprises a small part of Hawaii's total economy. Nevertheless fishing, in all its myriad forms, continues to play a significant role in Hawaii's society and culture. These forms vary by place and individual, ranging from subsistence activities by residents to non-consumptive recreational tag and release fishing and snorkeling by tourists, to commercial harvests of the “red fish” that are culturally important and much anticipated for Christmas and New Year’s holiday celebrations. The longest human use of Hawaii’s marine resources has obviously been that of subsistence use. The continuing importance of subsistence activities to today’s Native Hawaiians has been recently described by Davianna McGregor (McGregor 2006) as follows below. Although McGregor wrote primarily about Native Hawaiians, her words are also relevant for many other groups and individuals in Hawaii.

Through subsistence, families attain essential resources to compensate for low incomes. They can also obtain food items, especially seafood that might be prohibitively expensive in a strict cash economy. If families on fixed incomes were required to purchase these items, they would probably opt for cheaper, less healthy food that would predispose them to health problems. In this respect, subsistence not only provides food, but also ensures a healthy diet.

Subsistence generally requires a great amount of physical exertion e.g., fishing, diving, hunting), which is a valuable form of exercise and stress reduction and contributes to good physical and mental health. It is also a form of recreation that the whole family can share in. Family members of all ages contribute to different phases of subsistence, be it active hunting, fishing, gathering, or cleaning and preparing the food for eating. Older family members teach younger ones how to engage in subsistence and prepare the food, thus passing on ancestral knowledge, experience, and skill.

Another benefit of subsistence is sharing and gift giving within the community. Families and neighbors exchange resources when they are abundant and available, and the elderly are often the beneficiaries of resources shared by younger, more able-bodied practitioners. Most ku’aina believe that generosity is rewarded with better luck in the future.

Resources obtained through subsistence are also used for a variety of special life cycle occasions that bond families and communities. Resources such as fish, limu, opihi, wild venison, and so on are foods served at luau for baby birthdays, graduations, weddings, and funerals. Ohana and community residents participate in these gatherings, which cultivate and reinforce a sense of family and community identity. If ohana members had to purchase such resources rather than acquire through subsistence, the cost would be prohibitive, and the number of ohana gatherings would decrease. Subsistence activities therefore enable ohana to gather frequently and reinforce important relationships and support networks.

The author goes on to provide case studies of five cultural kipuka or areas in which Native Hawaiian traditions and lifestyles have persisted most strongly. In each area, subsistence fishing, hunting and gathering continues to play an essential role in allowing Hawaiians (and surely some non-Hawaiians as well) to interact with the natural environment and to continue their family and cultural traditions on a daily basis.

Few studies have attempted to quantify the importance of subsistence activities to Hawaii’s residents. One study that did so was conducted by the University of Hawaii and focused on Molokai. A random survey of Molokai families found that 28 percent of their food came from subsistence activities, and for Native Hawaiian families 38 percent of their food came from subsistence activities. The authors also noted that virtually every family interviewed stated that subsistence was important (not just a necessary component but a desirable one) to the lifestyle of Molokai. (Matsuoka et al. *in* McGregor 2006). Molokai is likely to represent the high end of the scale of subsistence activities among the islands due to its relative isolation, lack of employment opportunities, rural character and continued availability of natural resources. However, subsistence fishing, hunting and gathering are important and respected aspects of life for many Hawaii residents.

Fishing plays many roles in the lives of Hawaii residents and tourists, in addition to providing subsistence resources. A myriad of books, television shows and magazines highlight various aspects of Hawaii's fisheries and fishery resources and local newspapers provide lively commentary on fishery issues. Hawaii's image as a marine wonderland is a major tourism draw and many tourists are likely to either view fish (e.g., go snorkeling visit an aquarium or buy attire, souvenirs or art with a fish motif), catch fish (e.g., go fishing) or eat fish during their visit. Indeed locally caught fish comprise many of Hawaii's "signature dishes" which are a tourism draw in themselves.

Shoreline fishing is an important social and competitive activity in Hawaii. Shoreline fishing tournaments are extremely popular and both young and old fishermen can be seen along Hawaii's shores every weekend (HDAR 2000). Many of these will be targeting ulua but pulses of weke, akule and opelu will also draw crowds of fishermen to certain areas, including Honolulu's shoreline and major harbors. Smaller groups gather regularly at harbors, beaches, cliffs and breakwalls in the early morning and evening hours to fish and talk story with their friends and neighbors.

Fishing clubs provide another avenue for social interaction, support, and service. Schultz et al. (2006) provide a list of 25 fishing clubs that were active in 2003. Many of Hawaii's fishing clubs focus on pelagic fishing; however the majority of club members are also likely to target non-pelagic species over the course of a year. Fishing clubs usually meet at least one time per month and often engage in community services such as providing fishing opportunities for young, disabled or senior citizens who would otherwise be unable to participate. Not only do fishing clubs allow for social interaction between old friends, they also bring together people from many disparate social and economic groups that may not otherwise interact on a regular basis (Schultz et al. 2006).

As described in Chapter 4, landings by commercial fishermen (those who sell at least one fish during the year) are captured through the State's reporting system. The volume and ex-vessel value of these landings are described in Chapter 4. Due to the lack of either State or Federal reporting requirements for recreational (i.e., non-commercial, including subsistence) fishermen, available estimates of their landings are based primarily on data collected through intermittent creel and phone surveys. Estimates of recreational catches have varied widely over the past decade, perhaps due to differences in survey definitions and/or wording, or perhaps due to differences in sample design and subsequent data extrapolation. In several recent cases, no definition of the term "recreational" was provided to survey respondents, which is believed to have resulted in double-counting of catches by fishermen who consider their motivation for fishing to be recreational, but who nevertheless sell some of their catch. Assuming that these respondents followed State laws, their catches are categorized as, and included with, other commercial catches and to count them again as recreational catches inappropriately inflates total Hawaii landings.

Reported commercial landings alone convey to some degree the importance of fishing to Hawaii's society. As shown in Chapter 4 and Section 3.4, these landings and their sales (and related jobs and shoreside support industries) are a significant part of Hawaii's dwindling primary production industries.

In order to have the most complete understanding of the importance of fishing to Hawaii's society, fishing and fishery related data need to be obtained and disaggregated based on both fishing motivation (e.g., subsistence, family and cultural traditions, fun, camaraderie, competition, non-consumptive uses, income, or profit) and fish disposition (e.g., consumed by family, used for ohana or community events, bartered, displayed, or sold). Such information would provide a clearer picture of the many roles that fish and fishing play in Hawaii's contemporary society. This is becoming increasingly important as non-fishermen have become interested and active in the management of Hawaii's fisheries and have sought to have their voices heard. One major initiative has been a movement to establish marine protected areas in which no fishing is allowed. Several such areas have been implemented, some with the agreement of the majority of affected fishermen, others against their wishes. Other recent concerns include the potential impacts of fishing on protected species such as the Hawaiian monk seal and green sea turtle, as well as questions regarding the appropriate levels of scientific analysis needed for decision making in a social and political environment of conflicting values and priorities.

CHAPTER 5: HAWAII ARCHIPELAGO FISHERY ECOSYSTEM PLAN MANAGEMENT PROGRAM

5.1 Introduction

This chapter describes the Council's existing management program for bottomfish, crustaceans, precious corals, and coral reef ecosystem fisheries of the Hawaii Archipelago as well as the criteria used to assess the status of managed species. Existing management measures include NWHI federal permit, reporting and observer requirements as well as limited entry programs, vessel size limits, harvest guidelines, quotas, minimum size limits and gear restrictions to monitor and control NWHI harvests of bottomfish, lobsters and precious corals. There are no MSA management measures for NWHI coral reef ecosystem fisheries as the inclusion of this area in the Coral Reef Ecosystems FMP was disapproved by NMFS.

MHI management measures include federal permitting and reporting requirements to provide data on harvests of precious corals and certain coral reef ecosystem species. In addition the MHI precious corals fishery is subject to gear restrictions, quotas and minimum size limits. The MHI lobster fishery is subject to seasonal closures as well as minimum size and gear restrictions. Further, all federal fisheries are subject to control rules which allow evaluation of whether stocks are being overfished. If any stocks are determined by NMFS to be overfished (or subject to overfishing) Councils and the agency now have two years from the notice of overfishing to prepare and implement plans to end overfishing and rebuild pursuant to the reauthorized MSA. For more information on these measures please see the Council's FMPs and amendments as those documents contain complete discussions of the need for and analysis of each measure discussed here. All existing measures and pending recommendations were developed, analyzed and transmitted to NMFS in accordance with the MSA in response to changing fishery or environmental conditions. In this manner federal fisheries around Hawaii have been and will continue to be adaptively managed under the MSA using a precautionary approach which rejects a lack of information as a basis for inaction.

The 2003 administrative and enforcement costs of conserving and managing the domestic fisheries of the Western Pacific Region were estimated by NMFS and the Council to total $37 million, with future annual costs predicted to be $74 million (NOAA and WPRFMC 2004).

5.2 Description of National Standard 1 Guidelines on Overfishing

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

The National Standard Guidelines for National Standard 1 call for rules identifying good versus bad fishing conditions in the fishery and the stock and describing how a variable such as F will be controlled as a function of some stock size variable such as B in order to achieve good fishing conditions. Restrepo et al. 1998 provides a number of recommended default control rules that may be appropriate, depending on such things as the richness of data available. For the purpose of illustrating the following discussion of approaches for fulfilling the overfishing-related requirements of the MSA, a generic model that includes example MSY, target, and rebuilding control rules is shown in Figure 20. The y-axis, F/F_{MSY}, indicates the variable which managers must control as a function of B/B_{MSY} on the x-axis. The specific application of these guidelines to Hawaii's fisheries is discussed for each fishery in turn in the remainder of this chapter. This FEP carries forward the provisions pertaining to compliance with the Sustainable Fisheries Act which were recommended by the Council and subsequently approved by NMFS (68 FR 16754, April 7, 2003). Because biological and fishery data are limited for all species managed by this FEP, MSY-based control rules and overfishing thresholds are specified for multi-species stock complexes.

The Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006 (MSRA) amended the MSA to include new requirements for annual catch limits (ACLs) and accountability measures (AMs) and other provisions regarding preventing and ending overfishing and rebuilding fisheries as follows:

SEC. 302. *REGIONAL FISHERY MANAGEMENT COUNCILS*
(h) FUNCTIONS.--Each Council shall, in accordance with the provisions of this Act--
(6) develop annual catch limits for each of its managed fisheries that may not exceed the fishing level recommendations of its scientific and statistical committee or the peer review process established under subsection g;

SEC. 303. *CONTENTS OF FISHERY MANAGEMENT PLANS*
(a) REQUIRED PROVISIONS – Any fishery management plan which is prepared by any Council, or by the Secretary, with respect to any fishery, shall -
(10) specify objective and measurable criteria for identifying when the fishery to which the plan applies is overfished (with an analysis of how the criteria were determined and the relationship of the criteria to the reproductive potential of stocks of fish in that fishery) and, in the case of a fishery which the Council or the Secretary has determined is approaching an overfished condition or is overfished, contain conservation and management measures to prevent overfishing or end overfishing and rebuild the fishery;
(15) establish a mechanism for specifying annual catch limits in the plan (including a multiyear plan), implementing regulations, or annual specifications, at a level such that overfishing does not occur in the fishery, including measures to ensure accountability.

EFFECTIVE DATES; APPLICATION TO CERTAIN SPECIES.—The amendment made by subsection (a)(10) [and 303(a)(15) above]—
(1) shall, unless otherwise provided for under an international agreement in which the United States participates, take effect—
(A) in fishing year 2010 for fisheries determined by the Secretary to be subject to overfishing; and

(B) in fishing year 2011 for all other fisheries; and
(2) shall not apply to a fishery for species that have a life cycle of approximately 1 year unless the Secretary has determined the fishery is subject to overfishing of that species; and
(3) shall not limit or otherwise affect the requirements of section 301(a)(1) or 304(e) of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1851(a)(1) or 1854(e), respectively..

The Council will continue the development of a mechanism(s) to meet the new requirements for specifying ACLs including measures to ensure accountability and this FEP will undergo future amendments to meet the new MSRA requirements. For additional information on NMFS' guidance regarding National Standard 1, please see 74 FR 3178.

5.2.1 MSY Control Rule and Stock Status Determination Criteria

An MSY control rule is a control rule that specifies the relationship of F to B or other indicator of productive capacity under an MSY harvest policy. Because fisheries must be managed to achieve optimum yield, not MSY, the MSY control rule is a benchmark control rule rather than an operational one. However, the MSY control rule is useful for specifying objective and measurable criteria for identifying when the fishery to which the plan applies is overfished that are required under the MSA. The National Standard Guidelines (74 FR 3178) refer to these criteria as "status determination criteria" and state that they must include two limit reference points, or thresholds: one for F that identifies when overfishing is occurring and a second for B or its proxy that indicates when the stock is overfished.

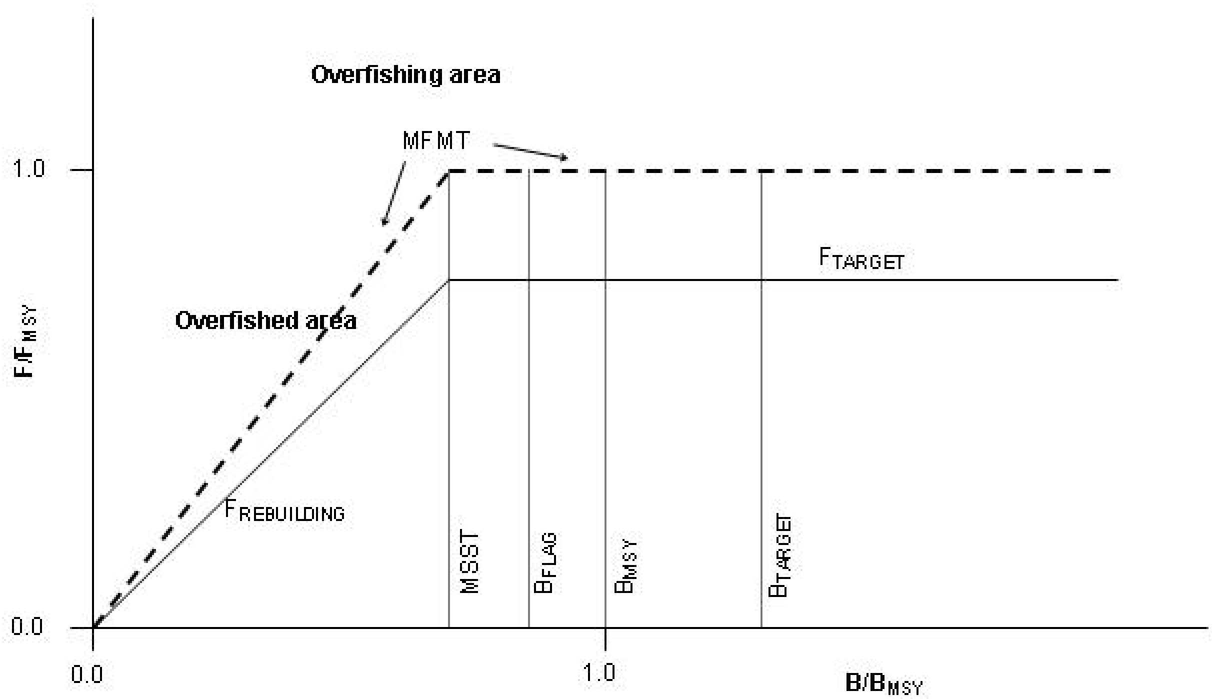

Figure 20: Example MSY, Target, and Rebuilding Control Rules

Source: Restrepo et al. 1998

In Figure 20 the dashed horizontal and diagonal line represents a model MSY control rule that is used as the MFMT; the solid horizontal and diagonal line represents a model integrated target (F_{target}) and rebuilding ($F_{rebuilding}$) control rule.

The status determination criterion for F is the maximum fishing mortality threshold (MFMT). Minimum stock size threshold (MSST) is the criterion for B. If fishing mortality exceeds the MFMT for a period of one year or more, overfishing is occurring. A stock or stock complex is considered overfished when its biomass has declined below a level that jeopardizes the capacity of the stock to produce MSY on a continuing basis (i.e., the biomass falls below MSST). A Council must take remedial action in the form of a new FMP, an FMP amendment, or proposed regulations within two years following notification by the Secretary of Commerce that overfishing is occurring, a stock or stock complex is overfished or approaching an overfished condition,[20] or existing remedial action to end previously identified overfishing or to rebuild an overfished stock has not resulted in adequate progress.

The National Standard Guidelines state that the MFMT may be expressed as a single number or as a function of some measure of the stock's productive capacity. Guidance in Restrepo et al. (1998:17) regarding specification of the MFMT is based on the premise that the MSY control rule constitutes the MFMT. In the example in Figure 20 the MSY control rule sets the MFMT constant at F_{MSY} for values of B greater than the MSST and decreases the MFMT linearly with biomass for values of B less than the MSST. This is the default MSY control rule recommended in Restrepo et al. (1998). Again, if F is greater than the MFMT for a period of one year or more, overfishing is occurring.

The National Standard Guidelines state that to the extent possible, the MSST should equal whichever of the following is greater: One-half the MSY stock size, or the minimum stock size at which rebuilding to the MSY level would be expected to occur within 10 years if the stock or stock complex were exploited at the MFMT. The MSST is indicated in Figure 20 by a vertical line at a biomass level somewhat less than B_{MSY}. A specification of MSST below B_{MSY} would allow for some natural fluctuation of biomass above and below B_{MSY}, which would be expected under, for example, an MSY harvest policy. Again, if B falls below MSST the stock is overfished.

Warning reference points comprise a category of reference points that will be considered together with the required thresholds. Although not required under the MSA, warning reference points provide warning in advance of B or F approaching or reaching their respective thresholds. For example a stock biomass flag (B_{FLAG}) could be specified at some point above MSST, as indicated in Figure 20. The control rule would not call for any change in F as a result of breaching B_{FLAG} – it would merely serve as a trigger for consideration of action or perhaps preparatory steps towards such action. Intermediate reference points set above the thresholds

[20] A stock or stock complex is approaching an overfished condition when it is projected that there is more than a 50 percent chance that the biomass of the stock or stock complex will decline below MSST within two years (74 FR 3178).

could also be specified in order to trigger changes in F – in other words, the MFMT could have additional inflection points.

5.2.2 Target Control Rule and Reference Points

A target control rule specifies the relationship of F to B for a harvest policy aimed at achieving a given target. Optimum yield (OY) is one such target, and National Standard 1 requires that conservation and management measures both prevent overfishing and achieve OY on a continuing basis. Optimum yield is the yield that will provide the greatest overall benefits to the nation, and is prescribed on the basis of MSY, as reduced by any relevant economic, social, or ecological factor. MSY is therefore an upper limit for OY.

A target control rule can be specified using reference points similar to those used in the MSY control rule, such as F_{TARGET} and B_{TARGET}. For example, the recommended default in Restrepo et al. (1998) for the target fishing mortality rate for certain situations (ignoring all economic, social, and ecological factors except the need to be cautious with respect to the thresholds) is 75 percent of the MFMT, as indicated in Figure 20. Simulation results using a deterministic model have shown that fishing at 0.75 F_{MSY} would tend to result in equilibrium biomass levels between 1.25 and 1.31 B_{MSY} and equilibrium yields of 0.94 MSY or higher (Mace 1994).

It is emphasized that while MSST and MFMT are limits, the target reference points are merely targets. They are guidelines for management action, not constraints. For example Restrepo et al. (1998) state that "Target reference points should not be exceeded more than 50% of the time, nor on average").

5.2.3 Rebuilding Control Rule and Reference Points

If it has been determined that overfishing is occurring, a stock or stock complex is overfished or approaching an overfished condition, or existing remedial action to end previously identified overfishing or to rebuild an overfished stock has not resulted in adequate progress, the Council must take remedial action within two years. In the case that a stock or stock complex is overfished (i.e., biomass falls below MSST in a given year), the action must be taken through a stock rebuilding plan (which is essentially a rebuilding control rule as supported by various analyses) with the purpose of rebuilding the stock or stock complex to the MSY level (B_{MSY}) within an appropriate time frame, as required by MSA §304(e)(4). The details of such a plan, including specification of the time period for rebuilding, would take into account the best available information regarding a number of biological, social, and economic factors, as required by the MSRA and National Standard Guidelines.

If B falls below MSST, management of the fishery would shift from using the target control rule to the rebuilding control rule. Under the rebuilding control rule in the example in Figure 20, F would be controlled as a linear function of B until B recovers to MSST (see $F_{REBUILDING}$), then held constant at F_{TARGET} until B recovers to B_{MSY}. At that point, rebuilding would have been achieved and management would shift back to using the target control rule (F set at F_{TARGET}). The target and rebuilding control rules "overlap" for values of B between MSST and the rebuilding target (B_{MSY}). In that range of B, the rebuilding control rule is used only in the case that B is recovering from having fallen below MSST. In the example in Figure 20 the two rules are identical in that range of B (but they do not need to be), so the two rules can be considered a single, integrated, target control rule for all values of B.

5.2.4 Measures to Prevent Overfishing and Overfished Stocks

The control rules specify how fishing mortality will be controlled in response to observed changes in stock biomass or its proxies. Implicitly associated with those control rules are management actions that would be taken in order to manipulate fishing mortality according to the rules. In the case of a fishery which has been determined to be "approaching an overfished condition or is overfished," MSA §303(a)(10) requires that the FMP "contain conservation and management measures to prevent overfishing or end overfishing and rebuild the fishery."

5.3 Management Program for Bottomfish and Seamount Groundfish Fisheries

5.3.1 Management Areas and Sub-areas

The fishery management area in the Hawaiian Islands FEP is divided into three sub-areas:
(1) Main Hawaiian Islands (MHI) means the EEZ of the Hawaiian Islands Archipelago lying to the east of 161° W longitude.
(2) Northwestern Hawaiian Islands (NWHI) means the EEZ of the Hawaiian Islands Archipelago lying to the west of 161° W. Midway Island is treated as part of the Northwestern Hawaiian Islands Subarea.

> (i) Ho'omalu Zone means that portion of the EEZ around the NWHI west of 165°W. longitude.
> (ii) Mau Zone means that portion of the EEZ around the NWHI between 161°' W longitude and 165° W longitude.

(3) Hancock Seamount means that portion of the EEZ in the Northwestern Hawaiian Islands west of 180°00' W longitude and north of 28°00' N latitude.

5.3.2 Permit and Reporting Requirements

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), requires the registration of individuals who engage in recreational fishing. Effective October 1, 2008, a Federal bottomfish permit is required for vessel owners and fishermen to conduct vessel-based non-commercial fishing for any bottomfish management unit species in Federal waters around the MHI (except customers of charter fishing trips). The operators and owners of non-commercial fishing vessels must submit daily Federal logbooks that document bottomfish fishing effort and catch for each fishing trip. Fishery participants have the option of using NMFS approved electronic logbooks in lieu of paper logbooks.

To date, there are no Federal permitting or reporting requirements for commercial vessel operators targeting or harvesting bottomfish MUS in the MHI; however, commercial fishery participants (those who sell at least one fish during the year) must obtain commercial marine licenses from HDAR and submit monthly fishing reports (this reporting requirement is reinforced by a Federal regulation requiring compliance with State reporting requirements).

Federal permits are required for any vessel fishing for bottomfish MUS in the NWHI Subarea and the permit must be registered for use with the vessel. A single vessel can not be registered for use with a Ho'omalu Zone permit and a Mau Zone permit at the same time and vessels participating in the Mau Zone and Ho'omalu Zone limited entry fishery must meet the requirements and obtain a limited access permit. Requirements for a Ho'omalu Zone limited access permit include:

(i) A Ho'omalu zone permit may not be sold or otherwise transferred to a new owner. A Ho'omalu zone permit or permits may be held by a partnership or corporation. If 50 percent or more of the ownership of the vessel passes to persons other than those listed in the original application, the permit will lapse and must be surrendered to the NMFS Regional Administrator.
(ii) Upon application by the owner of a permitted vessel, the NMFS Regional Administrator will transfer that owner's permit to a replacement vessel owned by that owner, provided that the replacement vessel does not exceed 60 ft (18.3 meters) in length. The replacement vessel must be put into service no later than 12 months after the owner applies for the transfer, or the transfer shall be void. An owner of a permitted vessel may apply to the Regional Administrator for transfer of that owner's permit to a replacement vessel greater than 60 ft (18.3 meters) in length. The Regional Administrator may transfer the permit upon determining, after consultation with the Council and considering the objectives of the limited access program, that the replacement vessel has catching power that is comparable to the rest of the vessels holding permits for the fishery, or has catching power that does not exceed that of the original vessel, and that the transfer is not inconsistent with the objectives of the program. The Regional Administrator shall consider vessel length, range, hold capacity, gear limitations, and other appropriate factors in making determinations of catching power equivalency and comparability of the catching power of vessels in the fishery.
(iii) Ho'omalu Zone limited access permit renewal-- A qualifying landing for Ho'omalu Zone permit renewal is a landing of at least 2,500lbs (1,134 kilograms) of bottomfish management unit species from the Ho'omalu Zone or a landing of at least 2,500lbs (1,134 kilograms) of fish from the Ho'omalu Zone, of which at least 50 percent by weight was bottomfish management unit species. A permit is eligible for renewal for the next calendar year if the vessel covered by the permit made three or more qualifying landings during the current calendar year.
(iv) The NMFS Regional Administrator may issue new Ho'omalu Zone limited access permits if the Regional Administrator determines, in consultation with the Council that bottomfish stocks in the Ho'omalu Zone are able to support additional fishing effort. When the Regional Administrator has determined that new permits may be issued, they shall be issued to applicants based upon eligibility, determined as follows:

(a) Point system:
Two points will be assigned for each year in which the applicant was owner or captain of a vessel that made three or more of any of the following types of landings in the NWHI: Any amount of bottomfish management unit species, regardless of weight, if made on or before August 7, 1985; at least 2,500lbs (1,134 kilograms) of bottomfish management unit species, if made after August 7, 1985; or at least 2,500lbs (1,134 kilograms) of any fish lawfully harvested from the NWHI, of which at least 50 percent by weight was bottomfish, if made after August 7, 1985. One point will be assigned for each year in which the applicant was owner or captain of a

vessel that landed at least 6,000lbs (2,722 kilograms) of bottomfish from the main Hawaiian Islands. For any one year, points will be assigned for landings in the Northwestern Hawaiian Islands Subarea or main Hawaiian Islands Subarea, but not in both subareas. New permits shall be awarded to applicants in descending order, starting with the applicant with the largest number of points. If two or more persons have an equal number of points, and there are insufficient new permits for all such applicants, the new permits shall be awarded by the Regional Administrator through a lottery.
(b) Before the NMFS Regional Administrator issues a Ho'omalu zone permit to fish for bottomfish, the primary operator and relief operator named on the application form must have completed a protected species workshop conducted by NMFS.
(c) An applicant must own at least a 25 percent share in the vessel that the permit would cover, and only one permit will be assigned to any vessel.

Requirements for a Mau Zone limited access permit include:

(i) Eligibility for new Mau Zone limited access permits:
(a) NMFS will issue an initial Mau Zone permit to a vessel owner who qualifies for at least three points under the following point system: An owner who held a Mau Zone permit on or before December 17, 1991, and whose permitted vessel made at least one qualifying landing of bottomfish management unit species on or before December 17, 1991, shall be assigned 1.5 points; an owner whose permitted vessel made at least one qualifying landing of bottomfish management unit species during 1991, shall be assigned 0.5 point; an owner whose permitted vessel made at least one qualifying landing of bottomfish management unit species during 1992, shall be assigned 1.0 point; an owner whose permitted vessel made at least one qualifying landing of bottomfish management unit species during 1993, shall be assigned 1.5 points; an owner whose permitted vessel made at least one qualifying landing of bottomfish management unit species during 1994, shall be assigned 2.0 points; an owner whose permitted vessel made at least one qualifying landing of bottomfish management unit species during 1995, shall be assigned 2.5 points; an owner whose permitted vessel made at least one qualifying landing of bottomfish management unit species during 1996, shall be assigned 3.0 points. A "qualifying landing" means any amount of bottomfish management unit species lawfully harvested from the Mau Zone and offloaded for sale. No points shall be assigned to an owner for any qualifying landings reported to the State of Hawaii more than 1 year after the landing.
(b) More than one Mau Zone permit may be issued to an owner of two or more vessels, provided each of the owner's vessels for which a permit will be registered for use has made the required qualifying landings for the owner to be assigned at least three eligibility points.
(c) A Mau Zone permit holder who does not own a vessel at the time initial permits are issued must register the permit for use with a vessel owned by the permit holder within 12 months from the date the permit was issued. In the interim, the permit holder may register the permit for use with a leased or chartered vessel. If within 12 months of initial permit issuance, the permit holder fails to apply to NMFS to register the permit for use with a vessel owned by the permit holder, then the permit expires.
(d) Before NMFS issues a Mau Zone permit to fish for bottomfish, the primary operator and relief operator named on the application form must have completed a protected species workshop conducted by NMFS.

(e) A Mau Zone permit may be held by an individual, partnership, or corporation. No more than 49 percent of the underlying ownership interest in a Mau Zone permit may be sold, leased, chartered, or otherwise transferred to another person or entity. If more than 49 percent of the underlying ownership of the permit passes to persons or entities other than those listed in the original permit application supplemental information sheet, then the permit expires and must be surrendered to NMFS. A Mau Zone permit holder may apply to NMFS to register the permit for use with another vessel if that vessel is owned by the permit holder, and is no longer than 60 ft (18.3 meters). If a Mau Zone permit holder sells the vessel, for which the permit is registered for use, the permit holder must within 12 months of the date of sale apply to NMFS to register the permit for use with a vessel owned by the permit holder. If the permit holder has not applied to register a replacement vessel within 12 months, then the permit expires. If a permitted vessel owned by the permit holder is sold or becomes un-seaworthy, the Mau Zone permit with which the vessel was registered may be registered for use with a leased or chartered vessel for a period not to exceed 12 months from the date of registration of the leased or chartered vessel. If by the end of that 12-month period the permit holder fails to apply to NMFS to register the permit for use with a vessel owned by the permit holder, then the permit expires.
(ii) A Mau Zone permit will be eligible for renewal if the vessel for which the permit is registered for use made at least five separate fishing trips with landings of at least 500lbs (227 kg) of bottomfish management unit species per trip during the calendar year. Only one landing of bottomfish management unit species per fishing trip to the Mau Zone will be counted toward the landing requirement. If the vessel for which the permit is registered for use fails to meet the landing requirement, the owner may apply to the NMFS Regional Administrator for a waiver of the landing requirement. Grounds for a waiver are limited to captain incapacitation, vessel breakdowns, and the loss of the vessel at sea if the event prevented the vessel from meeting the landing requirement. Lack of profitability is not sufficient for waiver of the landing requirement.

The NWHI Bottomfish fishery will close on June 15, 2011, in accordance with the provisions of the Papahanaumokuakea Marine National Monument, which was established in the NWHI through Presidential Proclamation No. 8031 on June 15, 2006.

5.3.3 Gear Restrictions

Gear restrictions include prohibitions against the use or possession of bottom trawls and bottom set gillnets; and the use or possession of poisons, explosives, or intoxicating substances to harvest bottomfish or seamount groundfish in the bottomfish fishery.

5.3.4 At-sea Observer Coverage

All fishing vessels with bottomfish permits must carry an on-board observer when directed to do so by NMFS. Vessel owners or operators will be given at least 72 hour prior notice by NMFS of an observer requirement. Required standards of treatment and accommodations for observers must be followed.

5.3.5 Framework for Regulatory Adjustments

By June 30 of each year, a Council-appointed bottomfish monitoring team will prepare an annual report on the fishery by area covering the following topics: fishery performance data; summary of recent research and survey results; habitat conditions and recent alterations; enforcement activities and problems; administrative actions (e.g., data collection and reporting, permits); and state and territorial management actions. Indications of potential problems warranting further investigation may be signaled by the following indicator criteria: mean size of the catch of any species in any area is a pre-reproductive size; ratio of fishing mortality to natural mortality for any species; harvest capacity of the existing fleet and/or annual landings exceed best estimate of MSY in any area; significant decline (50 percent or more) in bottomfish catch per unit of effort from baseline levels; substantial decline in ex-vessel revenue relative to baseline levels; significant shift in the relative proportions of gear in any one area; significant change in the frozen/fresh components of the bottomfish catch; entry/exit of fishermen in any area; per-trip costs for bottomfishing exceed per-trip revenues for a significant percentage of trips; significant decline or increase in total bottomfish landings in any area; change in species composition of the bottomfish catch in any area; research results; habitat degradation or environmental problems; and reported interactions between bottomfish fishing operations and protected species.

The team may present management recommendations to the Council at any time. Recommendations may cover actions suggested for federal regulations, state/territorial action, enforcement or administrative elements, and research and data collection. Recommendations will include an assessment of urgency and the effects of not taking action. The Council will evaluate the team's reports and recommendations, and the indicators of concern. The Council will assess the need for one or more of the following types of management action: catch limits, size limits, closures, effort limitations, access limitations, or other measures. The Council may recommend management action by either the state/territorial governments or by federal regulation.

If the Council believes that management action should be considered, it will make specific recommendations to the NMFS Regional Administrator after requesting and considering the views of its Scientific and Statistical Committee and Bottomfish Advisory Panel and obtaining public comments at a public hearing. The Regional Administrator will consider the Council's recommendation and accompanying data, and, if he or she concurs with the Council's recommendation, will propose regulations to carry out the action. If the Regional Administrator rejects the Council's proposed action, a written explanation for the denial will be provided to the Council within two weeks of the decision. The Council may appeal denial by writing to the Assistant Administrator, who must respond in writing within 30 days.

5.3.6 Bycatch Measures

As described in Chapter 4, bycatch in Hawaii's bottomfish fisheries differs between the two separately managed fisheries: a strictly commercial fishery in the NWHI and a mixed, commercial, subsistence and recreational fishery in the MHI. The commercial fleet in the NWHI uses bottomfish gear types and fishing strategies that are highly selective for desired species and sizes while MHI fishery participants tend to be less selective and generally keep every fish caught. Federal regulatory measures in place to reduce bycatch include prohibitions on the use of non-selective fishing methods including bottom trawls, bottom gillnets, explosive and poisons.

As there is a moratorium on the seamount groundfish fishery, there is no bycatch or bycatch mortality associated with the fishery.

Five types of non-regulatory measures aimed at reducing bycatch and bycatch mortality, and improving bycatch reporting are also being implemented. They include: 1) outreach to fishermen and engagement of fishermen in management, including research and monitoring activities, to increase awareness of bycatch issues and to aid in development of bycatch reduction methods; 2) research into fishing gear and method modifications to reduce bycatch quantity and mortality; 3) research into the development of markets for discard species; 4) improvement of data collection and analysis systems to better quantify bycatch and 5) outreach and training of fishermen in methods to reduce baraotrauma in fish that are to be released.

To reduce the number and impact of potential protected species interactions in the NWHI bottomfish fishery, primary and relief operators (captains) in the NWHI limited access program are required to complete a one-time protected species workshop.

5.3.7 Application of National Standard 1

MSY Control Rule

Biological and fishery data are poor for all bottomfish species in Hawaii. Generally, data are only available on commercial landings by species and catch-per-unit-effort (CPUE) for the multi-species complexes as a whole. At this time, it is not possible to partition these effort measures among the various bottomfish MUS for any fishery except the MHI, where effort data are available for the four major species caught.

The overfishing criteria and control rules are applied to individual species within the multi-species stock whenever possible. When this is not possible, they are based on an indicator species for the multi-species stock. It is important to recognize that individual species are affected differently based on this type of control rule, and it is important that for any given species fishing mortality does not exceed a level that would lead to its required protection under the Endangered Species Act (ESA). For the seamount groundfish stocks, armorhead serves as the indicator species. No indicator species are used for the four bottomfish multi-species stock complexes (American Samoa, CNMI, Guam and Hawaii). Instead, the control rules are applied to each of the four stock complexes as a whole.[21]

The MSY control rule is used as the MFMT. The MFMT and MSST are specified based on the recommendations of Restrepo et al. (1998) and both are dependent on the natural mortality rate (M). The range of M among species within a stock complex is taken into consideration when estimating and choosing the M to be used for the purpose of computing the reference point values.

[21] The National Standards Guidelines allow overfishing of "other" components in a mixed stock complex if (1) long-term benefits to the nation are obtained, (2) similar benefits cannot be obtained by modification of the fishery to prevent the overfishing, and (3) the results will not necessitate ESA protection of any stock component or ecologically significant unit.

In addition to the thresholds MFMT and MSST, a warning reference point, B_{FLAG}, is also specified at a point above the MSST to provide a trigger for consideration of management action prior to B reaching the threshold. MFMT, MSST, and B_{FLAG} are specified as indicated in Table 20.

Table 20: Overfishing Threshold Specifications:Bottomfish and Seamount Groundfish Stocks

MFMT	MSST	B_{FLAG}
$F(B) = \frac{F_{MSY} B}{c\ B_{MSY}}$ for $B \leq c\ B_{MSY}$ $F(B) = F_{MSY}$ for $B > c\ B_{MSY}$	$c\ B_{MSY}$	B_{MSY}
where $c = \max(1\text{-}M, 0.5)$		

Standardized values of fishing effort (E) and catch-per-unit-effort (CPUE) are used as proxies for F and B, respectively, so E_{MSY}, $CPUE_{MSY}$, and $CPUE_{FLAG}$ are used as proxies for F_{MSY}, B_{MSY}, and B_{FLAG}, respectively. In cases where reliable estimates of $CPUE_{MSY}$ and E_{MSY} are not available, they will be estimated from catch and effort times series, standardized for all identifiable biases. $CPUE_{MSY}$ would be calculated as half of a multi-year average reference CPUE, called $CPUE_{REF}$. The multi-year reference window would be objectively positioned in time to maximize the value of $CPUE_{REF}$. E_{MSY} will be calculated using the same approach or, following Restrepo et al. (1998), by setting E_{MSY} equal to E_{AVE}, where E_{AVE} represents the long-term average effort prior to declines in CPUE. When multiple estimates are available, the more precautionary one is used.

In Hawaii, archipelago-wide estimates of the reference points are calculated as the weighted average of estimates for each of the three management zones (MHI, Mau, and Hoomalu). Weighting factors are calculated using the zone-specific fraction of the total length of the 100-fm contour in the archipelago. Ralston and Polovina (1982) have shown that the 100-fm contour is a valid measure of available bottomfish habitat. These weightings are used when calculating archipelago-wide F and CPUE for the deep slope complex as a whole, rather than for any specific BMUS.

Since the MSY control rule specified in this chapter applies to multi-species stock complexes, it is important to ensure that no particular species within the complex has a mortality rate that leads to required protection under the ESA. In order to accomplish this, a secondary set of reference points is specified to evaluate stock status with respect to recruitment overfishing. A secondary "recruitment overfishing" control rule is specified to control fishing mortality with respect to that status. The rule is applied only to those component stocks (species) for which adequate data are available. The ratio of a current spawning stock biomass proxy ($SSBP_t$) to a given reference level ($SSBP_{REF}$) is used to determine if individual stocks are experiencing recruitment overfishing. SSBP is CPUE scaled by percent mature fish in the catch. When the ratio $SSBP_t/SSBP_{REF}$, or the "SSBP ratio" (SSBPR) for any species drops below a certain limit ($SSBPR_{MIN}$), that species is considered to be recruitment overfished and management measures will be implemented to reduce fishing mortality on that species. The rule applies only when the SSBP ratio drops below the $SSBPR_{MIN}$, but it will continue to apply until the ratio achieves the "SSBP ratio recovery target" ($SSBPR_{TARGET}$), which is set at a level no less than $SSBPR_{MIN}$. These two reference points and their associated recruitment overfishing control rule, which prescribe a target fishing mortality rate ($F_{RO\text{-}REBUILD}$) as a function of the SSBP ratio, are specified as indicated in Table 21. Again, E_{MSY} is used as a proxy for F_{MSY}.

Table 21: Recruitment Overfishing Control Rule Specifications: Bottomfish and Seamount Groundfish Stocks

$F_{RO\text{-}REBUILD}$	$SSBPR_{MIN}$	$SSBPR_{TARGET}$
$F(SSBPR) = 0$ for $SSBPR \leq 0.10$ $F(SSBPR) = 0.2\ F_{MSY}$ for $0.10 < SSBPR \leq SSBPR_{MIN}$ $F(SSBPR) = 0.5\ F_{MSY}$ for $SSBPR_{MIN} < SSBPR \leq SSBPR_{TARGET}$	0.20	0.30

Target Control Rule and Reference Points

While there is an established OY, it is not quantified or in the form of a target control rule for bottomfish stocks of the Hawaii Archipelago.

Rebuilding Control Rule and Reference Points

No rebuilding control rules or reference points are currently specified for bottomfish stocks of the Hawaii Archipelago. However, the seamount groundfish stock complex, the only stock determined to be overfished, is already subject to a rebuilding plan in which fishing mortality is set at zero.

Stock Status Determination Process

Stock status determinations involve three procedural steps. First, the appropriate MSY, target or rebuilding reference points are specified. However, because environmental changes may affect the productive capacity of the stocks, it may be necessary to occasionally modify the specifications of some of the reference points or control rules. Modifications may also be desirable when better assessment methods become available, when fishery objectives are modified (e.g., OY), or better biological, socio-economic, or ecological data become available.

Second, the values of the reference points are estimated; and third, the status of the stock is determined by estimating the current or recent values of fishing mortality and stock biomass or their proxies and comparing them with their respective reference points.

The second step (including estimation of M, on which the values of the overfishing thresholds would be dependent) and third step will be undertaken by NMFS and the latest results published annually in the Stock Assessment and Fishery Evaluation (SAFE) report. In practice, the second and third steps may be done simultaneously—in other words, the reference point values could be re-estimated as often as the stocks' status. No particular stock assessment period or schedule is specified, but in practice the assessments are likely be conducted annually in coordination with the preparation of the annual SAFE report.

The best information available is used to estimate the values of the reference points and to determine the status of stocks in relation to the status determination criteria. The determinations are based on the latest available stock and fishery assessments. Information collected includes logbook data, creel survey data, vessel observer data (the observer program in the NWHI fishery was recently reinitiated), and occasional fishery-independent surveys; however, at this time only the logbook data are used in stock assessments.

The combination of control rules and reference points is illustrated in Figure 21. The primary control rules that are applied to the stock complexes are shown in part (a). Note that the position of the MSST is illustrative only; its value would depend on the best estimate of M at any given time. The secondary control rule that will be applied to particular species as needed to provide for recovery from recruitment overfishing is shown in part (b).

Moffitt et al. (2006) employed a dynamic production model applied to a time series of 2004 bottomfish catch and effort data for the three management zones in the Hawaii Archipelago. In the Hoomalu Zone and Mau Zone, the analysis involved commercial fishery data (catch-per-day) from vessel logbooks and interview data (1988−2004). In the MHI, only the State of Hawaii commercial catch data for the 1948−2004 period were used. A simplified three-parameter dynamic production model was fit simultaneously to the three time series of catch data by nonlinear regression. The model used is similar to the one described by Kobayashi (1996). This approach reduces the number of fitted parameters by using outside information for some parameters and incorporating some shared parameters where applicable. It has been shown to be a useful approach for short time series involving geographically separate regions thought to have similar biological dynamics (Polovina 1989). The basic equation Moffitt et al.(2006) used for the dynamic production model is from Hilborn and Walters (1992) with a slight modification to the catch formula that prevents catch from exceeding population size at high levels of exploitation (Dr. Richard B. Deriso, Inter-American Tropical Tuna Commission, pers. comm.). The equation can be found in Moffitt et al. (2006). For each management zone, zonal MSY contribution (ZMC) reference points for the bottomfish fishery are calculated separately. Table 22 shows the metrics which resulted from this model and which indicated that MHI fishing mortality metrics were well above those of the other two zones and that excessive fishing pressure in the MHI was the major contributor to overfishing in the archipelago (Moffitt et al. 2006).

Table 22: Archipelagic Reference Values for the Dynamic Production Model (2004 data)

Archipelagic Reference Values for Dynamic Production Model Parameters			
Model Parameter	**Reference Value**		
Carrying Capacity (*k*) [lbs]	7,131,473		
B_{MSY} [lbs]	3,565,736		
MSY [lbs]	811,225		
Zonal Model Outputs and Metrics			
Model Output/Metric	**MHI**	**Mau**	**Ho'omalu**
Catchability (*q*) [per day]	Period / *q* value < 1961: 0.000166 1961–1984: 0.000190 1985–1991: 0.000238 1992–present: 0.000285	0.000991	0.000262
Intrinsic Rate of Population Increase (*r*)	0.455011	0.455011	0.455011
Zonal Carrying Capacity Contribution [lbs]	3,186,215	882,608	3,062,650
Zonal MSY Contribution (ZMC) [lbs]	362,441	100,399	348,385
Biomass at ZMC [lbs]	1,593,107	441,304	1,531,325
$CPUE_{ZMC}$ [lbs per day]	405	437	400
E_{ZMC} [days]	895	230	870
Zonal Weighting Factors (proportion of archipelagic 100 fathom contour)	0.447	0.124	0.429

Source: Moffitt et al. (2006)

An updated stock assessment and overfishing risk assessment was completed by PIFSC in 2008 (Brodziak et al. 2008). Conducting the stock assessment on bottomfish throughout the Hawaiian archipelago has been consistent with the Council and NMFS decision to treat Hawaii bottomfish as a single management unit (Amendment 3 to the Bottomfish FMP). Recent stock assessments have allowed fishery scientists to decompose the results into the three sub-areas: the MHI and the two NWHI limited entry zones. PIFSC scientists used information developed in the recently completed bottomfish CPUE standardization workshop to produce updated total allowable catch projections with associated risks of overfishing (Brodziak et al. 2008).

The assessment foundthat the Hawaiian Archipelagic bottomfish stocks are in better condition than the previous stock assessment indicated and concluded that, at present, Hawaiian bottomfish are currently not experiencing overfishing and are not overfished ; however the MHI remain vulnerable to excessive fishing effort.

More recently, PIFSC published a stock assessment update (Brodziak et al. 2009) which reached the same conclusions regarding overfishing and which contained upwardly revised MSY estimates (see Section 4.2.4).

Measures to Address Overfishing and Overfished Stocks

During the 1990’s, the best available scientific information indicated that onaga or 'ula'ula koa'e (*Etelis coruscans*) and ehu or 'ula'ula (*Etelis carbunculus*) were subject to excessive fishing pressure in the MHI. Evidence of these declining bottomfish stocks in the MHI spurred the State of Hawaii to implement several management measures applicable to seven species of bottomfish in State waters.They include gear restrictions, bag limits for non-commercial fishermen, and 20 areas closed to fishing and possession of bottomfish.

As described in Section 4.2.3, despite the State restrictions on bottomfish fishing, in June 2005 (70 FR 34452, June 14, 2005), NMFS determined that overfishing of the bottomfish complex was occurring in the Hawaii Archipelago. NMFS noted that the overfishing was primarily occurring in waters around the MHI, rather than the NWHI. In response to a notice from NMFS that overfishing was occurring, the Council recommended and NMFS approved Amendment 14 to the Bottomfish FMP which implemented an annual total allowable catch limit (TAC) for landings of Deep 7 species by the MHI commercial fishery, federal non-commercial permits and reporting requirements, non-commercial bag limits and a closed season for fishing for Deep 7 species in the Main Hawaiian Islands. Amendment 14 also defined the Main Hawaiian Islands bottomfish fishing year as September 1-August 31 and implemented a TAC of 178,000 lbs for the 2007-2008 fishing year.

After reviewing the 2008 updated stock assessment, the Council recommended and NMFS approved a 2008-09 MHI commercial Deep 7 TAC of 241,000lbs, which is associated with an approximate 40 percent risk of overfishing (FY 2009) in the MHI management subarea, decreasing to a 25 percent risk for FY 2010. Given that the establishment of a TAC for Deep 7 bottomfish in the MHI management subarea is a precautionary measure to address overfishing in the entire Hawaiian Archipelago, it should be recognized that the probability of overfishing bottomfish in the Hawaiian Archipelago is essentially zero for all alternatives considered under the most recent stock and risk assessments.

Seamount Groundfish Stocks

The Hancock Seamount, 1,400 miles northwest of Honolulu, is the only area where a seamount fishery has been conducted. This fishery was developed by foreign fishing vessels in the 1960’s until the stocks of alfonsin and armorhead collapsed. In 1986 the Bottomfish FMP enacted a moratorium on this fishery to conserve pelagic armorhead (*Psuedopentaceros wheeleri*, formerly *Pentaceros richardsoni*) which has been determined to be overfished. Successive stock status estimates have indicated no recovery of the stocks. The moratorium is currently in effect until August 31, 2010.

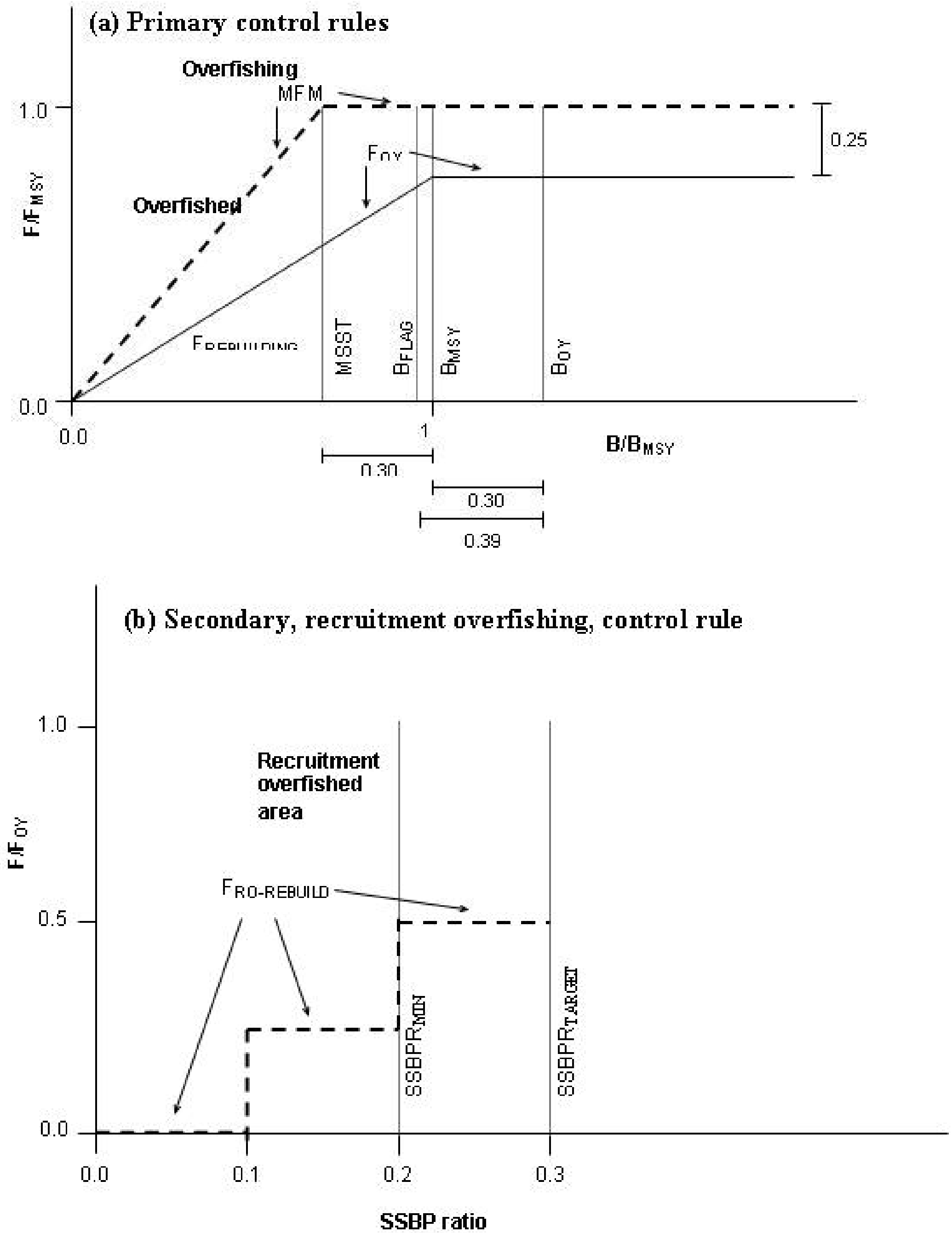

Figure 21: Combination of Control Rules and Reference Points for Bottomfish and Seamount Groundfish Stocks

5.4 Management Program for Crustacean Fisheries

5.4.1 Management Areas and Subareas

The fishery management area for the Hawaiian Islands crustacean fisheries is divided into two Permit Areas:
(1) Permit Area 1 is the EEZ around the Northwestern Hawaiian Islands.
(2) Permit Area 2 is the EEZ around the main Hawaiian Islands.

Permit Area 1 is divided into four subareas:
(1) Necker Island Lobster Grounds - waters bounded by straight lines connecting the following coordinates in the order presented: 24° 00' N latitude, 165°00' W longitude; 24° 00' N latitude, 164°00' W longitude; 23°00' N latitude, 164°00' W longitude; and 23°00' N latitude, 165°00' W longitude.
(2) Gardner Pinnacles Lobster Grounds - waters bounded by straight lines connecting the following coordinates in the order presented: 25°20' N latitude, 168°20' W longitude; 25°20' N latitude, 167°40' W longitude; 24°20' N latitude, 167°40' W longitude; and 24°20' N latitude, 168°20' W longitude.
(3) Maro Reef Lobster Grounds - waters bounded by straight lines connecting the following coordinates in the order presented: 25°40' N latitude, 171°00' W longitude; 25°40' N latitude, 170°20' W longitude; 25°00' N latitude, 170°20' W longitude; and 25°00' N latitude, 171°00' W longitude.
(4) General NWHI Lobster Grounds - all waters within Crustaceans Permit Area 1 except for the Necker Island, Gardner Pinnacles, and Maro Reef Lobster Grounds.

Crustaceans Permit Area 1 VMS Subarea means an area within the EEZ off the NWHI 50 nm from the center geographical positions of the islands and reefs in the NWHI as follows: Nihoa Island 23°05' N latitude, 161°55' W longitude; Necker Island 23°35' N latitude, 164°40' W longitude; French Frigate Shoals 23°45' N latitude, 166°15' W longitude; Gardner Pinnacles 25°00' N latitude, 168°00' W longitude; Maro Reef 25°25' N latitude, 170°35' W longitude; Laysan Island 25°45' N latitude, 171°45' W longitude; Lisianski Island 26°00' N latitude, 173°55' W longitude; Pearl and Hermes Reef 27°50' N latitude, 175°50' W longitude; Midway Islands 28°14' N latitude, 177°22' W longitude; and Kure Island 28°25' N latitude, 178°20' W longitude. The remainder of the VMS subarea is delimited by parallel lines tangent to and connecting the 50 nm areas around the following: from Nihoa Island to Necker Island; from French Frigate Shoals to Gardner Pinnacles; from Gardner Pinnacles to Maro Reef; from Laysan Island to Lisianski Island; and from Lisianski Island to Pearl and Hermes Reef.

5.4.2 Permit and Reporting Requirements

Each vessel used to fish for deepwater shrimp in Permit Areas 1 or 2 must have a permit issued for that vessel.

Each vessel used to fish for lobster in Permit Area 1 must have a limited access permit issued for such vessel and only one permit will be assigned to any vessel. The owner of any vessel used to fish for lobster in Permit Area 2 or Permit Area 3 must have a permit issued for such a vessel. No vessel owner will have permits for a single vessel to harvest lobsters in Permit Areas 1 and 2 at the same time. A limited access permit is valid for fishing only in Permit Area 1.

To obtain a permit, an application must be submitted to the NMFS Pacific Islands Regional Office. If the application for a limited access permit is submitted on behalf of a partnership or corporation, the application must be accompanied by a supplementary information sheet obtained from NMFS and contain the names and mailing addresses of all partners or shareholders and their respective percentage of ownership in the partnership or corporation. A maximum of 15 limited access permits can be valid at any time.

Permits may be transferred or sold, but no one individual, partnership or corporation will be allowed to hold a whole or partial interest in more than one permit, except that an owner who qualifies initially for more than one permit may maintain those permits, but may not obtain additional permits. Layering of partnerships or corporations shall not insulate a permit holder from this requirement. If 50 percent or more of the ownership of a limited access permit is passed to persons other than those listed on the permit application, NMFS must be notified of the change in writing and provided copies of the appropriate documents confirming the changes within 30 days. Upon the transfer or sale of a limited access permit, a new application must be submitted by the new permit owner. The transferred permit is not valid until this process is completed.

A limited access permit may, without limitation as to frequency, be transferred by the permit holder to a replacement vessel owned by that person. The NMFS Regional Administrator may issue limited access permits under this section when fewer than 15 vessel owners hold active permits. When the Regional Administrator has determined that limited access permits may be issued to new persons, a notice shall be placed in the Federal Register, and other means will be used to notify prospective applicants of the opportunity to obtain permits under the limited access management program. A period of 90 days will be provided after publication of the Federal Register notice for submission of new applications for a limited access permit. First priority to receive limited access permits goes to owners of vessels that were used to land lobster from Permit Area 1 during the period 1983 through 1990, and who were excluded from the fishery by implementation of the limited access system. If there are insufficient permits for all such applicants, the new permits shall be issued by the NMFS Regional Administrator through a lottery. Second priority to receive limited access permits goes to owners with the most points, based upon a point system. If two or more owners have the same number of points and there are insufficient permits for all such owners, the NMFS Regional Administrator shall issue the permits through a lottery.

Under the point system, limited access permits will be issued, in descending order, beginning with owners who have the most points and proceeding to owners who have the least points, based on the following: three points shall be assigned for each calendar year after August 8, 1985, that the applicant was the operator of a vessel that was used to land lobster from Permit Area 1; two points shall be assigned for each calendar year or partial year after August 8, 1985, that the applicant was the owner, operator, or crew member of a vessel engaged in either commercial fishing in Permit Area 2 for lobster, or fishing in Permit Area 1 for fish other than lobster with an intention to sell all or part of the catch; and one point shall be assigned for each calendar year or partial year after August 8, 1985, that the applicant was the owner, operator, or crew member of a vessel engaged in any other commercial fishing in the EEZ surrounding

Hawaii. In addition, the holder of a new limited access permit must own at least a 50-percent share in the vessel that the permit would cover.

The operator of any fishing vessel must maintain on board the vessel an accurate and complete record of catch, effort, and other data on report forms provided by the NMFS Regional Administrator. All information specified on the forms must be recorded on the forms within 24 hours after the completion of each fishing day. The original logbook form for each day of the fishing trip must be submitted to the Regional Administrator within 72 hours of each landing of crustacean management unit species. Each form must be signed and dated by the fishing vessel operator. Fishery participants have the option of using NMFS approved electronic logbooks in lieu of paper logbooks.

The operator of any fishing vessel must submit to the Regional Administrator, within 72 hours of offloading of crustacean management unit species, an accurate and complete sales report on a form provided by the Regional Administrator. The form must be signed and dated by the fishing vessel operator.

The operator of any fishing vessel must attach packing or weigh-out slips provided to the operator by the first-level buyer(s), unless the packing or weigh-out slips have not been provided in time by the buyer(s). Upon request, any first-level buyer must immediately allow an authorized officer and any employee of NMFS designated by the Regional Administrator, to access, inspect, and copy all records relating to the harvest, sale, or transfer of crustacean management unit species taken by vessels that have permits. The information must include, but is not limited to the name of the vessel involved in each transaction and the owner or operator of the vessel; the amount, number and size of each management unit species involved in each transaction; and prices paid by the buyer and proceeds to the seller in each transaction.

5.4.3 Prohibitions

In Permit Area 1, it is unlawful for any person to:
(1) Fish for, take, or retain lobsters without a limited access permit; by methods other than lobster traps or by hand for lobsters; from closed areas for lobsters; during a closed season; after the closure date, and until the fishery opens again in the following calendar year; or in a lobster grounds after closure of that grounds.
(2) Fail to report before landing or offloading.
(3) Fail to comply with any protective measures.
(4) Leave a trap unattended in the Management Area.
(5) Maintain on board the vessel or in the water more than 1,200 traps per fishing vessel, of which no more than 1,100 can be assembled traps.
(6) Land lobsters taken in Permit Area 1 after the closure date until the fishery opens again the following year.
(7) Refuse to make available any required records to an authorized officer and employee of NMFS designated by the Regional Administrator for inspection and copying.
(8) Possess on a fishing vessel that has a limited access permit any lobster trap in Crustaceans Permit Area 1 when fishing for lobster is prohibited.

(9) Possess on a fishing vessel that has a limited access permit any lobster trap in Crustaceans Permit Area 1 VMS Subarea when fishing for lobsters is prohibited.
(10) Interfere with, tamper with, alter, damage, disable or impede the operation of a VMS unit or to attempt any of the same while engaged in the Permit Area 1 fishery or to move or remove a VMS unit while engaged in the Permit Area 1 fishery without first notifying the NMFS Regional Administrator.
(11) Make a false statement, oral or written, to the NMFS Regional Administrator or an authorized officer, regarding the certification, use, operation, or maintenance of a VMS unit used in the fishery.
(12) Fail to allow an authorized officer to inspect and certify a VMS unit used in the fishery.
(13) Possess, on a fishing vessel that has a limited access permit, any lobster trap in a lobster grounds that is closed, unless the vessel has an operational VMS unit, certified by NMFS, on board.

In Permit Area 2, it is unlawful for any person to:
(1) Fish for, take, or retain lobsters by methods other than lobster traps or by hand; or during a closed season.
(2) Retain or possess on a fishing vessel any lobster taken in Permit Area 2 that is less than the minimum size.
(3) Possess on a fishing vessel any lobster or lobster part taken in Permit Area 2 in a condition where the lobster is not whole and undamaged.
(4) Retain or possess on a fishing vessel, or remove the eggs from, any egg-bearing lobster.
(5) Possess on a fishing vessel that has a permit for Permit Area 2 any lobster trap in Permit Area 2 when fishing for lobster in the main Hawaiian Islands is prohibited during the months of May, June, July and August.

In any Permit Area, it is unlawful for any person to:
(1) Fish for, take, or retain deepwater shrimp without a permit.
(2) Falsify or fail to make, keep, maintain, or submit Federal reports and records of harvests of deepwater shrimp.

5.4.4 Notifications

Vessel operators must report not less than 24 hours, but not more than 36 hours, before landing, the port, the approximate date and the approximate time at which spiny and slipper lobsters will be landed. They must also report not less than six hours, and not more than twelve hours, before offloading, the location and time that offloading spiny and slipper lobsters will begin. The Regional Administrator will notify permit holders of any change in the reporting method and schedule required at least 30 days prior to the opening of the fishing season.

5.4.5 Size Restrictions

In Permit Area 2 only spiny lobsters with a carapace length of 8.26 cm or greater may be retained and any lobster with a punctured or mutilated body, or a separated carapace and tail, may not be retained. In addition, a female lobster of any size may not be retained if it is carrying eggs externally and eggs may not be removed from female lobsters.

5.4.6 Closed Seasons

Lobster fishing is prohibited in Permit Area 1 during the months of January through June, inclusive. In Permit Area 2 lobster fishing is prohibited during the months of May, June, July, and August.

5.4.7 Closed Areas

All lobster fishing is prohibited within 20 nm of Laysan Island, and within the EEZ landward of the 10-fathom curve as depicted on National Ocean Survey Charts, Numbers 19022, 19019, and 19016.

5.4.8 Gear Identification and Restrictions

In Permit Area 1, the vessel's official number must be marked legibly on all traps and floats maintained on board the vessel or in the water by that vessel. In Permit Area 1 lobsters may be taken only with lobster traps or by hand. Lobsters may not be taken by means of poisons, drugs, other chemicals, spears, nets, hooks, or explosives. The smallest opening of an entry way of any lobster trap may not allow any sphere or cylinder greater than 6.5 inches (16.5 cm) in diameter to pass from outside the trap to inside the trap. Each lobster trap must have a minimum of two escape vent panels that meet the following requirements: panels must have at least four unobstructed circular holes no smaller than 67 mm in diameter, with centers at least 82 mm apart; the lowest part of any opening in an escape vent panel must not be more than 85 mm above the floor of the trap; and panels must be placed opposite one another in each trap. A vessel fishing for or in possession of lobster in any permit area may not have on board the vessel any trap that does not meet these requirements.

A maximum of 1,200 traps per vessel may be maintained on board or in the water, provided that no more than 1,100 assembled traps are maintained on board or in the water. If more than 1,100 traps are maintained, the unassembled traps may be carried as spares only, in order to replace assembled traps that may be lost or become unusable. Traps shall not be left unattended in any permit area, except in the event of an emergency, in which case the vessel operator must notify the NMFS Law Enforcement Office of the emergency that necessitated leaving the traps on the grounds, and the location and number of the traps, within 24 hours after the vessel reaches port.

A vessel whose owner has a limited access permit and has an operating VMS unit certified by the NMFS may enter Crustaceans Permit Area 1 with lobster traps on board on or after June 25, but must remain outside the Crustaceans Permit Area 1 VMS Subarea until the NWHI lobster season opens on July 1. A vessel whose owner has a limited access permit and has on board an operational VMS unit certified by NMFS may transit Crustaceans Permit Area 1, including Crustaceans Permit Area 1 VMS Subarea, with lobster traps on board for the purpose of moving to another lobster grounds or returning to port following the closure date, providing the vessel does not stop or fish and is making steady progress to another lobster grounds or back to port as determined by NMFS. The operator of a permitted vessel must notify the NMFS Regional Administrator or an authorized officer no later than June 15 of each year if the vessel will use a VMS unit in the fishery and allow for inspection and certification of the unit.

In Permit Area 2 lobsters may be taken only with lobster traps or by hand. Lobsters may not be taken by means of poisons, drugs, other chemicals, spears, nets, hooks, or explosives.

5.4.9 Harvest Limitation Program

Harvest guidelines for the Necker Island Lobster Grounds, Gardner Pinnacles Lobster Grounds, Maro Reef Lobster Grounds, and General NWHI Lobster Grounds for Permit Area 1 will be set annually for the calendar year and shall apply to the total catch of spiny and slipper lobsters and be expressed in terms of numbers of lobsters. The NMFS Regional Administrator shall use information from daily lobster catch reports and lobster sales reports from previous years, and may use information from research sampling and other sources to establish the annual harvest guideline in accordance with the FMP after consultation with the Council. NMFS shall publish a document indicating the annual harvest guideline in the Federal Register by February 28 of each year and shall use other means to notify permit holders of the harvest guideline for the year. The Regional Administrator shall determine, on the basis of the information reported to NMFS by the operator of a vessel fishing, when the harvest guideline for each lobster ground will be reached. Notice of the date when the harvest guideline for a lobster ground is expected to be reached and specification of the closure date will be provided to each permit holder and/or operator of each permitted vessel at least 24 hours in advance of the closure. After a closure, the harvest of lobster in that lobster ground is prohibited, and the possession of lobster traps on board the vessel in that lobster ground is prohibited by any permitted vessel that is not operating a VMS unit certified by NMFS. The operator of each vessel fishing during the open season shall report lobster catch (by species) and effort (number of trap hauls) data while at sea to NMFS in Honolulu. As described above, the designation of the NWHI monument included a requirement that the area's annual harvest guideline be set at zero until 2011, at which time commercial fishing will be prohibited in the monument.

5.4.10 Monk Seal Protective Measures

Upon receipt of a report of a monk seal mortality that appears to be related to the lobster fishery, the NMFS Regional Administrator will notify all interested parties of the facts known about the incident. The Regional Administrator will also notify them that an investigation is in progress, and that, if the investigation reveals a threat of harm to the monk seal population, protective measures may be implemented. The Regional Administrator will investigate the incident reported and will attempt to verify that the incident occurred; determine the extent of the harm to the monk seal population; determine the probability of a similar incident recurring; determine details of the incident such as the number of animals involved, the cause of the mortality, the age and sex of the dead animal(s), the relationship of the incident to the reproductive cycle, for example, breeding season (March-September), non-breeding season (October- February), the population estimates or counts of animals at the island where the incident occurred, and any other relevant information; discover and evaluate any extenuating circumstances; and evaluate any other relevant factors. The Regional Administrator will make the results of the investigation available to the interested parties and request their advice and comments. The Regional Administrator will review and evaluate the results of the investigation and any comments received from interested parties. If there is substantial evidence that the death of the monk seal was related to the lobster fishery, the Regional Administrator will advise the interested parties of his or her conclusion and the facts upon which it is based and request from the interested parties their advice on the necessity of protective measures and suggestions for appropriate protective measures. Protective measures may include, but are not limited to, changes in trap design, changes in gear, closures of specific areas, or closures for specific periods of time.

If the Regional Administrator decides that protective measures are necessary and appropriate, the Regional Administrator will prepare a document that describes the incident, the protective measures proposed, and the reasons for the protective measures; provide it to the interested parties; and request their comments. The Regional Administrator will then recommend the protective measures to the Assistant Administrator and provide notice of this recommendation to the Chairman of the Council and the Director of the Division of Aquatic Resources, Department of Land and Natural Resources, State of Hawaii. If the Assistant Administrator concurs with the Regional Administrator's recommendation, NMFS will publish a notice in the Federal Register that includes a description of the incident that triggered the procedure described in this section, the protective measures to be taken, and the reasons for the protective measures. If, at any point in the process, the Regional Administrator or Assistant Administrator decides that no further action is required, the interested parties will be notified of this decision. The protective measures will take effect 10 days after the date of publication in the Federal Register.

If, at any time during the above process, the Regional Administrator determines that an emergency exists involving monk seal mortality related to the lobster fishery and that measures are needed immediately to protect the monk seal population, the Regional Administrator will notify the interested parties of this determination and request their immediate advice and comments and forward a recommendation for emergency action and any advice and comments received from interested parties to the Assistant Administrator. If the Assistant Administrator agrees with the recommendation for emergency action, the Regional Administrator will determine the appropriate emergency protective measures. NMFS will publish the emergency protective measures in the Federal Register and the Regional Administrator will notify the interested parties of the emergency protective measures. Emergency protective measures are effective for 10 days from the day following the day the first permit holder is notified of the protective measures. Emergency protective measures may be extended for an additional 10 days, if necessary.

5.4.11 At-sea Observer Coverage

All NWHI fishing vessels must carry an observer when requested to do so by the NMFS Regional Administrator. In addition, any fishing vessel (commercial or non-commercial) operating in the territorial seas or EEZ of the U.S. in a fishery identified through NMFS' annual determination process must carry an observer when directed to do so.

5.4.12 Framework Procedures

New management measures may be added through rulemaking if new information demonstrates that there are biological, social, or economic concerns in Permit Areas 1 or 2. By June 30 of each year, the Council-appointed Crustaceans Plan Team will prepare an annual report on the fisheries in the management area. The report shall contain, among other things, recommendations for Council action and an assessment of the urgency and effects of such action(s).

Established measures are management measures that, at some time, have been included in regulations implementing the FMP, and for which the impacts have been evaluated in Council/NMFS documents in the context of current conditions. Following the framework procedures of Amendment 9 to the FMP, the Council may recommend to the NMFS Regional Administrator that established measures be modified, removed, or re-instituted. Such recommendation shall include supporting rationale and analysis, and shall be made after advance public notice, public discussion, and consideration of public comment. NMFS may implement the Council's recommendation by rulemaking if approved by the Regional Administrator.

New measures are management measures that have not been included in regulations implementing the FMP, or for which the impacts have not been evaluated in Council/NMFS documents in the context of current conditions. Following the framework procedures of Amendment 9 to the FMP, the Council will publicize, including by a Federal Register document, and solicit public comment on, any proposed new management measure. After a Council meeting at which the measure is discussed, the Council will consider recommendations and prepare a Federal Register document summarizing the Council's deliberations, rationale, and analysis for the preferred action, and the time and place for any subsequent Council meeting(s) to consider the new measure. At subsequent public meeting(s), the Council will consider public comments and other information received to make a recommendation to the Regional Administrator about any new measure. NMFS may implement the Council's recommendation by rulemaking if approved by the Regional Administrator.

5.4.13 Bycatch Measures

Bycatch of non-targeted species account for a small percentage of the total catch in the NWHI lobster fishery. This is due to the requirement that all lobster traps fished in the NWHI are required to be equipped with escape vents. In addition, to prevent the entrapment of juvenile monk seals, the smallest opening of an entry way ma not allow any sphere or cylinder greater than 6.5 inches in diameter to pass from outside the trap to inside the trap. Section 5.5.10 describes measures which would be taken if the lobster fishery interacted in any way with a Hawaiian monk seal. Bycatch in the MHI is also likely to be low as the most common harvest method for MHI lobsters is hand harvest, however details on gear types and bycatch are not available. No specific measures are currently needed to reduce interactions with the other protected species groups based on the absence of interactions.

5.4.14 Application of National Standard 1

MSY Control Rule

The MSY control rule is used as the MFMT. The specifications for MFMT, MSST, and B_{FLAG} are specified as indicated in Table 23. The MFMT is more conservative than the default recommendation in Restrepo et al. (1998), as the inflection point would be at a higher level of B (B_{MSY} rather than some level less than B_{MSY}). The MSST specification is based on the default recommendation of Restrepo et al. (1998) and is dependent on the natural mortality rate (M). The value of M to be used to determine the MSST is not specified in this document. The latest estimate, published annually in the SAFE report, is used, and the value is occasionally re-estimated using the best available information.

Table 23: Overfishing Threshold Specifications: NWHI Lobster Stocks

MFMT	MSST	B_{FLAG}
$F(B) = \frac{F_{MSY} B}{B_{MSY}}$ for $B \leq B_{MSY}$ $F(B) = F_{MSY}$ for $B > B_{MSY}$	$c\ B_{MSY}$	B_{MSY}
where c = max (1-M, 0.5)		

Target Control Rule and Reference Points

While there is an established OY, it is quantified or in the form of a target control rule for lobster stocks of the Hawaii Archipelago.

Rebuilding Control Rule and Reference Points

A rebuilding control rule is specified for the NWHI lobster stocks such that for levels of B where the rebuilding control rule is applicable (i.e., between 0 and the rebuilding target, B_{MSY}), as specified in Table 24.

Table 24: Rebuilding Control Rule Specifications: NWHI Lobster Stocks

$F_{REBUILDING}$
$F(B) = 0$ for $B \leq c\ B_{MSY}$ $F(B) = \frac{r\ F_{MSY} B}{B_{MSY}}$ for $c\ B_{MSY} < B \leq B_{MSY}$
where c = max (1-M, 0.5) and r is the value such that fishing at $r\ F_{MSY}$ would result in a 10% chance of SPR falling to 0.20

Stock Status Determination Process

Stock status determinations involve three procedural steps. First, the appropriate MSY, target or rebuilding reference points are specified. However, because environmental changes may affect the productive capacity of the stocks, it may be necessary to occasionally modify the specifications of some of the reference points or control rules. Modifications may also be desirable when better assessment methods become available, when fishery objectives are modified (e.g., OY), or better biological, socio-economic, or ecological data become available.

Second, the values of the reference points are estimated and third, the status of the stock is determined by estimating the current or recent values of fishing mortality and stock biomass or their proxies and comparing them with their respective reference points.

The second step (including estimation of M, on which the values of the overfishing thresholds would be dependent) and third step will be undertaken by NMFS and the latest results published annually in the Stock Assessment and Fishery Evaluation (SAFE) report. In practice, the second and third steps may be done simultaneously—in other words, the reference point values could be re-estimated as often as the stocks' status. No particular stock assessment period or schedule is specified, but in practice the assessments are likely be conducted annually in coordination with the preparation of the annual SAFE report.

The best information available is used to estimate the values of the reference points and to determine the status of stocks in relation to the status determination criteria. The determinations are based on the latest available stock and fishery assessments. Information used in the assessments includes logbook data, vessel observer data, and the findings of fishery-independent surveys when they are conducted.

Measures to Address Overfishing and Overfished Stocks

At present, no crustacean stocks in Hawaii have been determined to be overfished or that overfishing is occurring. If in the future it is determined that overfishing is occurring, a stock is overfished, or either of those two conditions is being approached, the Council will establish additional management measures using the FEP amendment process or the framework adjustment process. One important potential measure that would be considered is adjustments to the harvest rate. Other potential measures that would be considered include additional area closures and adjustments to the NWHI seasonal closure.

The combination of control rules and reference points is illustrated in Figure 22. Note that the positions of the MSST and F_{OY} are illustrative only; their values would depend on the best estimates of M and *r* at any given time. As noted in Section 4.3.3, the NWHI lobster fishery has been closed since 2000 due to uncertainty regarding NMFS' population models, as well as the impostion of the NWHI Marine National Monument which stipulates that any commercial lobster fishing permit shall be subject to a zero annual harvest limit.

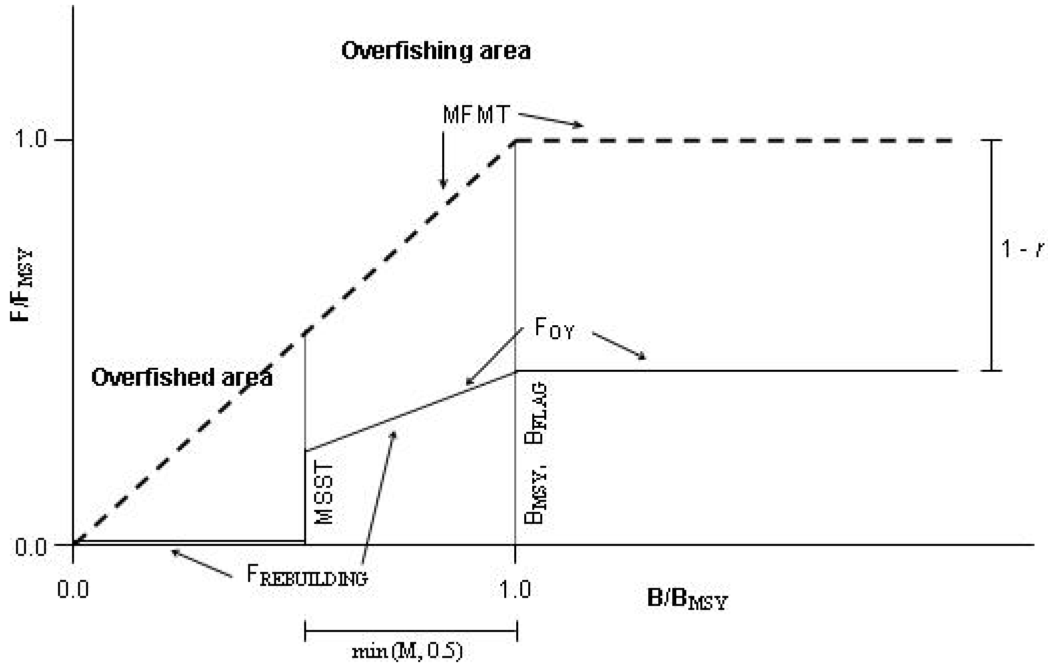

Figure 22: Combination of Control Rules and Reference Points for NWHI Lobster Stocks

5.5 Management Program for Precious Corals Fisheries

5.5.1 Permit and Reporting Requirements

Any vessel of the United States fishing for, taking or retaining precious corals in any precious corals permit area must have a permit. Each permit will be valid for fishing only in the permit area. No more than one permit will be valid for any one person at any one time. The holder of a valid permit to fish one permit area may obtain a permit to fish another permit area only upon surrendering to the NMFS Regional Administrator any current permit for the precious corals fishery.

The operator of any fishing vessel must maintain on board the vessel an accurate and complete record of catch, effort, and other data on report forms provided by the NMFS Regional Administrator. All information specified on the forms must be recorded on the forms within 24 hours after the completion of each fishing day. The original logbook form for each day of the fishing trip must be submitted to the Regional Administrator within 72 hours of each landing of precious corals management unit species. Each form must be signed and dated by the fishing vessel operator. Fishery participants have the option of using NMFS approved electronic logbooks in lieu of paper logbooks.

5.5.2 Seasons and Quotas

The fishing year for precious corals begins on July 1 and ends on June 30 the following year, except at the Makapuu and Auʻau Channel Beds, which have a two-year fishing period that begins July 1 and ends June 30, two years later. Precious coral permit areas are the areas encompassing the precious coral beds in a management area. Each bed is designated by a permit area code and assigned to one of the following four categories: Established, Conditional, Exploratory or Refugium.

The Makapuʻu and Auʻau Channel Beds are the only two precious coral "Established Beds" in the Hawaii Archipelago.

(i) Makapuʻu (Oahu), Permit Area E-B-1, includes the area within a radius of 2.0 nm of a point at 21° 18.0' N. lat., 157° 32.5' W. long.

(ii) Auʻau Channel (Maui), Permit Area E-B-2, includes the area west and south of a point at 21° 10' N. lat., 156° 40' W. long., and east of a point at 21° N. lat., 157° W. long., and west and north of a point at 20° 45' N. lat., 156° 40' W. long.

A conditional bed will be closed to all nonselective coral harvesting after the quota for one species has been taken. The quotas for exploratory areas will be held in reserve for harvest by vessels of the U.S. by determining at the beginning of each fishing year that the reserve for each of the three exploratory areas will equal the quota minus the estimated domestic annual harvest for that year. As soon as practicable after December 31, each year, the Regional Administrator will determine the amount harvested by vessels of the U.S. between July 1 and December 31 of that year. NMFS will release to TALFF an amount of precious coral for each exploratory area equal to the quota minus the two times amount harvested by vessels of the U.S. in that July 1 to December 31 period. Finally, NMFS will publish in the Federal Register a notification of the Regional Administrator's determination and a summary of the information of which it is based a soon as practicable after the determination is made.

Quotas are determined limiting the amount of precious corals that may be taken in any precious corals permit area during the fishing year. Only live coral is counted toward the quota. Live coral means any precious coral that has live coral polyps or tissue. The quota limiting the amount of precious corals that may be taken in any exploratory bed during the fishing year is 1,000 kg per area, all species combined (except black corals). No fishing for coral is authorized in refugia and there is a five-year moratorium on the harvest of gold coral in any precious coral permit area in effect through June 30, 2013 to allow further studies of the growth rate of this species.

5.5.3 Closures

If the NMFS Regional Administrator determines that the harvest quota for any coral bed will be reached prior to the end of the fishing year, or the end of the 2-year fishing period at Makapuu Bed or Auʻau Channel Bed, NMFS will issue a Federal Register notice closing the bed and the public will be informed through appropriate news media. Any such field order must indicate the reason for the closure, delineate the bed being closed, and identify the effective date of the closure. A closure is also effective for a permit holder upon the permit holder's actual harvest of the applicable quota.

5.5.4 Size Restrictions

The height of a live coral specimen shall be determined by a straight line measurement taken from its base to its most distal extremity. The stem diameter of a living coral specimen shall be determined by measuring the greatest diameter of the stem at a point no less than one inch (2.54

cm) from the top surface of the living holdfast. Live pink coral harvested from any precious corals permit area must have attained a minimum height of 10 inches (25.4 cm). Live black coral harvested from any precious corals permit area must have attained either a minimum stem diameter of 1 inch (2.54 cm), or a minimum height of 48 inches (122 cm).

5.5.5 Area Restrictions

Fishing for coral on the WestPac Bed is not allowed. The specific area closed to fishing is all waters within a 2-nm radius of the midpoint of 23°18.0' N latitude, 162°35.0' W longitude.

5.5.6 Gear Restrictions

Only selective gear may be used to harvest coral from any precious corals permit area. Selective gear means any gear used for harvesting corals that can discriminate or differentiate between type, size, quality, or characteristics of living or dead corals.

5.5.7 Framework Procedures

Established management measures may be revised and new management measures may be established and/or revised through rulemaking if new information demonstrates that there are biological, social, or economic concerns in a precious corals permit area. By June 30 of each year, the Council-appointed Precious Corals Plan Team will prepare an annual report on the fishery in the management area. The report will contain, among other things, recommendations for Council action and an assessment of the urgency and effects of such action(s). Established measures are management measures that, at some time, have been included in regulations implementing the FMP, and for which the impacts have been evaluated in Council/NMFS documents in the context of current conditions. According to the framework procedures of Amendment 3 to the FMP, the Council may recommend to the Regional Administrator that established measures be modified, removed, or re-instituted. Such recommendation will include supporting rationale and analysis and will be made after advance public notice, public discussion, and consideration of public comment. NMFS may implement the Council’s recommendation by rulemaking if approved by the Regional Administrator.

New measures are management measures that have not been included in regulations implementing the FMP, or for which the impacts have not been evaluated in Council/NMFS documents in the context of current conditions. Following the framework procedures of Amendment 3 to the FMP, the Council will publicize, including by a Federal Register document, and solicit public comment on, any proposed new management measure. After a Council meeting at which the measure is discussed, the Council will consider recommendations and prepare a Federal Register document summarizing the Council’s deliberations, rationale, and analysis for the preferred action and the time and place for any subsequent Council meeting(s) to consider the new measure. At a subsequent public meeting, the Council will consider public comments and other information received before making a recommendation to the Regional Administrator about any new measure. If approved by the Regional Administrator, NMFS may implement the Council’s recommendation by rulemaking.

5.5.8 Bycatch Measures

A variety of invertebrates and fish are known to utilize the same habitat as precious corals. Such organisms include *onaga* (*Etelis coruscans*), *kāhala* (*Seriola dumerallii*), and the shrimp (*Heterocarpus ensifer)*, however, there is no evidence that these species or others significantly depend on precious coral beds for shelter or food. Given the highly selective nature of this fishery, and the absence of reported or expected protected species interactions, no specific measures to reduce protected species interactions are considered necessary at this time. In addition any vessel (commercial or non-commercial) operating in the territorial seas or EEZ of the U.S. in a fishery identified through NMFS' annual determination process must carry an observer when directed to do so.

5.5.9 Application of National Standard 1

MSY Control Rule

Pink, gold and bamboo corals occur in all six known beds, although only the "Established" Makapuu Bed has been quantitatively surveyed. While it is believed that harvestable quantities of precious corals may exist in other areas of the Western Pacific Region, no information exists on their distribution, abundance or status.

The definition of overfished for all species of precious corals is when the total spawning biomass is less than or equal to 20 percent of its unfished condition (SPR≤20 percent), based on cohort analysis of the pink coral, *Corallium secundum*. This definition takes into account the mean survivorship, yield, age at maturity, reproductive potential and MSY of the coral populations. It also protects 20 percent of the spawning stock biomass. For beds other than the "Established" Makapuu bed more information is needed before the overfishing definition can be applied.

If recruitment is constant or independent of stock size, then MSY can be determined from controlling the fishing mortality rate (F) to maximize the yield per recruit (MYPR), i.e., MSY = MYPR(g/recruit) x R(recruits/yr)). MYPR is a function of area of the bed, average colony density and natural mortality. If a stock-recruitment relationship exists, recruitment is reduced as a function of reduced stock size, and MSY will also be reduced. The assumption of constant recruitment appears to be reasonable based on the robust recovery and verification of annual growth rings from a recent resurvey (Grigg 1977).

Alternatively, the Gulland (1969) method to estimate MSY is especially useful for gold and bamboo coral, where information on population dynamics is lacking. MSY is 40 percent of the natural mortality rate times virgin stock biomass (estimated from the product of area of the bed, average colony density and weighted average weight of a virgin colony; MSY = 0.4 x M x B). The mortality rate for pink coral (M=0.066) is used as a proxy for other species. Values for species with sufficient information to estimate MSY are summarized in Table 25 below. The estimation of these values is described in Section 4.4.4.

Table 25: Estimates of MSY of Precious Corals in the Makapuu Bed

Species (common name)	MSY (kg/yr)	MSY (rounded)	Method of calculation
Corallium secundum (pink)	1,185	1,000	Beverton and Holt Cohort production model
Corallium secundum (pink)	1,148	1,000	Gulland model
Gerardia spp. (gold)	313	300	Gulland model
Lepidisis olapa (bamboo)	285	250	Gulland model

Harvest quotas for Hawaii's four Conditional Beds have been extrapolated (see Table 26), based on bed size as compared to that of the Makapuu Bed. As discussed in Section 4.4.5, the harvest quotas represent OY values and are based on extrapolations from the rounded down MSY values for the Makapuu Bed.

MSY has also been estimated to correspond to a 30 percent SPR level to maintain 30 percent of the spawning stock biomass. The Council currently manages at the MSY level. From the mid-1960s to late 1970s, annual landings from the Makapuu bed averaged 685 kg (below the MSY of 1,000 kg). No known harvesting of precious corals has occurred in the U.S. EEZ for the past 20 years. The 1997 resurvey found that pink coral in the Makapuu bed has recovered to 74-90 percent of its pristine biomass, while recruitment of gold coral is low.

Table 26: Precious Coral Harvest Quotas

Type of coral bed	Name of coral bed	Harvest quota in kilograms	Number of years
Established Beds	Auau Channel	Black: 5,000	2
	Makapuu	Pink: 2,000 Gold: 0 (zero) Bamboo: 500	2 -- 2
Conditional Beds	180 Fathom Bank	Pink: 222 Gold: 67 Bamboo: 56	1 1 1
	Brooks Bank	Pink: 17 Gold: 133 Bamboo: 111	1 1 1
	Kaena Point	Pink: 67 Gold: 20 Bamboo: 17	1 1 1
	Keahole Point	Pink: 67 Gold: 20 Bamboo: 17	1 1 1

Refugia	Westpac	All: 0 (zero)	--
Exploratory Areas	Hawaii, American Samoa, Guam, CNMI, U.S. Pacific Remote Island Areas	1,000 per area (all species combined except black corals)	1

Notes:
1. The final rule implementing the FMP lists the harvest quota for pink coral at Brooks Bank as 17 kg. This is a typographical error; the correct harvest quota is 444 kg.
2. No fishing for coral is authorized in refugia.
3. A moratorium on gold coral harvesting is in effect through June 30, 2013.

Measures to Address Overfishing and Overfished Stocks

At present no stocks of precious corals have been determined to be overfished or that overfishing is occurring. The provisions of the Precious Corals FMP, including minimum sizes and harvest quotas are sufficient to prevent overfishing and these measures are carried over into this FEP. Precious coral beds are classified as Established (with fairly accurate estimated harvest levels), Conditional (with extrapolated MSY estimates) and Refugia (reproductive reserves or baseline areas). Exploratory Areas are all other EEZ waters and are available for harvesting with an Exploratory Permit, subject to the above quotas.

5.6 Management Program for Coral Reef Ecosystem Fisheries

5.6.1 Permit and Reporting Requirements

Special permits are required for any directed fisheries on potentially harvested coral reef taxa (PHCRT) or to fish for any CRE MUS with any gear not normally permitted. Those issued a Federal permit to fish for non-CRE MUS but who incidentally catch CRE MUS are exempt from the CRE permit requirement. Those fishing for currently harvested coral reef taxa (CHCRT) outside of an MPA and do not retain any incidentally-caught PHCRT, or any person collecting marine organisms for scientific research are also exempt from the CRE permit requirement. Permits are only valid for fishing in the fishery management subarea specified on the permit.

The harvest of live rock and living corals is prohibited throughout the federally managed U.S. EEZ waters of the region; however, under special permits with conditions specified by NMFS following consultation with the Council, indigenous people could be allowed to harvest live rock or coral for traditional uses, and aquaculture operations could be permitted to harvest seed stock. A Federal reporting system for all fishing under special permits is in place. Fishery participants have the option of using NMFS approved electronic logbooks in lieu of paper logbooks. Resource monitoring systems administered by state, territorial, and commonwealth agencies continue to collect fishery data on the existing coral reef fisheries that do not require special permits.

5.6.2 Notification

Any special permit holder must contact the appropriate NMFS enforcement agent in Hawaii at least 24 hours before landing any CRE MUS harvested under a special permit, and report the port and the approximate date and time at which the catch will be landed.

5.6.3 Gear Restrictions

Allowable gear types include: (1) Hand harvest; (2) spear; (3) slurp gun; (4) hand/dip net; (5) hoop net for Kona crab; (6) throw net; (7) barrier net; (8) surround/purse net that is attended at all times; (9) hook-and-line (powered and unpowered handlines, rod and reel, and trolling); (10) crab and fish traps with vessel ID number affixed; and (11) remote operating vehicles/submersibles. New fishing gears that are not included in the allowable gear list may be allowed under the special permit provision. CRE MUS may not be taken by means of poisons, explosives, or intoxicating substances. Possession and use of these materials is prohibited.

All fish and crab trap gear used by permit holders must be identified with the vessel number. Unmarked traps and unattended surround nets or bait seine nets found deployed in the CRE regulatory area will be considered unclaimed property and may be disposed of by NMFS or other authorized officers.

5.6.4 Framework Procedures

A framework process, providing for an administratively simplified procedure to facilitate adjustments to management measures previously analyzed in the CRE FMP, is an important component of the FEP. These framework measures include designating "no-anchoring" zones and establishing mooring buoys, requiring vessel monitoring systems on board fishing vessels, designating areas for the sole use of indigenous peoples, and moving species from the PHCRT to the CHCRT list when sufficient data has been collected. A general fishing permit program could also be established for all U.S. EEZ coral reef ecosystem fisheries under the framework process.

The framework process can be used for either established or new measures. Established measures are management measures that, at some time, have been included in regulations implementing the FMP or FEP, and for which the impacts have been evaluated in Council/NMFS documents in the context of current conditions. Under these conditions, the Council may recommend to the NMFS Regional Administrator that established measures be modified, removed, or re-instituted. Such recommendation shall include supporting rationale and analysis, and shall be made after advance public notice, public discussion, and consideration of public comment. NMFS may implement the Council's recommendation by rulemaking if approved by the Regional Administrator.

New measures are management measures that have not been included in regulations implementing the FMP or FEP, or for which the impacts have not been evaluated in Council/NMFS documents in the context of current conditions. The Council will publicize, including by a Federal Register document, and solicit public comment on, any proposed new management measure. After a Council meeting at which the measure is discussed, the Council will consider recommendations and prepare a Federal Register document summarizing the Council's deliberations, rationale, and analysis for the preferred action, and the time and place for any subsequent Council meeting(s) to consider the new measure. At subsequent public meeting(s), the Council will consider public comments and other information received to make a recommendation to the Regional Administrator about any new measure. NMFS may implement the Council's recommendation by rulemaking if approved by the Regional Administrator.

5.6.5 Bycatch Measures

Almost all coral reef fishes caught in Hawaii are considered food fishes and are kept, regardless or size or species. There is no specific information available on bycatch from coral reef fisheries, particularly inshore fisheries. However implementation of Federal prohibitions on the use of non-selective fishing methods including bottom trawls, bottom gillnets, explosive and poisons are intended to reduce or avoid bycatch in this fishery in EEZ waters. These restrictions further reduce the potential for bycatch in this fishery. In addition any fishing vessel (commercial or non-commercial) operating in the territorial seas or EEZ of the U.S. in a fishery identified through NMFS' annual determination process must carry an observer when directed to do so.

5.6.6 Other Measures

There are other non-regulatory measures consistent with plan objectives that are being undertaken by the Council outside of the regulatory regime. These include a process and criteria for EFH consultations; formal plan team coordination to identify and to address coral reef ecosystem impacts from existing fisheries; a system to facilitate consistent state and territorial level management; and research and education efforts.

5.6.7 Application of National Standard 1

MSY Control Rule

Available biological and fishery data are limited for most coral reef ecosystem management unit species in the Hawaii Archipelago. There is scant information on the life histories, ecosystem dynamics, fishery impact, community structure changes, yield potential, and management reference points for many coral reef ecosystem species. Additionally, total fishing effort cannot be adequately partitioned between the various management unit species (MUS) for any fishery or area. Biomass, maximum sustainable yield, and fishing mortality estimates are not available for any single MUS. Once these data are available, fishery managers will then be able to establish limits and reference points based on the multi-species coral reef ecosystem as a whole.

When possible, the MSY control rule should be applied to the individual species in a multi-species stock. When this is not possible, MSY may be specified for one or more species; these values can then be used as indicators for the multi-species stock's MSY.

Clearly, any given species that is part of a multi-species complex will respond differently to an OY-determined level of fishing effort (F_{OY}). Thus, for a species complex that is fished at F_{OY}, managers still must track individual species' mortality rates in order to prevent species-specific population declines that would lead to excessive stock depletion. For the coral reef fisheries, the multi-species complex as a whole is used to establish limits and reference points for each area.

When possible, available data for a particular species is used to evaluate the status of individual MUS stocks in order to prevent recruitment overfishing. When better data and the appropriate multi-species stock assessment methodologies become available, all stocks will be evaluated independently, without proxy.

Establishing Reference Point Values

Standardized values of catch per unit effort (CPUE) and effort (E) are used to establish limit and reference point values, which act as proxies for relative biomass and fishing mortality, respectively. Limits and reference points are calculated in terms of $CPUE_{MSY}$ and E_{MSY} included in Table 27.

Table 27: CPUE-based Overfishing Limits and Reference Points: Coral Reef Species

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

When reliable estimates of E_{MSY} and $CPUE_{MSY}$ are not available, they are estimated from the available time series of catch and effort values, standardized for all identifiable biases using the best available analytical tools. $CPUE_{MSY}$ is calculated as one-half a multi-year moving average reference CPUE ($CPUE_{REF}$). This value has not been finalized yet; however, preliminary values from the types of commercial fishery data (not including aquarium or aquaculture fisheries) presently available for Hawaii are shown in Figures 23-25. These are time series of data from the State of Hawaii commercial catch reports, screened to include only CHCRT from all gear types for the entire area of the MHI. CPUE is estimated as the aggregate weight reported for that year, divided by the number of records for that year. A twenty-year time window is used for the multi-year average. Figure 23 presents all CHCRT in aggregate. Figure 24 is for *menpachi* (*Myripristis* spp.) while Figure 25 is for *weke* (*Mulloidichthys* spp.). These two latter examples were chosen because they are well-represented in the catch report database. $CPUE_{REF}$ and E_{MSY} could be estimated directly from this, as shown in the figures. Alternatively, following Restrepo *et al.* (1998), they could be estimated as $E_{MSY} = E_{AVE}$, where E_{AVE} represents the long-term average effort prior to declines in CPUE. When multiple estimates are available, the more precautionary value will be used. All values will be calculated using the best available data. When new data become available, reference point values will be recalculated.

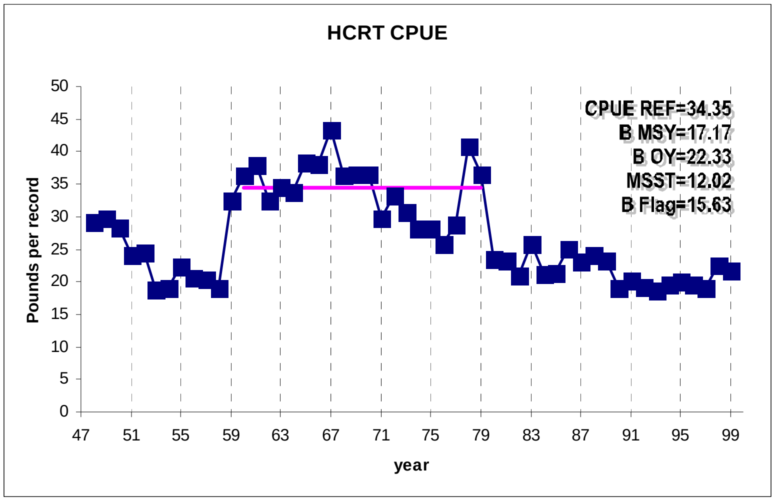

Figure 23: Time Series of Aggregate CHCRT CPUE from HDAR Data

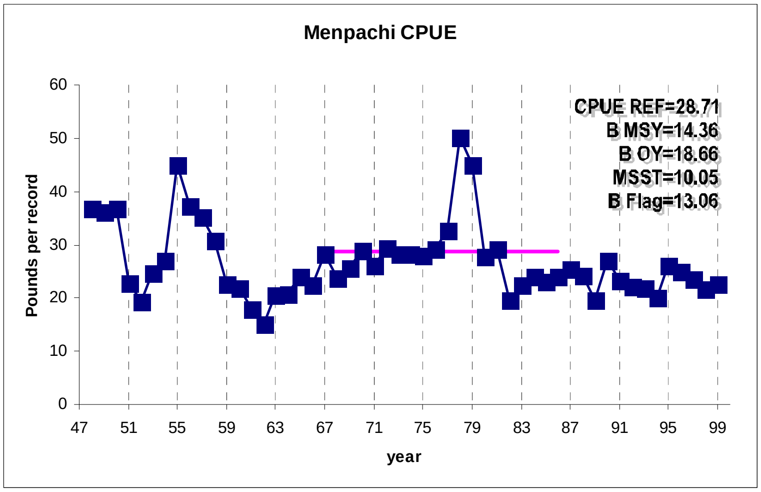

Figure 24: Time Series of Menpachi (*Myripristis* spp.) CPUE from HDAR Data

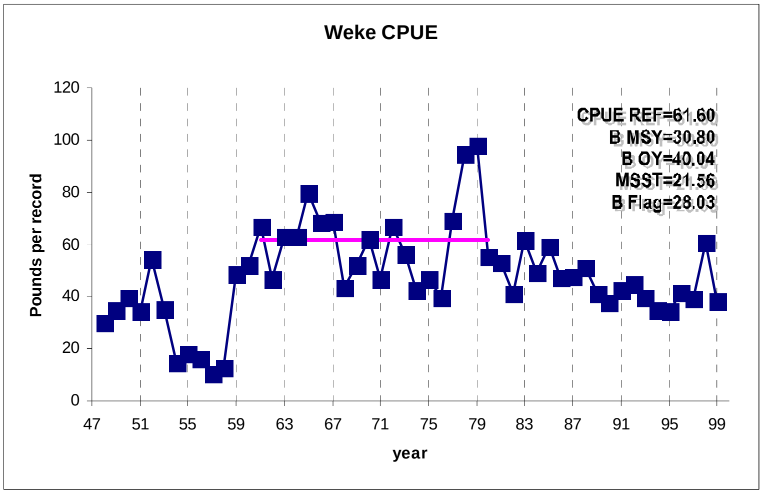

Figure 25: Time Series of Weke (*Mulloidichthys* spp.) CPUE from HDAR Data

Measures to Address Overfishing and Overfished Stocks

At present, no CRE stocks in the Hawaii Archipelago have been determined to be overfished or that overfishing is occurring. If in the future it is determined that overfishing is occurring, a stock is, or either of those two conditions is being approached, the Council will establish additional management measures. Measures that may be considered include additional area closures, seasonal closures, establishment of limited access systems, limits on catch per trip, limits on effort per trip, and fleet-wide limits on catch or effort.

The limits and reference points illustrated in Figure 23 can be applied to both multi-species stocks and to individual component species stocks, realizing however, that much of the data in the State of Hawaii commercial catch reports are often at the genus or family level. As stated earlier, while managing the multi-species stock to provide maximum benefit, fishery managers must also ensure that the resulting fishing mortality rate does not result in excessive stock depletion. Preventing recruitment overfishing on any component stock will satisfy this need in a precautionary manner. Best available data are used for each fishery to estimate these values. These reference points are related primarily to recruitment overfishing and are expressed in units such as spawning potential ratio or spawning stock biomass. However, no examples can be provided at present. Species' for which managers have collected extensive survey data and know their life history parameters, such as growth rate and size at reproduction, are the best candidates for determining these values.

Using the best available data, managers will monitor changes in species abundance and/or composition. They will pay special attention to those species they consider important because of their trophic level or other ecological importance to the larger community. For Hawaii, a preliminary approach aggregates HDAR data into two five-year bins for comparison, an early bin comprising 1948-1952 and a recent bin comprising 1995-1999. Table 28 ranks coral reef ecosystem management unit species based on their proportion of total commercial fishery landings (not including aquarium or aquaculture fisheries) in the 1948-1952 data bin. Although it is difficult to draw definitive conclusions from this exercise, the differences in the landings data indicate, in a preliminary way, how in an exploited ecosystem species composition has changed over time.

Table 28: Change in Landings for Selected Hawaii CHCRT, 1948-1952 vs. 1995-1999
Note: Species are ranked based on 1948-1952 landings

Hawaiian, English & Latin names	1948-1952 aggregate			1995-1999 aggregate		
	Pounds	%	Rank	Pounds	%	Rank
Menpachi, soldierfish (*Myripristis* spp.)	415,252	18.54	1	218,781	15.04	1
Ama ama, striped mullet (*Mugil cephalus*)	321,480	14.35	2	27,285	1.88	12
Weke, yellow goatfish (*Mulloidichthys* spp.)	305,108	13.62	3	148,149	10.18	4
Moano, banded goatfish (*Parupeneus* spp.)	172,493	7.70	4	20,656	1.42	19
Wekeula, Pflueger's goatfish (*Mulloidichthys* spp.)	101,189	4.52	5	104,909	7.21	5
Moi, threadfin (*Polydactylus sexfilis*)	96,385	4.30	6	5,126	0.35	28
Manini, convict tang (*Acanthurus triostegus*)	88,335	3.94	7	70,448	4.84	7
Kumu, whitesaddle goatfish (*Parupeneus porphyreus*)	86,445	3.86	8	23,620	1.62	13
Kawelea, Hellers barracuda (*Sphyraena helleri*)	84,075	3.75	9	15,589	1.07	21
Kaku, great barracuda (*Sphyraena barracuda*)	82,062	3.66	10	14,847	1.02	22
Tako, octopus (*Octopus* spp.)	80,950	3.61	11	98,016	6.74	6
Uhu, parrotfish (*Scaridae*)	49,795	2.22	12	159,252	10.95	3
Pualu, yellowfin surgeonfish (*Acanthurus xanthopterus, A. blochii*)	46,338	2.07	13	28,020	1.93	11
Palani, eyestriped surgeonfish (*Acanthurus dussumieri*)	43,054	1.92	14	165,164	11.35	2
Aweoweo, bigeye (Priacanthidae)	32,058	1.43	15	22,133	1.52	14
Aholehole, flagtail (*Kuhlia sandvicensis*)	31,637	1.41	16	21,627	1.49	18
Kala, unicornfish (*Naso* spp.)	27,727	1.24	17	66,686	4.58	8

Hawaiian, English & Latin names	1948-1952 aggregate			1995-1999 aggregate		
	Pounds	%	Rank	Pounds	%	Rank
Nenue, rudderfish (*Kyphosus* spp.)	27,156	1.21	18	56,628	3.89	9
Puhiuha, conger eel (*Conger cinereus*)	20,616	0.92	19	1,378	0.09	33
Aawa, hogfish (*Bodianus bilunulatus*)	20,173	0.90	20	13,576	0.93	25
Nabeta, razorfish (*Xyrichthys* spp., *Cymolutes lecluse*)	17,559	0.78	21	22,014	1.51	15
Mu, porgy (*Monotaxis grandoculis*)	15,937	0.71	22	11,479	0.79	26
Uouoa, false mullet (*Neomyxus leuciscus*)	15,873	0.71	23	2,658	0.18	30
Humuhumu, triggerfish (Balistidae)	14,460	0.65	24	873	0.06	36
Kamanu, rainbow runner (*Elagatis bipinnulatus*)	10,540	0.47	25	21,867	1.50	17
Maiko, bluelined surgeonfish (*Acanthurus nigroris*)	10,067	0.45	26	17,953	1.23	20
Alaihe, squirrelfish (*Neoniphon* spp., *Sargocentron* spp.)	9,718	0.43	27	1,376	0.09	34
Panuhunuhu, parrotfish (*Calotomus* spp.)	8,117	0.36	28	5,316	0.37	27
Kupoupou, cigar wrasse (*Cheilio inermis*)	2,035	0.09	29	227	0.02	39
Kihikihi, Moorish idol (*Zanclus cornutus*)	1,768	0.08	30	0	0.00	43
Naenae, orangespot surgeonfish (*Acanthurus olivaceus*)	945	0.04	31	28,590	1.97	10
Amaama, summer mullet (*Moolgarda engeli*)	376	0.02	32	421	0.03	38
Pakuikui, Achilles tang (*Acanthurus achilles*)	253	0.01	33	2,233	0.15	32
Kole, goldring surgeonfish (*Ctenochaetus strigosus*)	65	0.00	34	13,882	0.95	23
Maikoiko, whitebar surgeonfish (*Acanthurus leucopareius*)	44	0.00	35	0	0.00	44
Uukanipou, squirrelfish (*Sargocentron spiniferum*)	32	0.00	36	873	0.06	37

Hawaiian, English & Latin names	1948-1952 aggregate			1995-1999 aggregate		
	Pounds	**%**	**Rank**	**Pounds**	**%**	**Rank**
Pala, Yellow tang (*Zebrasoma flavescens*)	23	0.00	37	47	0.00	41
Lauwiliwili, longnose butterflyfish (*Forcipiger* spp.)	11	0.00	38	1	0.00	42
Wekepueo, bandtail goatfish (*Upeneus arge*)	8	0.00	39	60	0.00	40
Opelu kala, unicornfish (*Naso hexacanthus*)	0	0.00	40	22,001	1.51	16
Munu, striped goatfish (*Parupeneus bifasciatus*)	0	0.00	41	1072	0.07	35
Moanokea, blue goatfish (*Parupeneus cyclostomus*)	0	0.00	42	13,821	0.95	24
Roi, seabass (*Cephalopholis* argus)	0	0.00	43	2,304	0.16	31
Poopaa, hawkfish (Cirrhitidae)	0	0.00	44	3,744	0.26	29

CHAPTER 6: IDENTIFICATION AND DESCRIPTION OF ESSENTIAL FISH HABITAT

6.1 Introduction

In 1996, Congress passed the Sustainable Fisheries Act, which amended the MSA and added several new FMP provisions. From an ecosystem management perspective, the identification and description of EFH for all federally managed species were among the most important of these additions.

According to the MSA, EFH is defined as "those waters and substrate necessary to fish for spawning, breeding or growth to maturity." This new mandate represented a significant shift in fishery management. Because the provision required councils to consider a MUS's ecological role and habitat requirements in managing fisheries, it allowed Councils to move beyond the traditional single-species or multispecies management to a broader ecosystem-based approach. In 1999, NMFS issued guidelines intended to assist Councils in implementing the EFH provision of the MSA, and set forth the following four broad tasks:

1. Identify and describe EFH for all species managed under an FMP.
2. Describe adverse impacts to EFH from fishing activities.
3. Describe adverse impacts to EFH from non-fishing activities.
4. Recommend conservation and enhancement measures to minimize and mitigate the adverse impacts to EFH resulting from fishing and non–fishing related activities.

The guidelines recommended that each Council prepare a preliminary inventory of available environmental and fisheries information on each managed species. Such an inventory is useful in describing and identifying EFH, as it also helps to identify missing information about the habitat utilization patterns of particular species. The guidelines note that a wide range of basic information is needed to identify EFH. This includes data on current and historic stock size, the geographic range of the managed species, the habitat requirements by life history stage, and the distribution and characteristics of those habitats. Because EFH has to be identified for each major life history stage, information about a species' distribution, density, growth, mortality, and production within all of the habitats it occupies, or formerly occupied, is also necessary.

The guidelines also state that the quality of available data used to identify EFH should be rated using the following four-level system:

- Level 1: All that is known is where a species occurs based on distribution data for all or part of the geographic range of the species.
- Level 2: Data on habitat-related densities or relative abundance of the species are available.
- Level 3: Data on growth, reproduction, or survival rates within habitats are available.
- Level 4: Production rates by habitat are available.

With higher quality data, those habitats most utilized by a species could be identified, allowing a more precise designation of EFH. Habitats of lesser value to a species may also be essential, depending on the health of the fish population and the ecosystem. For example, if a species is overfished, and habitat loss or degradation is thought to contribute to its overfished condition, all habitats currently used by the species may be essential.

The EFH provisions are especially important because of the procedural requirements they impose on both Councils and federal agencies. First, for each FMP, Councils must identify adverse impacts to EFH resulting from both fishing and non-fishing activities, and describe measures to minimize these impacts. Second, the provisions allow Councils to provide comments and make recommendations to federal or state agencies that propose actions which may affect habitat, including EFH, of a managed species. In 2002, NMFS revised the guidelines by providing additional clarifications and guidance to ease implementation of the EFH provision by Councils.

Based on the best available information on habitats in waters of the Hawaii Archipelago and the existing fisheries, the Council has determined that the fisheries operating in the Hawaii Archipelago are not expected to have adverse impacts on EFH or HAPC for managed species. Continued and future operations of fisheries under the Hawaii Archipelago FEP are not likely to lead to substantial physical, chemical, or biological alterations to the habitat, or result in loss of, or injury to, these species or their prey.

6.2 EFH Designations

The following EFH designations were developed by the Council and approved by the Secretary of Commerce. EFH designations for Bottomfish and Seamount Groundfish, Crustaceans, and Precious Corals were approved by the Secretary on February 3, 1999 (64 FR 19068). EFH designations for Coral Reef Ecosystem MUS were approved by the Secretary on June 14, 2002 (69 FR 8336).

In describing and identifying EFH for Bottomfish and Seamount Groundfish, Crustacean, Precious Coral, Coral Reef Ecosystem, and Pelagic MUS, four alternatives were considered: (1) designate EFH based on the best available scientific information (preferred alternative), (2) designate all waters EFH, (3) designate a minimal area as EFH, and (4) no action. Ultimately, the Council selected Alternative 1 designate EFH based on observed habitat utilization patterns in localized areas as the preferred alternative.

This alternative was preferred by the Council for three reasons. First, it adhered to the intent of the MSA provisions and to the guidelines that have been set out through regulations and expanded on by NMFS because the best available scientific data were used to make carefully considered designations. Second, it resulted in more precise designations of EFH at the species complex level than would be the case if Alternative 2 were chosen. At the same time, it did not run the risk of being arbitrary and capricious as would be the case if Alternative 3 were chosen. Finally, it recognized that EFH designation is an ongoing process and set out a procedure for reviewing and refining EFH designations as more information on species' habitat requirements becomes available.

The Council has used the best available scientific information to describe EFH in text and tables that provide information on the biological requirements for each life stage (egg, larvae, juvenile, adult) of all MUS. Careful judgment was used in determining the extent of the essential fish habitat that should be designated to ensure that sufficient habitat in good condition is available to maintain a sustainable fishery and the managed species' contribution to a healthy ecosystem. Because there are large gaps in scientific knowledge about the life histories and habitat requirements of many MUS in the Western Pacific Region, the Council adopted a precautionary approach in designating EFH to ensure that enough habitats are protected to sustain managed species.

The depth ranges specific life stages have been observed or identified as utilizing were used to designate EFH for bottomfish and crustaceans. In the case of crustaceans, the designation was further refined based on productivity data. The precious corals designation combines depth and bottom type as indicators, but it is further refined based on the known distribution of the most productive areas for these organisms. Species were grouped into complexes because available information suggests that many of them occur together and share similar habitat.

In addition to the narratives, the general distribution and geographic limits of EFH for each life history stage are available in the form of maps. The Council incorporated these data into a geographic information system to facilitate analysis and presentation. More detailed and informative maps will be produced as more complete information about population responses to habitat characteristics (e.g., growth, survival or reproductive rates) becomes available.

At the time the Council's EFH designations were approved by the Secretary, there was not enough data on the relative productivity of different habitats to develop EFH designations based on Level 3 or Level 4 data for any of the Western Pacific Council's MUS. The Council adopted a fifth level, denoted Level 0, for situations in which there is no information available about the geographic extent of a particular managed species' life stage. Subsequently, very limited habitat information has been made available for MUS for the Council to review and use to revise the initial EFH designations previously approved by the Secretary. However, habitat-related studies for bottomfish and precious coral and to a limited extent, crustaceans, are currently ongoing in the NWHI and MHI. Additionally, fish and benthic surveys conducted during the NMFS Coral Reef Ecosystem Division's Pacific-Wide Rapid Assessment and Monitoring Program, along with other near-shore coral reef habitat health assessments undertaken by other agencies, may provide additional information to refine EFH designations for Coral Reef Ecosystem MUS in all island areas, including the Hawaii Archipelago.

For additional details on the life history and habitat utilization patterns of individual Hawaii MUS, please see the EFH descriptions and maps contained in Supplements to Amendment 4, 6, and 10 to the Precious Corals, Bottomfish and Seamount Groundfish, and Crustaceans FMPs respectively (WPRFMC 2002), and the Coral Reef Ecosystems FMP (WPRFMC 2001).

6.2.1 Bottomfish

Except for several of the major commercial species, very little is known about the life histories, habitat utilization patterns, food habits, or spawning behavior of most adult bottomfish and seamount groundfish species. Furthermore, very little is known about the distribution and habitat requirements of juvenile bottomfish.

Generally, the distribution of adult bottomfish in the Western Pacific Region is closely linked to suitable physical habitat. Unlike the U.S. mainland with its continental shelf ecosystems, Pacific islands are primarily volcanic peaks with steep drop-offs and limited shelf ecosystems. The BMUS under the Council's jurisdiction are found concentrated on the steep slopes of deepwater banks. The 100-fathom isobath is commonly used as an index of bottomfish habitat. Adult bottomfish are usually found in habitats characterized by a hard substrate of high structural complexity. The total extent and geographic distribution of the preferred habitat of bottomfish is not well known. Bottomfish populations are not evenly distributed within their natural habitat; instead, they are found dispersed in a non-random, patchy fashion. Deepwater snappers tend to aggregate in association with prominent underwater features, such as headlands and promontories.

There is regional variation in species composition, as well as a relative abundance of the MUS of the deepwater bottomfish complex in the Western Pacific Region. In American Samoa, Guam, and the Northern Mariana Islands, the bottomfish fishery can be divided into two distinct fisheries: a shallow- and a deep-water bottomfish fishery, based on species and depth. The shallow-water (0–100 m) bottomfish complex comprises groupers, snappers, and jacks in the genera *Lethrinus*, *Lutjanus*, *Epinephelus*, *Aprion*, *Caranx, Variola,* and *Cephalopholis.* The deep-water (100–400 m) bottomfish complex comprises primarily snappers and groupers in the genera *Pristipomoides, Etelis, Aphareus, Epinephelus,* and *Cephalopholis*. In Hawaii, the bottomfish fishery targets several species of eteline snappers, carangids, and a single species of grouper. The target species are generally found at depths of 50–270 meters.

To reduce the complexity and the number of EFH identifications required for individual species and life stages, the Council has designated EFH for bottomfish assemblages pursuant to Section 600.805(b) of 62 FR 66551. The species complex designations include deep-slope bottomfish (shallow water and deep water) and seamount groundfish complexes. The designation of these complexes is based on the ecological relationships among species and their preferred habitat. These species complexes are grouped by the known depth distributions of individual BMUS throughout the Western Pacific Region. These are summarized in Table 28.

At present, there are insufficient data on the relative productivity of different habitats to develop EFH designations based on Level 3 or Level 4 data. Given the uncertainty concerning the life histories and habitat requirements of many BMUS, the Council designated EFH for adult and juvenile bottomfish as the water column and all bottom habitat extending from the shoreline to a depth of 400 meters (200 fathoms) encompassing the steep drop-offs and high-relief habitats that are important for bottomfish throughout the Western Pacific Region.

The eggs and larvae of all BMUS are pelagic, floating at the surface until hatching and subject thereafter to advection by the prevailing ocean currents. There have been few taxonomic studies of these life stages of snappers (lutjanids) and groupers (epinepheline serranids). Presently, few larvae can be identified to species. As snapper and grouper larvae are rarely collected in plankton surveys, it is extremely difficult to study their distribution. Because of the existing scientific uncertainty about the distribution of the eggs and larvae of bottomfish, the Council designated the water column extending from the shoreline to the outer boundary of the EEZ to a depth of 400 meters as EFH for bottomfish eggs and larvae throughout the Western Pacific Region.

In the past, a large-scale foreign seamount groundfish fishery extended throughout the southeastern reaches of the northern Hawaiian Ridge. The seamount groundfish complex consists of three species (pelagic armorheads, alfonsins, and ratfish). These species dwell at 200–600 meters on the submarine slopes and summits of seamounts. A collapse of the seamount groundfish stocks has resulted in a greatly reduced yield in recent years. Although a moratorium on the harvest of the seamount groundfish within the EEZ has been in place since 1986, no substantial recovery of the stocks has been observed. Historically, there has been no domestic seamount groundfish fishery.

The life histories and distributional patterns of seamount groundfish are also poorly understood. Data are lacking on the effects of oceanographic variability on migration and recruitment of individual management unit species. On the basis of the best available data, the Council designated the EFH for the adult life stage of the seamount groundfish complex as all waters and bottom habitat bounded by latitude 29°–35° N and longitude 171° E–179° W between 80–600 meters. EFH for eggs, larvae, and juveniles is the epipelagic zone (0-200 m) of all waters bounded by latitude 29°–35° N and longitude 171° E–179° W. This EFH designation encompasses the Hancock Seamounts, part of the northern extent of the Hawaiian Ridge, located 1,500 nautical miles northwest of Honolulu.

6.2.2 Crustaceans

Spiny lobsters are found throughout the Indo-Pacific region. All spiny lobsters in the Western Pacific Region belong to the family Palinuridae. The slipper lobsters belong to the closely related family Scyllaridae. There are 13 species of the genus *Panulirus* distributed in the tropical and subtropical Pacific between 35° N and 35° S. *Panulirus penicillatus* is the most widely distributed, the other three species are absent from the waters of many island nations of the region. The Hawaiian spiny lobster (*P. marginatus*) is endemic to Hawaii and the Johnston Atoll and was the primary species of interest in the NWHI fishery, the principal commercial lobster fishery in the Western Pacific Region. This fishery also targeted the slipper lobster *Scyllarides squammosus.* Three other species of lobster—pronghorn spiny lobster (*Panulirus penicillatus*), ridgeback slipper lobster (*Scyllarides haanii*), and Chinese slipper lobster (*Parribacus antarcticus*)—and the Kona crab, family Raninidae, were taken in low numbers in the NWHI fishery.

In the NWHI, there is wide variation in lobster total density, size, and sex ratio among the different islands. Neither the extent of species interaction between *P. marginatus* and *Scyllarides squammosus* nor the role of density dependent factors in controlling population abundance is known although data strongly suggest that density-dependent increases in the fecundity of spiny lobster larvae have occurred in response to decreases in stock density (DeMartini et al. 2002).

In the MHI, most of the commercial, recreational, and subsistence catches of spiny lobster are taken from waters under state jurisdiction. Between 1984 and 2004, total reported commercial catch landings of lobsters around the MHI were 185,263 pounds with annual landings ranging between 7,000 and 12,000 pounds (Kelly and Messer 2005).

In Hawaii, adult spiny lobsters are typically found on rocky substrate in well-protected areas, in crevices, and under rocks. Unlike many other species of *Panulirus*, the juveniles and adults of *P. marginatus* are not found in separate habitats apart from one another. Juvenile *P. marginatus* recruit directly to adult habitat; they do not utilize a separate shallow-water nursery habitat apart from the adults as do many palinurid lobsters. Similarly, juvenile and adult *P. penicillatus* also share the same habitat. *Panulirus marginatus* is found seaward of the reefs and within the lagoons and atolls of the islands. The reported depth distribution of *P. marginatus* is from 3–200 meters, however, it is most abundant in waters of 90 meters or less. Large adult spiny lobsters are captured at depths as shallow as 3 meters.

In the southwestern Pacific, spiny lobsters are typically found in association with coral reefs. Coral reefs provide shelter as well as a diverse and abundant supply of food items. *Panulirus penicillatus* inhabits the rocky shelters in the windward surf zones of oceanic reefs and moves on to the reef flat at night to forage.

Very little is known about the planktonic phase of the phyllosoma larvae of *Panulirus marginatus*. The oceanographic and physiographic features that result in the retention of lobster larvae within the Hawaii Archipelago are poorly understood. Evidence suggests that fine-scale oceanographic features, such as eddies and currents, serve to retain phyllosoma larvae within the Hawaiian Island chain. While there is a wide range of lobster densities between banks within the NWHI, the spatial distribution of phyllosoma larvae appears to be homogenous (Polovina and Moffitt 1995).

To reduce the complexity and the number of EFH identifications required for individual species and life stages, the Council has designated EFH for crustacean species assemblages. The species complex designations are spiny and slipper lobsters and Kona crab. The designation of these complexes is based on the ecological relationships among species and their preferred habitat.

At present, there is not enough data on the relative productivity of different habitats of CMUS to develop EFH designations based on Level 3 or Level 4 data. There are little data concerning growth rates, reproductive potentials, and natural mortality rates at the various life history stages. The relationship between egg production, larval settlement, and stock recruitment is also poorly understood. Although there is a paucity of data on the preferred depth distribution of phyllosoma larvae in Hawaii, the depth distribution of phyllosoma larvae of other species of *Panulirus* common in the Indo-Pacific region has been documented. Later stages of panulirid phyllosoma larvae have been found at depths between 80 and 120 meters. For these reasons, the Council designated EFH for spiny lobster larvae as the water column from the shoreline to the outer limit of the EEZ down to a depth of 150 meters throughout the Western Pacific Region. The EFH for juvenile and adult spiny lobster is designated as the bottom habitat from the shoreline to a depth of 100 meters throughout the Western Pacific Region. The EFH for deepwater shrimp eggs and larvae is designated as the water column and associated outer reef slopes between 550 m and 700m, and the EFH for juveniles and adults is designated as the outer reef slopes at depths between 300-700 m (see Table 28).

6.2.3 Precious Corals

In the Hawaiian Islands, precious coral beds have been found only in the deep interisland channels and off promontories at depths between 300 and 1,500 meters and 30 and 100 meters. There are currently eight known beds of pink, gold, and bamboo corals including Keahole Point, Makapuu, Kaena Point, Wespac, Brooks Bank, and 180 Fathom Bank; and two recently discovered beds, one near French Frigate Shoals in the NWHI, and a second on Cross Seamount, approximately 150 nm south of Oahu. The approximate areas of six of these eight beds have been determined. These beds are small; only two of them have an area greater than 1 km^2, and the largest is 3.6 km^2 in size. The Ke'ahole Bed off Hawaii's Kona coast, however, is substantially larger than originally thought. Scientists and industry are currently assessing its actual size. Initial calculations appear to increase its size twenty-fold. There are also three known major black coral beds in the Western Pacific Region, in addition to several minor beds (Grigg 1998). Most of these are located in Hawaii's state waters (0-3 nm). However the largest (the Auau Channel Bed) extends into federal waters.

Makapuu is the only bed that has been surveyed accurately enough to estimate MSY. The Wespac bed, located between Necker and Nihoa Islands in the NWHI, has been set aside for use in baseline studies and as a possible reproductive reserve. The harvesting of precious corals is prohibited in this area. Within the Western Pacific Region, the only directed fishery for precious corals has occurred in the Hawaiian Islands. At present, there is no commercial harvesting of precious corals in the EEZ, but several firms have expressed interest.

Precious corals may be divided into deep- and shallow-water species. Deep-water precious corals are generally found between 350 and 1,500 meters and include pink coral (*Corallium secundum*), gold coral (*Gerardia* spp. and *Parazoanthus* spp.), and bamboo coral (*Lepidisis olapa*). Shallow-water species occur between 30 and 100 meters and consist primarily of three species of black coral: *Antipathes dichotoma*, *Antipathes grandis,* and *Antipathes ulex*. In Hawaii, *Antipathes dichotoma* accounts for around 90 percent of the commercial harvest of black coral, and virtually all of it is harvested in state waters.

Precious corals are non–reef building and inhabit depth zones below the euphotic zone. They are found on solid substrate in areas that are swept relatively clean by moderate-to-strong (> 25 cm/sec) bottom currents. Strong currents help prevent the accumulation of sediments, which would smother young coral colonies and prevent settlement of new larvae. Precious coral yields tend to be higher in areas of shell sandstone, limestone, and basaltic or metamorphic rock with a limestone veneer.

Black corals are most frequently found under vertical drop-offs. Such features are common off Kauai and Maui in the MHI, suggesting that their abundance is related to suitable habitat (Grigg

1976). Off Oahu, many submarine terraces that otherwise would be suitable habitat for black corals are covered with sediments. In the MHI, the lower depth range of *Antipathes dichotoma* and *A. grandis* coincides with the top of the thermocline (ca. 100 m; Grigg 1993).

Pink, bamboo, and gold corals all have planktonic larval stages and sessile adult stages. Larvae settle on solid substrate where they form colonial branching colonies. The length of the larval stage of all species of precious corals is unknown. Like other cnidarians, black corals have life cycles that include both asexual and sexual reproduction. Asexual reproduction (budding) builds the colony by adding more living tissue that, in turn, secretes more skeleton. Regular growth rings laid down as the skeleton thickens can be used to estimate the age of the colony. Sexual reproduction involves the production of eggs and sperm to create young that can disperse and settle new areas. Polyps are either male or female, but a single colony may be hermaphroditic, with both male and female polyps. The larval stage, called a planula, can drift with currents until a suitable surface is found. Once the larva settles, it metamorphoses into a polyp form and secretes skeletal material that attaches it to the seafloor. Then it begins budding, creating more polyps that will form a young colony. Asexual reproduction can also occur naturally by fragmentation of branch ends. In one Hawaiian species that have been studied (*A. dichotoma*), the colony may grow about 2.5 inches (6.4 cm) per year. Reproductive maturity may be reached after 10 to 12 years and reproduction may occur annually. A large six-foot (1.8 m) tall coral tree is estimated to be between 30 and 40 years old; a colony life span may be 70 years. Some species may live even longer[22].

On Hawaii's deep reef slopes and throughout the world, black corals host unique communities of marine life. Their tree-like colonies create habitat for crustaceans, bivalves, and fish. Each coral may host a different combination of species. Some residents are commensals --dependent partners that live only on the black coral. Many species in this deep reef community are new to science. The habitat sustaining precious corals is generally believed to be in good condition. However, an alien species called snowflake coral, *Carijoa riisei*, has recently begun smothering native deep reef sea life including precious corals.[23] In 2001 deepwater surveys in the Auau Channel found a maximum impact between 70-110 m where more than 50 percent of black corals had snowflake coral overgrowth (Khang and Grigg 2005). A second survey in 2006 reexamined conditions in the Auau Channel and found that the impact of snowflake corals had not worsened and it was possible that conditions in some areas had stabilized or improved. This led researchers to conclude that the ecological impact of snowflake coral on black corals may have stabilized or possibly abated slightly (Khang 2007).

To reduce the complexity and the number of EFH identifications required for individual species and life stages, the Council designated EFH for precious coral assemblages. The species complex designations are deep- and shallow-water complexes (see Table 28). The designation of these complexes is based on the ecological relationships among the individual species and their preferred habitat.

The Council considered using the known depth range of individual PCMUS to designate EFH, but rejected this alternative because of the rarity of the occurrence of suitable habitat conditions.

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[22] http://www.waquarium.org/MLP/root/pdf/MarineLife/Invertebrates/Cnidarians/BlackCoral.pdf
[23] http://www.cop.noaa.gov/ecosystems/coralreefs/features/fs-2005-12-12-cr.html

Instead, the Council designated the six known beds of precious corals as EFH. The Council believes that the narrow EFH designation will facilitate the consultation process. In addition, the Council designated three black coral beds in the MHI—between Milolii and South Point on Hawaii, Auau Channel between Maui and Lanai, and the southern border of Kauai—as EFH.

6.2.4 Coral Reef Ecosystems

In designating EFH for Coral Reef Ecosystem MUS, the Council used an approach similar to one used by both the South Atlantic and the Pacific Fishery Management Councils. Using this approach, MUS are linked to specific habitat "composites" (e.g., sand, live coral, seagrass beds, mangrove, open ocean) for each life history stage, consistent with the depth of the ecosystem to 50 fathoms and to the limit of the EEZ.

Except for several of the major coral reef associated species, very little is known about the life histories, habitat utilization patterns, food habits, or spawning behavior of most coral reef associated species. For this reason, the Council, through the CRE FMP, designated EFH using a two-tiered approach based on the division of MUS into the Currently Harvested Coral Reef Taxa (CHCRT) and Potentially Harvested Coral Reef Taxa (PHCRT) categories. This is also consistent with the use of habitat composites. Please see the Coral Reef Ecosystems FMP for details on these designations.

Currently Harvested Coral Reef Taxa MUS

In the first tier, EFH has been identified for species that (a) are currently being harvested in state and federal waters and for which some fishery information is available and (b) are likely to be targeted in the near future based on historical catch data. Tables 29-30 summarize the habitat types used by CHCRT species.

To reduce the complexity and the number of EFH identifications required for individual species and life stages, the Council has designated EFH for species assemblages pursuant to 50 CFR 600.815 (a)(2)(ii)(E). The designation of these complexes is based on the ecological relationships among species and their preferred habitat. These species complexes are grouped by the known depth distributions of individual MUS. The EFH designations for CHCRT in Hawaii are summarized in Table 31.

Potentially Harvested Coral Reef Taxa MUS

EFH has also been designated for the second tier, PHCRT. These taxa include literally thousands of species encompassing almost all coral reef fauna and flora. However, there is very little scientific knowledge about the life histories and habitat requirements of the thousands of species of organisms that compose these taxa. In fact, a large percentage of these biota have not been described by science. Therefore, the Council has used the precautionary approach in designating EFH for PHCRT so that enough habitat is protected to sustain managed species. Table 32 summarizes the habitat types used by PHCRT species. The designation of EFH for PHCRT in Hawaii is summarized in Table 33. As with CHCRT, the Council has designated EFH for species assemblages pursuant to the federal regulations cited above.

Table 29: Occurrence of Currently Harvested Management Unit Species
Habitats: Mangrove (Ma), Lagoon (La), Estuarine (Es), Seagrass Beds (SB), Soft substrate (Ss), Coral Reef/Hard Substrate (Cr/Hr), Patch Reefs (Pr), Surge Zone (Sz), Deep-Slope Terraces (DST), Pelagic/Open Ocean (Pe)
Life history stages: Egg (E), Larvae (L), Juvenile (J), Adult (A), Spawners (S)

Species	**Ma**	**La**	**Es**	**SB**	**Ss**	**Cr/Hs**	**Pr**	**Sz**	**DST**	**Pe**
Acanthuridae (surgeonfishes) Subfamily Acanthurinae (surgeonfishes) Orange-spot surgeonfish (*Acanthurus olivaceus*) Yellowfin surgeonfish (*Acanthurus xanthopterus*) Convict tang (*Acanthurus triostegus*) Eye-striped surgeonfish (*Acanthurus dussumieri*) Blue-lined surgeon (*Acanthurus nigroris*) Whitebar surgeonfish (*Acanthurus leucopareius*) Whitecheek surgeonfish (*Acanthurus nigricans*) White-spotted surgeonfish (*Acanthurus guttatus*) Ringtail surgeonfish (*Acanthurus blochii*) Brown surgeonfish (*Acanthurus nigrofuscus*) Yellow-eyed surgeonfish (*Ctenochaetus strigosus*)	J	A, J, S	A, J, S	J	A, J, S	A, J, S	A, J, S	A,J	A, J	E, L

Species	**Ma**	**La**	**Es**	**SB**	**Ss**	**Cr/Hs**	**Pr**	**Sz**	**DST**	**Pe**
Subfamily Nasianae (unicornfishes) Bluespine unicornfish (*Naso unicornus*) Orangespine unicornfish (*Naso lituratus*) Blacktounge unicornfish (*Naso hexacanthus*) Whitemargin unicornfish (*Naso annulatus*) Spotted unicornfish (*Naso brevirostris*) Gray unicornfish (*Naso caesius*)	J	A, J, S	J		A, S	A, J, S	A, J, S		A, S	All
Balistidae (trigger fish) Pinktail triggerfish (*Melichthys vidua*) Black triggerfish (*M. niger*) Picassofish (*Rhinecanthus aculeatus*) Wedged Picassofish (*R.. rectangulus*) Bridled triggerfish (*Sufflamen fraenatus*)	J	A, J, S	J	J		A, J, S	A, J, S	A	A, S	L
Carangidae (jacks) Bigeye scad (*Selar crumenophthalmus*) Mackerel scad (*Decapterus macarellus*)	A, J, S	A, J, S	A, J, S	J	A, J, S	A, J, S	A, J, S	A, J, S	All	E, L
Carcharhinidae Grey reef shark (*Carcharhinus amblyrhynchos*) Galapagos shark (*Carcharhinus galapagenis*) Blacktip reef shark (*Carcharhinus melanopterus*) Whitetip reef shark (*Triaenodon obesus*)	A, J	A, J	A, J	J	A, J	A, J	A, J		A, J	A, J

Species	**Ma**	**La**	**Es**	**SB**	**Ss**	**Cr/Hs**	**Pr**	**Sz**	**DST**	**Pe**
Holocentridae (soldierfish/squirrelfish) Bigscale soldierfish (*Myripristis berndti*) Blotcheye soldierfish (*Myripristis murdjan*) Bricksoldierfish (*Myripristis amaena*) Yellowfin soldierfish (*Myripristis chryseres*) Pearly soldierfish (*Myripristis kuntee*) (*Myripristis hexagona*) File-lined squirrelfish (*Sargocentron microstoma*) Peppered squirrelfish (*Sargocentron punctatissimum*) Blue-lined squirrelfish (*Sargocentron tiere*) Hawaiian squirrelfish (*Sargocentron xantherythrum*) Saber squirrelfish (*Sargocentron spiniferum*) Spotfin squirrelfish (*Neoniphon* spp.)		A, J, S	A, J, S	J		A, J, S	A, J, S		A, S	E, L
Kuhliidae (flagtails) Hawaiian flagtail (*Kuhlia sandvicensis*)	A, J	A, J	A, J	A, J				A		E, L
Kyphosidae (rudderfishes) Highfin chub (*K. cinerascens*) Lowfin chub (*K. vaigiensis*)	J	A, J, S	A, J, S		A, J	A, J, S	A, J, S	A, J		All
Labridae (wrasses) Saddleback hogfish (*Bodianus bilunulatus*)[25] Razor wrasse (*Xyrichtys pavo*)[26]		J	J	A, J	A, J, S	A, J, S	A, J, S		A, J, S	E, L

[25] Randall (2007) followed the taxonomic revision of *Bodianus* by Gomon (2006) in recognizing the Hawaii Archipelago subspecies *Bodianus bilunulatus albotaeniatus* as a distinct and valid species, *B. albotaeniatus*.
[26] *Xyrichtys pavo* and *X. aneitensis* have both now been placed in the genus *Iniistius (Randall 2007)*.

Species	**Ma**	**La**	**Es**	**SB**	**Ss**	**Cr/Hs**	**Pr**	**Sz**	**DST**	**Pe**
Ring-tailed wrasse (*Oxycheilinus unifasciatus*)		A, J			A, J, S	A, J, S	A, J, S		A, J, S	E, L
Cigar wrasse (*Cheilio inermis*)				A, J						E, L
Surge wrasse (*Thalassoma purpureum*) Redribbon wrasse (*Thalassoma quinquevittatum*)		A, J	J		A, J, S	A, J, S		A, J		E, L
Sunset wrasse (*Thalassoma lutescens*)		A, J		J	A, J, S	A, J, S	A, J, S			E, L
Rockmover wrasse (*Novaculichthys taeniourus*)		A, J			A, J, S	A, J, S		A, J		
Mullidae (goatfish) Yellow goatfish (*Mulloidichthys* spp.) (*Mulloidichthys pfleugeri*) (*Mulloidichthys vanicolensis*) (*Mulloidichthys flavolineatus*) Banded goatfish (*Parupeneus spp*.) (*Parupeneus bifasciatus*) (*Parupeneus cyclostomas*) (*Parupeneus pleurostigma*) (*Parupeneus multifaciatus*) Bandtail goatfish (*Upeneus arge*)		A, J	A	A, J	A, J	A, J	A, J			E, L
Octopodidae (octopuses) Day octopus (*Octopus cyanea)* Night octopus (*Octupus ornatus)*	A, J, S	All	A, J, S	All	All	All	All		All	L

Species	**Ma**	**La**	**Es**	**SB**	**Ss**	**Cr/Hs**	**Pr**	**Sz**	**DST**	**Pe**
Mugilidae (mullets) Stripped mullet (*Mugil cephalus)* Engel's mullet (*Moolgarda engeli*) False mullet (*Neomyxus leuciscus*)	J	A, J, S	A, J, S	J		A, J		A		E, L
Muraenidae (moray eels) Yellowmargin moray (*Gymnothorax flavimarginatus*) Giant moray (*Gymnothorax javanicus*) Undulated moray (*Gymnothorax undulatus*)	A, J, S	A, J, S	A, J, S	A, J	A, J, S	A, J, S	A, J, S	A, J, S	E, L	
Polynemidae (threadfins) Threadfin/Moi (*Polydactylus sexfilis*)	A, J	A, J, S	A, J, S		A, J, S			A, J		E, L
Priacanthidae (bigeyes) Glasseye (*Heteropriacanthus cruentatus*) Bigeye (*Priacanthus hamrur*)						A, J	A, J		A, J	E, L
Scaridae (parrotfishes) Parrotfishes (*Scarus* and *Chlorurus* spp.) Stareye parrotfish (*Calotomus carolinus*)	J	A, J, S		A, J		A, J, S	A, J, S			E, L
Sphyraenidae (barracudas) Heller's barracuda (*Sphyraena helleri*) Great barracuda (*Sphyraena barracuda*)	A, J	A, J, S	A, J, S	J		A, J, S	A, J, S		A, S	All

Note: Some species names have been changed recently with updates made per Randall (2007).

Table 30: Occurrence of Currently Harvested Management Unit Species: Aquarium Taxa/Species
Habitats: Mangrove (Ma), Lagoon (La), Estuarine (Es), Seagrass Beds (SB), Soft substrate (Ss), Coral Reef/Hard Substrate (Cr/Hr), Patch Reefs (Pr), Surge Zone (Sz), Deep-Slope Terraces (DST), Pelagic/Open Ocean (Pe)
Life history stages: Egg (E), Larvae (L), Juvenile (J), Adult (A), Spawners (S)

Species	**Ma**	**La**	**Es**	**SB**	**Ss**	**Cr/Hs**	**PR**	**Sz**	**DST**	**Pe**
Acanthuridae (surgeonfishes) Yellow tang (*Zebrasoma flavescens*) Yellow-eyed surgeonfish (*Ctenochaetus strigosus*) Achilles tang (*Acanthurus achilles*)	J	A, J, S	A, J, S	J	A, J, S	A, J, S	A, J, S	A	A, J	E, L
Zanclidae Moorish Idol (*Zanclus cornutus*)	J	A, J, S	J	J		A, J, S	A, J, S			E, L
Muraenidae Dragon moray (*Enchelycore pardalis*)	A, J, S	A, J, S	A, J, S	A, J	A, J, S	A, J, S	A, J, S	A	A, J, S	E, L
Cirrhitidae (hawkfishes) Longnose hawkfish (*Oxycirrhites typus*)		A, J, S				A, J, S	A, J, S	A	A, J, S	E, L
Chaetodontidae (butterflyfishes) Threadfin butterflyfish (*Chaetodon auriga*) Raccoon butterflyfish (*Chaetodon lunula*) Saddled butterflyfish (*Chaetodon ephippium*)		A, J				A, J	A, J			E, L

Species	**Ma**	**La**	**Es**	**SB**	**Ss**	**Cr/Hs**	**PR**	**Sz**	**DST**	**Pe**
Pomacentridae (damselfishes) Three-spot chromis (*Chromis verater*) Hawaiian dascyllus (*Dascyllus albisella*)		A, J				A, J, E	A, J	A	A, J	L
Sabellidae (feather-duster worms)	A, J, S	A, J, S	A, J, S		A, J, S	A, J, S	A, J, S	A	A, J, S	E, L

Table 31: Summary of EFH Designations for Currently Harvested Coral Reef Taxa

Species Assemblage/Complex	EFH (Egg and Larvae)	EFH (Adult and Juvenile)
Acanthuridae	The water column from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All bottom habitat and the adjacent water column from 0 to 50 fm.
Balistidae	The water column from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All bottom habitat and the adjacent water column from 0 to 50 fm.
Carangidae	The water column from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All bottom habitat and the adjacent water column from 0 to 50 fm.
Carcharhinidae	N/A	All bottom habitat and the adjacent water column from 0 to 50 fm to the outer extent of the EEZ.
Holocentridae	The water column from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All rocky and coral areas and the adjacent water column from 0 to 50 fm.
Kuhliidae	The water column from the shoreline to the outer limits of the EEZ to a depth of 50 fm.	All bottom habitat and the adjacent water column from 0 to 25 fm.
Kyphosidae	Egg, larvae, and juvenile: the water column from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All rocky and coral bottom habitat and the adjacent water column from 0 to 15 fm.
Labridae	EFH for all life stages in the family Labridae is designated as the water column and all bottom habitat extending from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	

Species Assemblage/Complex	EFH (Egg and Larvae)	EFH (Adult and Juvenile)
Mullidae	The water column extending from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All rocky/coral and sand-bottom habitat and adjacent water column from 0 to 50 fm.
Mugilidae	The water column from the shoreline to the outer limits of the EEZ to a depth of 50 fm.	All sand and mud bottoms and the adjacent water column from 0 to 25 fm.
Muraenidae	The water column from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All rocky and coral areas and the adjacent water column from 0 to 50 fm.
Octopodidae	Larvae: The water column from the shoreline to the outer limits of the EEZ to a depth of 50 fm.	EFH for the adult, juvenile phase, and demersal eggs is defined as all coral, rocky, and sand-bottom areas from 0 to 50 fm.
Polynemidae	The water column extending from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All rocky/coral and sand-bottom habitat and the adjacent water column from 0 to 50 fm.
Priacanthidae	The water column extending from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All rocky/coral and sand-bottom habitat and the adjacent water column from 0 to 50 fm.
Scaridae	The water column from the shoreline to the outer limit of the EEZ to a depth of 50 fm.	All bottom habitat and the adjacent water column from 0 to 50 fm
Siganidae	The water column from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All bottom habitat and the adjacent water column from 0 to 50 fm.

Species Assemblage/Complex	**EFH (Egg and Larvae)**	**EFH (Adult and Juvenile)**
Scombridae	EFH for all life stages of dogtooth tuna is designated as the water column from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	
Sphyraenidae	EFH for all life stages in the family Sphyraenidae is designated as the water column from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	
Turbinidae	The water column from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All bottom habitat and the adjacent water column from 0 to 50 fm.
Aquarium Species/Taxa	All waters from 0–50 fm from the shoreline to the limits of the EEZ.	All coral, rubble, or other hard-bottom features and the adjacent water column from 0–50 fm.

Table 32: Occurrence of Potentially Harvested Coral Reef Taxa
Habitat: Mangrove (Ma), Lagoon (La), Estuarine (Es), Seagrass Beds (SB), Soft substrate (Ss), Coral Reef/Hard Substrate (Cr/Hr), Patch Reefs (Pr), Deep-Slope Terraces (DST), Pelagic/Open Ocean (Pe)
Life History Stage: Egg (E), Larvae (L), Juvenile (J), Adult (A), Spawners (S)

MUS/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	DST	Pe
Labridae (wrasses)	J	A, J, E	J	J	A, J	A, J, S	A, J, S	A, J	E, L
Kuhliidae	A, J	A, J	All	A, J		A, S	A, S		E, L
Carcharhinidae, Sphyrnidae, (sharks)	A, J	A, J	A, J		A, J	A, J	A, J	A, J	A, J
Dasyatididae, Myliobatidae, Mobulidae (rays)	A, J	A, J	A, J		A, J	A, J	A, J	A, J	A, J
Serranidae (groupers)	J	A, J		J	A, J, S	A, J, S	A J, S	A, S	E, L
Carangidae (jacks/trevallies)	A, J, S	A, J, S	A, J, S	J	A, J, S	A, J, S	A, J, S	A, J, S	All
Holocentridae (soldierfish/squirrelfish)		A, J, S	A, J, S	J		A, J, S	A, J, S	A, S	E, L
Scaridae (parrotfish)	J	A, J, S		A, J		A, J, S	A, J, S		E, L
Mullidae (goatfish)	A, J, S	A, J, S	A, J, S	A, J	A, J, S	A, J, S	A, J, S	A, J	E, L
Acanthuridae (surgeonfish/unicornfish)	J	A, J, S	A, J, S	J	A, J, S	A, J, S	A, J, S	A, J	E, L
Chlopsidae, Congridae, Moringuidae, Ophichthidae, Muraenidae (eels)	A, J, S	A, J, S	A, J, S	A, J	A, J, S	A, J, S	A, J, S	A, J, S	E, L
Apogonidae (cardinalfish)	A, J, S	A, J, S	A, J, S	A, J, S		A, J, S	A, J, S	A, J, S	E, L
Zanclidae (Moorish idols)		A, J				A, J	A, J		E, L
Chaetodontidae (butterflyfish)	J	A, J, S	J	J		A, J, S	A, J, S	A, S	E, L
Pomacanthidae (angelfish)	J	A, J, S	J	J		A, J, S	A, J, S	A, S	E, L

MUS/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	DST	Pe
Pomacentridae (damselfish)	J	A, J, S	J	J		A, J, S	A, J, S	A, S	E, L
Scorpaenidae (scorpionfish)	J	A, J, S	A, J, S	J		A, J, S	A, J, S		E, L
Blenniidae (blennies)		A, J, S	A, J, S		A, J, S	A, J, S	A, J, S	A, J, S	E, L
Ephippidae (batfish)	J	A, J, S	J		A, S	A, J, S	A, J, S	A, S	All
Echeneidae (remoras)						A, J, S	A, J, S	A, J, S	E, L
Malacanthidae (tilefish)		A, J, S			A, J, S	A, J, S	A, J, S		E, L
Caracanthidae (coral crouchers)						A, J, S	A, J, S		E, L
Grammistidae (soapfish)						A, J, S	A, J, S		E, L
Aulostomus chinensis (trumpetfish)	J	A, J, S		A, J	A	A, J, S	A, J, S		E, L
Fistularia commersoni (coronetfish)	J	A, J, S		A, J		A, J, S	A, J, S		E, L
Clupeidae (herrings)	A, J, S	A, J, S	A, J, S			A, J, S	A, J, S	A, S	All
Engraulidae (anchovies)	A, J, S	A, J, S	A, J, S			A, J, S	A, J, S	A, S	All
Gobiidae (gobies)	All	All	All	All	All	All	All	All	All
Lutjanidae (snappers)	A, J, S	A, J, S	A, J, S	J		A, J, S	A, J, S	A, S	E, L
Balistidae/Monacanthidae	J	A, J, S	J	J		A, J, S	A, J, S	A, S	L
Kyphosidae	J	A, J, S	A, J, S			A, J, S	A, J, S		All
Cirrhitidae		A, J, S				A, J, S	A, J, S	A, J, S	E, L
Antennariidae (frogfishes)		All		All		All	All		L
Syngnathidae (pipefishes/seahorses)	All	All		All		All	All		L

MUS/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	DST	Pe
Sphyraenidae spp. (barracudas)	A, J	A, J, S	A, J, S	J		A, J, S	A, J, S	A, S	All
Priacanthidae	J	A, J, S	J			A, J, S	A, J, S	A, S	E, L
Stony corals		A, J, S	A, J, S			A, J, S	A, J, S	A, J, S	E, L
Azooxanthellates (non–reef builders)		A, J, S	A, J, S		A, J, S	A, J, S	A, J, S	A, J, S	E, L
Fungiidae (mushroom corals)		A, J, S	A, J, S			A, J, S	A, J, S	A, J, S	E, L
Small/Large polyped corals (endemic spp.)		A, J				A, J	A, J	A, J	
Soft corals and gorgonians		A, J, S			A, J, S	A, J, S	A, J, S	A, J, S	E, L
Anemones (non-epifaunal)	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	E, L
Zooanthids	A, J, S	A, J, S	A, J, S		A, J, S	A, J, S	A, J, S	A, J, S	E, L
Sponges	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	E, L
Hydrozoans	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	E, L
Stylasteridae (lace corals)	A, J, S	A, J, S	A, J, S			A, J, S	A, J, S	A, J, S	E, L
Solanderidae (hydroid fans)	A, J, S	A, J, S	A, J, S			A, J, S	A, J, S	A, J, S	E, L
Bryozoans	A, J, S	A, J, S	A, J, S	A, J		A, J, S	A, J, S	A, J, S	E, L
Tunicates (solitary/colonial)	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	E, L
Feather duster worms (Sabellidae)	A, J, S	A, J, S	A, J, S		A, J, S	A, J, S	A, J, S	A, J, S	E, L
Echinoderms (e.g., sea cucumbers, sea urchins)	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	E, L
Mollusca	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	E, L

MUS/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	DST	Pe
Sea Snails (gastropods)	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	E, L
Opistobranchs (sea slugs)	A, J	A, J, S		A, J, S	A, J, S	A, J, S	A, J, S	A, J	E, L
Pinctada margaritifera (black lipped pearl oyster)	A, J	A, J, S				A, J, S	A, J, S	A, J, S	E, L
Tridacnidae		A, J, S			A, J, S	A, J, S	A, J, S		E, L
Other bivalves	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	E, L
Cephalopods		All	A, J, S	All	All	All	All	All	E, L
Octopodidae	A, J, S	All	A, J, S	All	All	All	All	All	L
Crustaceans	A, J	All	A, J	A, J	A, J	All	All	All	L
Lobsters		All			A, J	All	All	All	L
Shrimp/Mantis		All	A, J	A, J	A, J	All	All	All	L
Crabs	A, J	All	A, J	A, J	A, J	All	All	All	L
Annelids	A, J, S	A J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	E, L
Algae	All	All	All	All	All	All	All	All	
Live rock		A, J	A, J			A, J, A	A, J, A	A J, A	E, L

Table 33: Summary of EFH Designations for Potentially Harvested Coral Reef Taxa

Species Assemblage/Complex	EFH (Egg and Larvae)	EFH (Adult and Juvenile)
All Potentially Harvested Coral Reef Taxa	EFH for all life stages of Potentially Harvested Coral Reef Taxa is designated as the water column and bottom habitat from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	

6.3 HAPC Designations

In addition to EFH, the Council identified habitat areas of particular concern (HAPCs) within EFH for all FMPs. HAPCs are specific areas within EFH that are essential to the life cycle of important coral reef species. In determining whether a type or area of EFH should be designated as an HAPC, one or more of the following criteria established by NMFS should be met: (a) the ecological function provided by the habitat is important; (b) the habitat is sensitive to human-induced environmental degradation; (c) development activities are, or will be, stressing the habitat type; or (d) the habitat type is rare. However, it is important to note that if an area meets only one of the HAPC criteria, it will not necessarily be designated an HAPC. Table 33 summarizes the EFH and HAPC designations for all Western Pacific Archipelagic FEP MUS, including Hawaii Archipelago FEP MUS.

6.3.1 Bottomfish

On the basis of the known distribution and habitat requirements of adult bottomfish, the Council designated all escarpments/slopes between 40–280 meters throughout the Western Pacific Region, including the Hawaii Archipelago, as bottomfish HAPC. In addition, the Council designated the three known areas of juvenile opakapaka habitat (two off Oahu and one off Molokai) as HAPC. The basis for this designation is the ecological function that these areas provide, the rarity of the habitat, and the susceptibility of these areas to human-induced environmental degradation. Off Oahu, juvenile snappers occupy a flat, open bottom of primarily soft substrate in depths ranging from 40 to 73 meters. This habitat is quite different from that utilized by adult snappers. Surveys suggest that the preferred habitat of juvenile opakapaka in the waters around Hawaii represents only a small fraction of the total habitat at the appropriate depths. Areas of flat featureless bottom have typically been thought of as providing low-value fishery habitat. It is possible that juvenile snappers occur in other habitat types, but in such low densities that they have yet to be observed.

The recent discovery of concentrations of juvenile snappers in relatively shallow water and featureless bottom habitat indicates the need for more research to help identify, map, and study nursery habitat for juvenile snapper.

6.3.2 Crustaceans

Research indicates that banks with summits less than 30 meters support successful recruitment of juvenile spiny lobster while those with summit deeper than 30 meters do not. For this reason, the Council has designated all banks in the NWHI with summits less than 30 meters as HAPC. The basis for designating these areas as HAPC is the ecological function provided, the rarity of the habitat type, and the susceptibility of these areas to human-induced environmental degradation. The complex relationship between recruitment sources and sinks of spiny lobsters is poorly understood. The Council feels that in the absence of a better understanding of these relationships, the adoption of a precautionary approach to protect and conserve habitat is warranted.

The relatively long pelagic larval phase for palinurids results in very wide dispersal of spiny lobster larvae. Palinurid larvae are transported up to 2,000 nautical miles by prevailing ocean currents. Because phyllosoma larvae are transported by the prevailing ocean currents outside of EEZ waters, the Council has identified habitat in these areas as "important habitat." To date HAPC has not been identified or designated for deepwater shrimp.

6.3.3 Precious Corals

The Council designated three of the six precious coral beds—Makapuu, Wespac and Brooks Bank—as habitat areas of particular concern. Makapuu bed was designated as HAPC because of the ecological function it provides, the rarity of the habitat type, and its sensitivity to human-induced environmental degradation. The potential commercial importance and the amount of scientific information that has been collected on Makapuu bed were also considered. Wespac bed was designated as HAPC because of the ecological function it provides and the rarity of the habitat type. Its refugia status was also considered. Brooks Bank was designated HAPC because of the ecological function it provides and the rarity of the habitat type. Its possible importance as foraging habitat for the Hawaiian monk seal was also considered. For black corals, the Council designated the Auau Channel as HAPC because of the ecological function it provides, the rarity of the habitat type and its sensitivity to human-induced environmental degradation. Its commercial importance was also considered.

6.3.4 Coral Reef Ecosystems

Because of the already-noted lack of scientific data, the Council considered locations that are known to support populations of Coral Reef Ecosystem MUS and meet NMFS criteria for HAPC. Although not one of the criteria established by NMFS, the Council considered designating areas that are already protected—for example, wildlife refuges—as HAPC. The Coral Reef Ecosystem MUS HAPCs for Hawaii identified in Table 35 have met at least one of the four criteria listed above, or the fifth criterion (i.e., protected areas) identified by the Council. However, a great deal of life history work needs to be done in order to adequately identify the extent of HAPCs and link them to particular species or life stages.

Table 34: EFH and HAPC Designations for Hawaii Archipelago FEP MUS

	Species Complex	EFH	HAPC
Bottomfish and Seamount Groundfish	**Shallow-water species (0–50 fm):** uku (*Aprion virescens*), thicklip trevally (*Pseudocaranx dentex*), giant trevally (*Caranx ignoblis*), black trevally (*Caranx lugubris*), amberjack (*Seriola dumerili*), taape (*Lutjanus kasmira*)	**Eggs and larvae:** the water column extending from the shoreline to the outer limit of the EEZ down to a depth of 400 m (200 fm). **Juvenile/adults:** the water column and all bottom habitat extending from the shoreline to a depth of 400 m (200 fm)	All slopes and escarpments between 40–280 m (20 and 140 fm) Three known areas of juvenile opakapaka habitat: two off Oahu and one off Molokai
Bottomfish and Seamount Groundfish	**Deep-water species (50–200 fm):** ehu (*Etelis carbunculus*), onaga (*Etelis coruscans*), opakapaka (*Pristipomoides filamentosus*), yellowtail kalekale (*P. auricilla*), kalekale (*P. sieboldii*), gindai (*P. zonatus*), hapuupuu (*Epinephelus quernus*), lehi (*Aphareus rutilans*)	**Eggs and larvae:** the water column extending from the shoreline to the outer limit of the EEZ down to a depth of 400 m (200 fathoms) **Juvenile/adults:** the water column and all bottom habitat extending from the shoreline to a depth of 400 meters (200 fm)	All slopes and escarpments between 40–280 m (20 and 140 fm) Three known areas of juvenile opakapaka habitat: two off Oahu and one off Molokai

	Species Complex	EFH	HAPC
Bottomfish and Seamount Groundfish	**Seamount groundfish species (50–200 fm):** armorhead (*Pseudopentaceros richardsoni*), ratfish/butterfish (*Hyperoglyphe japonica*), alfonsin (*Beryx splendens*)	**Eggs and larvae:** the (epipelagic zone) water column down to a depth of 200 m (100 fm) of all EEZ waters bounded by latitude 29°–35° **Juvenile/adults:** all EEZ waters and bottom habitat bounded by latitude 29°–35° N and longitude 171° E–179° W between 200 and 600 m (100 and 300 fm)	No HAPC designated for seamount groundfish
Crustaceans	**Spiny and slipper lobster complex:** Hawaiian spiny lobster (*Panulirus marginatus*), spiny lobster (*P. penicillatus, P.* spp.), ridgeback slipper lobster (*Scyllarides haanii*), Chinese slipper lobster (*Parribacus antarcticus*) **Kona crab :** Kona crab (*Ranina ranina*)	**Eggs and larvae:** the water column from the shoreline to the outer limit of the EEZ down to a depth of 150 m (75 fm) **Juvenile/adults:** all of the bottom habitat from the shoreline to a depth of 100 m (50 fm)	All banks in the NWHI with summits less than or equal to 30 m (15 fathoms) from the surface
Crustaceans	**Deepwater shrimp (*Heterocarpus* spp.)**	**Eggs and larvae:** the water column and associated outer reef slopes between 550 and 700 m **Juvenile/adults:** the outer reef slopes at depths between 300-700 m	No HAPC designated for deepwater shrimp.

	Species Complex	EFH	HAPC
Precious Corals	**Deep-water precious corals (150–750 fm):** Pink coral (*Corallium secundum*), red coral (*C. regale*), pink coral (*C. laauense*), midway deepsea coral (*C.* sp nov.), gold coral (*Gerardia* spp.), gold coral (*Callogorgia gilberti*), gold coral (*Narella* spp.), gold coral (*Calyptrophora* spp.), bamboo coral (*Lepidisis olapa*), bamboo coral (*Acanella* spp.) **Shallow-water precious corals (10-50 fm):** black coral (*Antipathes dichotoma*), black coral (*Antipathis grandis*), black coral (*Antipathes ulex*)	EFH for Precious Corals is confined to six known precious coral beds located off Keahole Point, Makapuu, Kaena Point, Wespac bed, Brooks Bank, and 180 Fathom Bank EFH has also been designated for three beds known for black corals in the Main Hawaiian Islands between Milolii and South Point on the Big Island, the Auau Channel, and the southern border of Kauai	Includes the Makapuu bed, Wespac bed, Brooks Banks bed For Black Corals, the Auau Channel has been identified as a HAPC
Coral Reef Ecosystems	**All Currently Harvested Coral Reef Taxa** **All Potentially Harvested Coral Reef Taxa**	EFH for the Coral Reef Ecosystem MUS includes the water column and all benthic substrate to a depth of 50 fm from the shoreline to the outer limit of the EEZ	Includes all no-take MPAs identified in the CRE-FMP, all Pacific remote islands, as well as numerous existing MPAs, research sites, and coral reef habitats throughout the western Pacific

Table 35: Coral Reef Ecosystem HAPC Designations in the Hawaii Archipelago

	Rarity of Habitat	Ecological Function	Suscep-tibility to Human Impact	Likelihood of Develop-mental Impacts	Existing Protective Status
NWHI					
All substrate 0–10 fm	x	x	x		x
Laysan*:* All substrate 0–50 fm	x	x			
Midway*:* All substrate 0–50 fm	x	x	x		x
FFS*:* All substrate 0–50 fm	x	x	x	x	
Main Hawaiian Islands					
Kaula Rock (entire bank)		x	x		x
Niihau (Lehua Island)	x	x	x		
Kauai (Kaliu Point)		x	x		
Oahu					
Pupukea (MLCD)		x	x	x	x
Shark's Cove (MLCD)			x	x	x
Waikiki (MLCD)			x	x	x
Makapuu Head/Tide Pool Reef Area		x	x	x	
Kaneohe Bay	x	x	x	x	
Kaena Point		x	x		
Kahe Reef		x	x		
Maui					
Molokini	x	x	x	x	x
Olowalo Reef Area		x	x	x	
Honolua-Mokuleia Bay (MLCD)		x	x		x
Ahihiki Kinau Natural Area Reserve	x	x	x		x
Molokai (south shore reefs)		x	x		

	Rarity of Habitat	Ecological Function	Suscep-tibility to Human Impact	Likelihood of Develop-mental Impacts	Existing Protective Status
Lanai					
Halope Bay		x	x		
Manele Bay		x	x	x	
Five Needles		x	x		
Hawaii					
Lapakahi Bay State Park (MLCD)		x	x		x
Pauko Bay and Reef (MLCD)		x	x		x
Kealakekua		x	x		x
Waialea Bay (MLCD)	x	x	x		x
Kawaihae Harbor-Old Kona Airport (MLCD)		x	x		x
Additional Areas					
All Long-term Research Sites		x	x		
All CRAMP sites		x	x		

6.4 Fishing Related Impacts That May Adversely Affect EFH

The Council is required to act to prevent, mitigate, or minimize adverse effects from fishing on evidence that a fishing practice has identifiable adverse effects on EFH for any MUS covered by an FMP or FEP. Adverse fishing impacts may include physical, chemical, or biological alterations of the substrate and loss of, or injury to, benthic organisms, prey species, and their habitat or other components of the ecosystem.

The predominant fishing gear types—hook and line, longline, troll, traps—used in the fisheries managed by the Council cause few fishing-related impacts to the benthic habitat utilized by coral reef species, bottomfish, crustaceans, or precious corals. The current management regime prohibits the use of bottom trawls, bottom-set nets, explosives, and poisons. The use of non-selective gear to harvest precious corals is prohibited and only selective and non-destructive gear may be allowed to fish for Coral Reef Ecosystem MUS. The Council has determined that current management measures to protect fishery habitat are adequate and that no additional measures are necessary at this time. However, the Council has identified the following potential sources of fishery-related impacts to benthic habitat that may occur during normal fishing operations:

- Anchor damage from vessels attempting to maintain position over productive fishing habitat.
- Heavy weights and line entanglement occurring during normal hook-and-line fishing operations.
- Lost gear from lobster fishing operations.
- Remotely operated vehicle (ROV) tether damage to precious coral during harvesting operations.

Trash and discarded and lost gear (leaders, hooks, weights) by fishing vessels operating in the EEZ, are a Council concern. A report on a submersible-supported research project conducted in 2001 concluded that bottomfish gear had minimal to no impact on coral reef habitat (Kelley and Moffit, undated). A November 2001 cruise in the MHI determined that precious corals harvesting has "negligible" impact on the habitat (R. Grigg, personal communication). Although lobster traps have a potential to impact benthic habitat, the NWHI fishery is essentially closed and traps are not widely used in the MHI, thus these are not viewed as a threat to EFH or HAPC.

The Council is concerned with habitat impacts of marine debris originating from fishing operations outside the Western Pacific Region. NMFS is currently investigating the source and impacts of this debris. International cooperation will be necessary to find solutions to this broader problem.

Because the habitat of pelagic species is the open ocean, and managed fisheries employ variants of hook-and-line gear, there are no direct impacts to EFH. Lost gear may be a hazard to some species due to entanglement, but it has no direct effect on habitat. A possible impact would be caused by fisheries that target and deplete key prey species, but currently there is no such fishery.

There is also a concern that invasive marine and terrestrial species may be introduced into sensitive environments by fishing vessels transiting from populated islands and grounding on shallow reef areas. Of most concern is the potential for unintentional introduction of rats (*Rattus* spp.) to the remote islands in the NWHI and PRIA that harbor endemic birds. Although there are no restrictions that prohibit fishing vessels from transiting near these remote island areas, no invasive species introductions due to this activity have been documented. However, the Council is concerned that this could occur as fisheries expand and emerging fisheries develop in the future.

While the Council has determined that current management measures to protect fishery habitat are adequate, should future research demonstrate a need, the Council will act accordingly to protect habitat necessary to maintain a sustainable and productive fishery in the Western Pacific Region.

In modern times, some reefs have been degraded by a range of human activities. Comprehensive lists of human threats to coral reefs in the U.S. Pacific Islands are provided by Maragos et al.

(1996), Birkeland (1997b), Grigg 2002, and Clark and Gulko (1999). (These findings are summarized in Table 36.) More recently, the U.S. Coral Reef Task Force identified six key threats to coral reefs: (1) land based sources of pollutions, (2) overfishing, (3) recreational overuse, (4) lack of awareness, (5) climate change, and (6) coral bleaching and disease (Green 1997).

In general, reefs closest to human population centers are more heavily used and are in worse condition than those in remote locations (Green 1997). Nonetheless, it is difficult to generalize about the present condition of coral reefs in the U.S. Pacific Islands because of their broad geographic distribution and the lack of long-term monitoring to document environmental and biological baselines. Coral reef conditions and use patterns vary throughout the U.S. Pacific Islands.

A useful distinction is between coral reefs near inhabited islands of American Samoa, CNMI, Guam, and the main Hawaiian islands and coral reefs in the remote NWHI, PRIA, and northern islands of the CNMI. Reefs near the inhabited islands are heavily used for small-scale artisanal, recreational, and subsistence fisheries, and those in Hawaii, CNMI and Guam are also the focus of extensive non-consumptive marine recreation. Rather than a relatively few large-scale mechanized operations, many fishermen each deploy more limited gear. The more accessible banks in the MHI (e.g., Penguin Bank and Kaula Rock) are the most heavily fished offshore reefs in the Hawaii Archipelago.

6.5 Non-Fishing Related Impacts That May Adversely Affect EFH

On the basis of the guidelines established by the Secretary under Section 305 (b)(1)(A) of the MSA, NMFS has developed a set of guidelines to assist councils meet the requirement to describe adverse impacts to EFH from non-fishing activities in their FMPs or FEPs (67 FR 2376). A wide range of non-fishing activities throughout the U.S. Pacific Islands contribute to EFH degradation. FEP implementation will not directly mitigate these activities. However, as already noted, it will allow NMFS and the Council to make recommendations to any federal or state agency about actions that may impact EFH. Not only could this be a mechanism to minimize the environmental impacts of agency action, it will help them focus their conservation and management efforts.

The Council is required to identify non-fishing activities that have the potential to adversely affect EFH quality and, for each activity, describe its known potential adverse impacts and the EFH most likely to be adversely affected. The descriptions should explain the mechanisms or processes that may cause the adverse effects and how these may affect habitat function. The Council considered a wide range of non-fishing activities that may threaten important properties of the habitat used by managed species and their prey, including dredging, dredge material disposal, mineral exploration, water diversion, aquaculture, wastewater discharge, oil and hazardous substance discharge, construction of fish enhancement structures, coastal development, introduction of exotic species, and agricultural practices. These activities and impacts, along with mitigation measures, are detailed in the next section.

Table 36: Threats to Coral Reefs in the Hawaii Archipelago
Sources: Clark and Gulko 1999; Grigg 2002; Jokiel et al. 1999; Maragos et al. 1996

Activity	MHI	NWHI
Coastal construction	x	
Destructive fishing	x	
Flooding	x	
Industrial pollution		
Overuse/over harvesting	x	
Nutrient loading (sewage/eutrophication)	x	
Poaching/depletion of rare species		
Soil erosion/sedimentation		
Vessel groundings/oil spills		x
Military activity	x	x
Hazardous waste		x
Tourist impacts	x	
Urbanization	x	
Thermal pollution	x	
Marine debris	x	x
Introduced species	x	

6.5.1 Habitat Conservation and Enhancement Recommendations

According to NMFS guidelines, Councils must describe ways to avoid, minimize, or compensate for the adverse effects to EFH and promote the conservation and enhancement of EFH. Generally, non-water dependent actions that may have adverse impacts should not be located in EFH. Activities that may result in significant adverse effects on EFH should be avoided where less environmentally harmful alternatives are available. If there are no alternatives, the impacts of these actions should be minimized. Environmentally sound engineering and management practices should be employed for all actions that may adversely affect EFH. Disposal or spillage of any material (dredge material, sludge, industrial waste, or other potentially harmful materials) that would destroy or degrade EFH should be avoided. If avoidance or minimization is not possible, or will not adequately protect EFH, compensatory mitigation to conserve and enhance EFH should be recommended. FEPs may recommend proactive measures to conserve or enhance EFH. When developing proactive measures, Councils may develop a priority ranking of the recommendations to assist federal and state agencies undertaking such measures. Councils should describe a variety of options to conserve or enhance EFH, which may include, but are not limited to the following:

Enhancement of rivers, streams, and coastal areas through new federal, state, or local government planning efforts to restore river, stream, or coastal area watersheds.

Improve water quality and quantity through the use of the best land management practices to ensure that water-quality standards at state and federal levels are met. The practices include improved sewage treatment, disposing of waste materials properly, and maintaining sufficient in-stream flow to prevent adverse effects to estuarine areas.

Restore or create habitat, or convert non-EFH to EFH, to replace lost or degraded EFH, if conditions merit such activities. However, habitat conversion at the expense of other naturally functioning systems must be justified within an ecosystem context.

6.5.2 Description of Mitigation Measures for Identified Activities and Impacts

Established policies and procedures of the Council and NMFS provide the framework for conserving and enhancing EFH. Components of this framework include adverse impact avoidance and minimization, provision of compensatory mitigation whenever the impact is significant and unavoidable, and incorporation of enhancement. New and expanded responsibilities contained in the MSA will be met through appropriate application of these policies and principles. In assessing the potential impacts of proposed projects, the Council and the NMFS are guided by the following general considerations:

- The extent to which the activity would directly and indirectly affect the occurrence, abundance, health, and continued existence of fishery resources.
- The extent to which the potential for cumulative impacts exists.
- The extent to which adverse impacts can be avoided through project modification, alternative site selection, or other safeguards.
- The extent to which the activity is water dependent if loss or degradation of EFH is involved.
- The extent to which mitigation may be used to offset unavoidable loss of habitat functions and values.

Seven nonfishing activities have been identified that directly or indirectly affect habitat used by MUS. Impacts and conservation measures are summarized below for each of these activities. Although not all inclusive, what follows is a good example of the kinds of measures that can help to minimize or avoid the adverse effects of identified nonfishing activities on EFH.

Habitat Loss and Degradation

Impacts

- Infaunal and bottom-dwelling organisms
- Turbidity plumes

- Biological availability of toxic substances
- Damage to sensitive habitats
- Current patterns/water circulation modification
- Loss of habitat function
- Contaminant runoff
- Sediment runoff
- Shoreline stabilization projects

Conservation Measures

1. To the extent possible, fill materials resulting from dredging operations should be placed on an upland site. Fills should not be allowed in areas with subaquatic vegetation, coral reefs, or other areas of high productivity.

2. The cumulative impacts of past and current fill operations on EFH should be addressed by federal, state, and local resource management and permitting agencies and should be considered in the permitting process.

3. The disposal of contaminated dredge material should not be allowed in EFH.

4. When reviewing open-water disposal permits for dredged material, state and federal agencies should identify the direct and indirect impacts such projects may have on EFH. When practicable, benthic productivity should be determined by sampling prior to any discharge of fill material. Sampling design should be developed with input from state and federal resource agencies.

5. The areal extent of the disposal site should be minimized. However, in some cases, thin layer disposal may be less deleterious. All non-avoidable impacts should be mitigated.

6. All spoil disposal permits should reference latitude–longitude coordinates of the site so that information can be incorporated into GIS systems. Inclusion of aerial photos may also be required to help geo-reference the site and evaluate impacts over time.

7. Further fills in estuaries and bays for development of commercial enterprises should be curtailed.

8. Prior to installation of any piers or docks, the presence or absence of coral reefs and submerged aquatic vegetation should be determined. These areas should be avoided. Benthic productivity should also be determined, and areas with high productivity avoided. Sampling design should be developed with input from state and federal resource agencies.

9. The use of dry stack storage is preferable to wet mooring of boats. If that method is not feasible, construction of piers, docks, and marinas should be designed to minimize impacts to the coral reef substrate and subaquatic vegetation.

10. Bioengineering should be used to protect altered shorelines. The alteration of natural, stable shorelines should be avoided.

Pollution and Contamination

Impacts

- Introduction of chemicals
- Introduction of animal wastes
- Increased sedimentation
- Wastewater effluent with high contaminant levels
- High nutrient levels downcurrent of outfalls
- Biocides to prevent biofouling
- Thermal effects
- Turbidity plumes
- Affected submerged aquatic vegetation sites
- Stormwater runoff
- Direct physical contact
- Indirect exposure
- Cleanup

Conservation Measures

1. Outfall structures should be placed sufficiently far offshore to prevent discharge water from affecting areas designated as EFH. Discharges should be treated using the best available technology, including implementation of up-to-date methodologies for reducing discharges of biocides (e.g., chlorine) and other toxic substances.

2. Benthic productivity should be determined by sampling prior to any construction activity. Areas of high productivity should be avoided to the maximum extent possible. Sampling design should be developed with input from state and federal resource agencies.

3. Mitigation should be provided for the degradation or loss of habitat from placement of the outfall structure and pipeline as well as the treated water plume.

4. Containment equipment and sufficient supplies to combat spills should be on-site at all facilities that handle oil or hazardous substances.

5. Each facility should have a Spill Contingency Plan, and all employees should be trained in how to respond to a spill.

6. To the maximum extent practicable, storage of oil and hazardous substances should be located in an area that would prevent spills from reaching the aquatic environment.

7. Construction of roads and facilities adjacent to aquatic environments should include a storm-water treatment component that would filter out oils and other petroleum products.

8. The use of pesticides, herbicides, and fertilizers in areas that would allow for their entry into the aquatic environment should be avoided.

9. The best land management practices should be used to control topsoil erosion and sedimentation.

Dredging

Impacts

- Infaunal and bottom-dwelling organisms
- Turbidity plumes
- Bioavailability of toxic substances
- Damage to sensitive habitats
- Water circulation modification

Conservation Measures

1. To the maximum extent practicable, dredging should be avoided. Activities that require dredging (such as placement of piers, docks, marinas, etc.) should be sited in deep-water areas or designed in such a way as to alleviate the need for maintenance dredging. Projects should be permitted only for water-dependent purposes, when no feasible alternatives are available.

2. Dredging in coastal and estuarine waters should be performed during the time frame when MUS and prey species are least likely to be entrained. Dredging should be avoided in areas with submerged aquatic vegetation and coral reefs.

3. All dredging permits should reference latitude–longitude coordinates of the site so that information can be incorporated into Geographic Information Systems (GIS). Inclusion of aerial photos may also be required to help geo-reference the site and evaluate impacts over time.

4. Sediments should be tested for contaminants as per the EPA and U.S. Army Corps of Engineers requirements.

5. The cumulative impacts of past and current dredging operations on EFH should be addressed by federal, state, and local resource management and permitting agencies and should be considered in the permitting process.

6. If dredging needs are caused by excessive sedimentation in the watershed, those causes should be identified and appropriate management agencies contacted to assure action is done to curtail those causes.

7. Pipelines and accessory equipment used in conjunction with dredging operations should, to the maximum extent possible, avoid coral reefs, seagrass beds, estuarine habitats, and areas of subaquatic vegetation.

Marine Mining

Impacts

- Loss of habitat function

- Turbidity plumes
- Resuspension of fine-grained mineral particles

Composition of the substrate altered

Conservation Measures

1. Mining in areas identified as a coral reef ecosystem should be avoided.

2. Mining in areas of high biological productivity should be avoided.

3. Mitigation should be provided for loss of habitat due to mining.

Water Intake Structures

Impacts

- Entrapment, impingement, and entrainment
- Loss of prey species

Conservation Measures

1. New facilities that rely on surface waters for cooling should not be located in areas where coral reef organisms are concentrated. Discharge points should be located in areas that have low concentrations of living marine resources, or they should incorporate cooling towers that employ sufficient safeguards to ensure against release of blow-down pollutants into the aquatic environment.

2. Intake structures should be designed to prevent entrainment or impingement of MUS larvae and eggs.

3. Discharge temperatures (both heated and cooled effluent) should not exceed the thermal tolerance of the plant and animal species in the receiving body of water.

4. Mitigation should be provided for the loss of EFH from placement of the intake structure and delivery pipeline.

Aquaculture Facilities

Impacts

- Discharge of organic waste from the farms
- Impacts to the seafloor below the cages or pens (including moorings or anchors)

Conservation Measures

1. Facilities should be located in upland areas as often as possible. Tidally influenced wetlands should not be enclosed or impounded for mariculture purposes. This includes hatchery and grow-out operations. Siting of facilities should also take into account the size of the facility, the presence or absence of submerged aquatic vegetation and coral reef ecosystems, proximity of wild fish stocks, migratory patterns, competing uses, hydrographic conditions, and upstream uses. Benthic productivity should be determined by sampling prior to any operations. Areas of high productivity should be avoided to the

maximum extent possible. Sampling design should be developed with input from state and federal resource agencies.

2. To the extent practicable, water intakes should be designed to avoid entrainment and impingement of native fauna.

3. Water discharge should be treated to avoid contamination of the receiving water and should be located only in areas having good mixing characteristics.

4. Where cage mariculture operations are undertaken, water depths and circulation patterns should be investigated and should be adequate to preclude the buildup of waste products, excess feed, and chemical agents.

5. Non-native, ecologically undesirable species that are reared may pose a risk of escape or accidental release, which could adversely affect the ecological balance of an area. A thorough scientific review and risk assessment should be undertaken before any non-native species are allowed to be introduced.

6. Any net pen structure should have small enough webbing to prevent entanglement by prey species.

7. Mitigation should be provided for the EFH areas impacted by the facility.

Introduction of Exotic Species

Impacts

- Habitat alteration
- Trophic alteration
- Gene pool alteration
- Spatial alteration
- Introduction of disease

Conservation Measures

1. Vessels should discharge ballast water far enough out to sea to prevent introduction of nonnative species to bays and estuaries.

2. Vessels should conduct routine inspections for presence of exotic species in crew quarters and hull of the vessel prior to embarking to remote islands (PRIA, NWHI, and northern islands of the CNMI).

3. Exotic species should not be introduced for aquaculture purposes unless a thorough scientific evaluation and risk assessment are performed (see section on aquaculture).

4. Effluent from public aquaria display laboratories and educational institutes using exotic species should be treated prior to discharge.

6.6 EFH Research Needs

The Council conducted an initial inventory of available environmental and fisheries data sources relevant to the EFH of each managed fishery. Based on this inventory, a series of tables were created that indicated the existing level of data for individual MUS in each fishery. These tables are presented in Essential Fish Habitat Descriptions for Western Pacific Archipelagic and Remote Island Areas Fishery Ecosystem Plan Management Unit Species.

Additional research is needed to make available sufficient information to support a higher level of description and identification of EFH and HAPC. Additional research may also be necessary to identify and evaluate actual and potential adverse effects on EFH, including, but not limited to, direct physical alteration; impaired habitat quality/functions; cumulative impacts from fishing; or indirect adverse effects, such as sea level rise, global warming, and climate shifts.

The following scientific data are needed to more effectively address EFH provisions:

All Species

- Distribution of early life history stages (eggs and larvae) of MUS by habitat
- Juvenile habitat (including physical, chemical, and biological features that determine suitable juvenile habitat)
- Food habits (feeding depth, major prey species, etc.)
- Habitat-related densities for all MUS life history stages
- Habitat utilization patterns for different life history stages and species for BMUS
- Growth, reproduction, and survival rates for MUS within habitats

Bottomfish Species

- Inventory of marine habitats in the EEZ of the Western Pacific Region
- High-resolution maps of bottom topography/currents/water masses/primary productivity

Crustaceans Species

- Identification of postlarval settlement habitat of all CMUS
- Identification of source–sink relationships in the NWHI and other regions (i.e., relationships between spawning sites settlement using circulation models, and genetic techniques)
- Research to determine habitat related densities for all CMUS life history stages in Hawaii
- High-resolution mapping of bottom topography, bathymetry, currents, substrate types, algal beds, and habitat relief

Precious Corals Species

- Distribution, abundance, and status of precious corals in the Western Pacific Region

Coral Reef Ecosystem Species

- The distribution of early life history stages (eggs and larvae) of MUS by habitat
- Description of juvenile habitat (including physical, chemical, and biological features that determine suitable juvenile habitat)
- Food habits (feeding depth, major prey species, etc.)
- Habitat-related densities for all MUS life history stages
- Habitat utilization patterns for different life history stages and species
- Growth, reproduction, and survival rates for MUS within habitats.
- Inventory of coral reef ecosystem habitats in the EEZ of the Western Pacific Region
- Location of important spawning sites
- Identification of postlarval settlement habitat
- Establishment of baseline parameters for coral reef ecosystem resources
- High-resolution mapping of bottom topography, bathymetry, currents, substrate types, algal beds, and habitat relief

NMFS guidelines suggest that the Council and NMFS periodically review and update the EFH components of FMPs or FEPs as new data become available. The Council recommends that new information be reviewed, as necessary, during preparation of the annual reports by the Plan Teams. EFH designations may be changed under the FEP framework processes if information presented in an annual review indicates that modifications are justified.

CHAPTER 7: COORDINATION OF ECOSYSTEM APPROACHES TO FISHERIES MANAGEMENT IN THE HAWAII ARCHIPELAGO FEP

7.1 Introduction

In the Western Pacific Region, the management of ocean and coastal activities is conducted by a number of agencies and organizations at the federal, state, county, and even village levels. These groups administer programs and initiatives that address often overlapping and sometimes conflicting ocean and coastal issues.

To be successful, ecosystem approaches to management must be designed to foster intra and inter-agency cooperation and communication (Schrope 2002). Increased coordination with state and local governments and community involvement will be especially important to the improved management of near-shore resources that are heavily used. To increase collaboration with domestic and international management bodies, as well as other governmental and nongovernmental organizations, communities, and the public, the Council has adopted the multilevel approach described below. This process is depicted in Figure 21.

7.2 Council Panels and Committees

FEP Advisory Panel

The FEP Advisory Panel advises the Council on fishery management issues, provides input to the Council regarding fishery management planning efforts, and advises the Council on the content and likely effects of management plans, amendments, and management measures.

The Advisory Panel consists of four sub-panels. In general, each Advisory Sub-panel includes two representatives from the area's commercial, recreational, and subsistence fisheries, as well as two additional members (fishermen or other interested parties) who are knowledgeable about the area's ecosystems and habitat. The exception is the Mariana FEP Sub-panel, which has four representatives from each group to represent the combined areas of Guam and the Northern Mariana Islands (see Table 37). The Hawaii FEP Sub-panel addresses issues pertaining to demersal fishing in the PRIA due to the lack of a permanent population and because such PRIA fishing has primarily originated in Hawaii. The FEP Advisory Panel meets at the direction of the Council to provide continuing and detailed participation by members representing various fishery sectors and the general public.

Table 37: FEP Advisory Panel and Sub-panel Structure

Representative	**American Samoa FEP Sub-panel**	**Hawaii FEP Sub-panel**	**Mariana FEP Sub-panel**	**Pelagic FEP Sub-panel**
Commercial representatives	Two members	Two members	Four members	Two members
Recreational representatives	Two members	Two members	Four members	Two members

Subsistence representatives	Two members	Two members	Four members	Two members
Ecosystems and habitat representatives	Two members	Two members	Four members	Two members

Archipelagic FEP Plan Team

The Archipelagic FEP Plan Team oversees the ongoing development and implementation of the American Samoa, Hawaii, Mariana, and PRIA FEPs and is responsible for reviewing information pertaining to the performance of all the fisheries and the status of all the stocks managed under the four Archipelagic FEPs. Similarly, the Pelagic FEP Plan Team oversees the ongoing development and implementation of the Pacific Pelagic Fishery Ecosystem Plan.

The Archipelagic Plan Team meets at least once annually and comprises individuals from local and federal marine resource management agencies and non-governmental organizations. It is led by a Chair who is appointed by the Council Chair after consultation with the Council's Executive Standing Committee. The Archipelagic Plan Team's findings and recommendations are reported to the Council at its regular meetings. Plan teams are a form of advisory panel authorized under Section 302(g) of the MSA.

Science and Statistical Committee

The Scientific and Statistical Committee (SSC) is composed of scientists from local and federal agencies, academic institutions, and other organizations. These scientists represent a range of disciplines required for the scientific oversight of fishery management in the Western Pacific Region. The role of the SSC is to (a) identify scientific resources required for the development of FEPs and amendments, and recommend resources for Plan Teams; (b) provide multi-disciplinary review of management plans or amendments, and advise the Council on their scientific content; (c) assist the Council in the evaluation of such statistical, biological, economic, social, and other scientific information as is relevant to the Council's activities, and recommend methods and means for the development and collection of such information; and (d) advise the Council on the composition of both the Archipelagic and Pelagic Plan Teams.

FEP Standing Committees

The Council's four FEP Standing Committees are composed of Council members who, prior to Council action, review all relevant information and data including the recommendations of the FEP Advisory Panels, the Archipelagic and Pelagic Plan Teams, and the SSC. The Standing Committees are the American Samoa FEP Standing Committee, the Hawaii FEP Standing Committee (as in the Advisory Panels, the Hawaii Standing Committee will also consider demersal issues in the PRIA), the Mariana FEP Standing Committee, and the Pelagic FEP Standing Committee. The recommendations of the FEP Standing Committees, along with the recommendations from all of the other advisory bodies described above, are presented to the full Council for their consideration prior to taking action on specific measures or recommendations.

Regional Ecosystem Advisory Committees

Regional Ecosystem Advisory Committees for each inhabited area (American Samoa, Hawaii, and the Mariana archipelago) comprise Council members and representatives from federal, state, and local government agencies; businesses; and non-governmental organizations that have responsibility or interest in land-based and non-fishing activities that potentially affect the area's marine environment. Committee membership is by invitation and provides a mechanism for the Council and member agencies to share information on programs and activities, as well as to coordinate management efforts or resources to address non-fishing related issues that could affect ocean and coastal resources within and beyond the jurisdiction of the Council. Committee meetings coincide with regularly scheduled Council meetings, and recommendations made by the Committees to the Council are advisory as are recommendations made by the Council to member agencies. REACs are a form of advisory panel authorized under Section 302(g) of the MSA.

Advisory Body Coordination and Recommendations to Council

Recommendations from each Council advisory body are reviewed separately by the Council, although there may be comments from one advisory body on the recommendations arising in another team or panel. This is partially dependant on timing and typically, the SSC reviews those recommendations arising from the Plan Teams, Advisory Panels and other bodies that have met prior to a Council meeting, and either concurring with these recommendations or suggesting an alternative. The same is true of any recommendations arising from the REACs; the Council would look to the SSC for any available comments on recommendations arising from the REACs. Finally, the Pelagics Plan Team coordinates with the Archipelagic Plan Team on small boat issues, since the same fishing platform used for pelagic trolling and handlining, can be used for a variety of other fishing methods, e.g., bottomfish and coral reef fishes, and may involve cross cutting issues that have arisen in the past, such as shark depredation of fish catches.

Community Groups and Projects

As described above and in Chapter 2, communities and community members are increasingly involved in the Council's management process in explicit advisory roles, as sources of fishery data and as stakeholders invited to participate in public meetings, hearings, and comment periods. In addition, cooperative research initiatives have resulted in joint research projects in which scientists and fishermen work together to increase both groups' understanding of the interplay of humans and the marine environment, and both the Council's Community Development Program and the Community Demonstration Projects Program, described below, foster increased fishery participation by indigenous residents of the Western Pacific Region.

7.3. Indigenous Program

The Council's indigenous program addresses the economic and social consequences of militarization, colonization and immigration on the aboriginal people in the Council's area of responsibility and authority. Generally, the resultant cultural hegemony has manifested in poverty, unemployment, social disruption, poor education, poor housing, loss of traditional and cultural practices, and health problems for indigenous communities. These social disorders affect island society. Rapid changes in the patterns of environmental utilization are disruptive to ecological systems that developed over millennia into a state of equilibrium with traditional native cultural practices. The environmental degradation and social disorder impacts the larger community by reducing the quality of life for all island residents. The result is stratification along social and economic lines and conflict within the greater community.

The primary process for the indigenous community to formally participate in the Council process is through their participation in the Subsistence and Indigenous Advisory Panel discussions. Grant workshops and other Council public fora provide additional opportunity for the indigenous community to participate in the Council process. As described in Chapter 1, the Council is sponsoring the Hoohanohano I Na Kupuna (Honoring our Ancestors) conference series in partnership with the Association of Hawaiian Civic Clubs (AOHCC) and in consultation with the native Hawaiian community. The conference has received the support of the Kamehameha Schools/Bishop Estate, Office of Hawaiian Affairs, various departments of the State of Hawaii, the Hawaii Tourism Authority and numerous community organizations and projects throughout the State of Hawaii. Fishery ecosystem management provides the Council with the opportunity to utilize the manao (thoughts) and ike (knowledge) of our kupuna (elders) – ideas and practices that have sustained na kanaka maoli (native Hawaiian) culture for millennia.

The conference series was initiated by the Council to engage the Kanaka Maoli community in the development of the Hawaii Archipelago FEP and to increase their participation in the management of fisheries under the FEP’s authority. A series of workshops with the Kanaka Maoli community to promote the concept of ahupuaa (traditional natural resource unit) management began in 2003 through the AOHCC. This endeavor was continued by the Council in order to take the ahupuaa concept to the next level, the development of a process to implement traditional resource management practices into today’s management measures.

Under the Hawaii Archipelago FEP, this conference series will continue in Hawaii and will subsequently be extended to the other areas of the Western Pacific Region. Although the specific format will be tailored to each area’s cultures and communities, in all cases the Council will seek to increase the participation of indigenous communities in the harvest, research, conservation and management of marine resources as called for in Section 305 of the MSA.

There are two programs specifically mandated by the MSA for these communities to participate in the Council process: the Western Pacific Community Development Program and the Western Pacific Community Demonstration Project Program.

7.3.1 Western Pacific Community Development Program

The Western Pacific Community Development Program (CDP) establishes a process to increase participation of the indigenous community in fisheries managed by the Council through fishery plan amendments, program development or other administrative procedures to manage fisheries.

The Council will put into service a Community Development Program Advisory Panel (CDP AP). The advisory panel will review recommendations made by a community and report to the

Council. The AP will be one of the vehicles for communities to bring their concerns to the Council for consideration in the development and implementation of fishery ecosystem plans.

7.3.2 Western Pacific Community Demonstration Project Program

The Community Demonstration Project Program (CDPP) is a grant program. The Council has an advisory panel which reviews and ranks proposals and forwards to the Council for approval and transmittal to the Secretary of Commerce.

The purpose of the Western Pacific Demonstration Project Program is to promote the involvement of western Pacific communities in fisheries by demonstrating the application and/or adaptation of methods and concepts derived from traditional indigenous practices. Projects may demonstrate the applicability and feasibility of traditional indigenous marine conservation and fishing practices; develop or enhance community-based opportunities to participate in fisheries; involve research, community education, or the acquisition of materials and equipment necessary to carry out a demonstration project.

To support this program, region wide grant application trainings and workshops are conducted by the Council. These workshops also provide a forum for the community to make recommendations and participate in the Council process. The Council develops the funding priorities.

7.4 International Management, Research and Education

The Council participates in the development and implementation of international agreements regarding marine resources. These include the Western and Central Pacific Fisheries Commission (of which one Council member is a U.S. commissioner) as well as the Inter-American Tropical Tuna Commission (of which the U.S. is a member). Although the focus of these commissions is the management of pelagic fisheries, the Council also participates in workshops regarding demersal fisheries (e.g., the Tonga Bottomfish Workshop held in January of 2007).

The Council also participates in and promotes the formation of regional and international arrangements for assessing and conserving all marine resources throughout their range, including the ecosystems and habitats that they depend on (e.g., the Forum Fisheries Agency, the Secretariat of the Pacific Community's Oceanic Fisheries Programme, the Food and Agriculture Organization of the UN, the Intergovernmental Oceanographic Commission of UNESCO, the Inter-American Convention for the Protection and Conservation of Sea Turtles, the International Scientific Council, and the North Pacific Marine Science Organization). The Council is also developing similar linkages with the Southeast Asian Fisheries Development Center and its turtle conservation program. Of increasing importance are bilateral agreements regarding demersal resources that are shared with adjacent countries. The Council also participates in broad international education initiatives such as the International Pacific Marine Educators Conference (held January 5-17, 2007 in Honolulu) as well as international marine debris conferences and fisheries forums. Figure 26 provides an illustration of the formal and informal institutional linkages in the Council process.

The Council is serving as a role model to other member nations with regard to ecosystem based-management through its participation in these and other international organizations. For example, the Council's comprehensive and interdisciplinary approach to pelagics fisheries management is an example of advances in conservation through improved gear technology; community participation through the public meeting process; sustainable fishing through limited entry programs and adherence to quota management; and using the best available science through cooperative research, improved stock assessments, and sharing knowledge within the regional fishery management organization (RFMO) process. In the future this same type of information sharing may include ecosystem-based management approaches for fisheries managed under this FEP.

Figure 26: Illustration of Institutional Linkages in the Council Process

CHAPTER 8: CONSISTENCY WITH APPLICABLE LAWS

8.1 Introduction

This chapter provides the basis for the Council's belief that the measures contained in this document are consistent with the MSA and other applicable laws. All FMP management measures included in this FEP were subject to review and approval by the Secretary of Commerce before their implementation. This review included an examination of their consistency with all applicable laws (e.g., MSA, NEPA, ESA, MMPA, CZM) and all measures were found to be consistent. Please see the FMPs for a detailed discussion of each measure. Nothing in this FEP changes or proposes changing those measures.

8.2 MSA Requirements

8.2.1 Fishery Descriptions

See Chapter 4 of this document for descriptions of the bottomfish, coral reef, crustacean and precious coral fisheries included in this FEP. Chapter 5 describes the management measures in place for these fisheries. For additional information, see the Council's annual reports which are available at www.wpcouncil.org or by mail.[27]

8.2.2 MSY and OY Estimates

Available estimates of MSY and definitions of OY for each fishery managed under this FEP are provided in Chapter 4.

8.2.3 Domestic Capacity to Harvest and Process OY

Chapter 4 describes the domestic capacity to harvest and process OY for each fishery managed under this FEP.

8.2.4 Fishery Data Requirements

Chapter 4 describes pertinent data with respect to the commercial, recreational, and charter sectors of demersal fisheries managed under this FEP. For information on the current Federal reporting requirements for Hawaii's fisheries, please see Chapter 5.

8.2.5 Description of EFH

Chapter 6 provides a description of EFH for fisheries managed under this FEP.

8.2.6 Fishery Impact Statement

[27] Western Pacific Fishery Management Council. 1164 Bishop St. Ste. 1400, Honolulu, HI. 96813.

The institutional structure for ecosystem approaches to management under this FEP does not introduce any new regulatory changes to fishery operations; therefore no short-term impacts are anticipated for fishery participants or communities in the Hawaii Archipelago. However, if successful, the long-term impact of transforming to ecosystem management is anticipated to be highly beneficial, as it will result in the integration of scientific information and human needs in a manner that increases the involvement of local communities in the management and conservation of marine resources. Given that many of the fisheries in the Hawaii Archipelago occur in remote areas, are almost exclusively prosecuted by local residents, and are subject to low enforcement levels, community involvement is crucial to successful fishery management. Not only are communities essential to voluntary compliance, local residents possess the majority of detailed place-based information regarding these resources and their interactions. In combination with the larger scale information held by government agencies, their knowledge provides the foundation for informed ecosystem management. The explicit recognition and increased inclusion of this local expertise in the management and conservation of marine resources could also stimulate and encourage communities to reclaim or continue their traditional proprietary roles, and strengthen their identities in a complex and changing world.

For detailed information on the economic and social impacts of the Hawaii Archipelago FEP see the Council's Draft Programmatic EIS on the Fishery Ecosystem Plans available from the Council by mail or online at www.wpcouncil.org.

8.2.7 Overfishing Criteria

Chapter 4 provides the stock status of each fishery managed under this FEP. Chapter 5 provides the overfishing criteria used to evaluate the status of management unit species in the Hawaii Archipelago.

8.2.8 Bycatch Reporting

For general information on bycatch issues in Hawaii Archipelago demersal fisheries refer to Chapter 4. For information on measures to reduce bycatch, see Chapter 5. Bycatch reporting is accomplished via the State and Federal reporting requirements described in Chapters 4 and 5.

Bycatch data sources for the region's bottomfish fisheries are listed in Table 38 below. Indicated for each program or survey instrument is the main agency responsible for implementing the data collection program. Additional agencies may be involved in collecting, managing, interpreting, and disseminating the data, as described above. Not included in the table are fishery-independent sources of bycatch data and sources of fisheries data that do not generally provide information on bycatch, such as programs that monitor fish sales. The bycatch-related forms used in each of these data collection programs are included in Appendix 1 of Amendment 6 to the Bottomfish FMP, Amendment 10 to the Crustaceans FMP and Amendment 4 to the Precious Corals FMP. Ensuring compliance with reporting requirements is difficult as data collection for these fisheries is conducted via non-Federal programs over which the Council and NMFS have limited authority.

Table 38: Bycatch Reporting Methodology for Hawaii Archipelago Demersal Fisheries

	Observer programs[27]	NMFS Federal Logbook programs (EEZ waters)	HDAR State Logbook Programs (All waters)	Creel surveys (All waters)
NWHI Bottomfish	NMFS: 1981-1982, 2003 - 2005 HDAR: 1990-1993 All fishing vessels must carry an observer when directed to do so by the NMFS Regional Administrator.	HDAR NWHI Bottomfish Trip Daily Log meets Federal requirement	NWHI Bottomfish Trip Daily Log	None
MHI Bottomfish	None	Federal reporting requirement recommended by Council	Fish Catch Report (commercial only)	HI Marine Recreational Fishing Survey
Coral Reef Ecosystem species	None	Required for all PHCRT catch and effort	Fish Catch Report (commercial only)	HI Marine Recreational Fishing Survey
Precious Corals	None	Required for all catch and effort	Fish Catch Report (commercial only)	None
Crustaceans	All fishing vessels must carry an observer when requested to do so by the NMFS Regional Administrator.	Required for all lobster and deepwater shrimp catch and effort	Fish Catch Report (commercial only)	HI Marine Recreational Fishing Survey

8.2.9 Recreational Catch and Release

Chapter 4 of this document describes the recreational demersal fisheries in the Hawaii Archipelago. There are no MSA recognized catch and release fishery management programs in the Hawaii Archipelago.

[27] Pursuant to the Endangered Species Act, NMFS may require fishing vessels in fisheries identified through an annual determination process to carry Federal observers (72 FR 43176, August 3, 2007).

8.2.10 Description of Fishery Sectors

Chapter 4 of this document describes the different demersal fishery sectors in the Hawaii Archipelago.

8.2.11 National Standards for Fishery Conservation and Management

National Standard 1 states that conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry.

The measures in this FEP are consistent with National Standard 1 because they emphasize managing the fisheries in a sustainable manner to best obtain optimum yield. The measures in this FEP are a result of the consolidation of the Council's previous four species-based demersal FMPs (Bottomfish and Seamount Groundfish, Coral Reef Ecosystems, Crustaceans, and Precious Corals) into one place-based Hawaii Archipelago Fishery Ecosystem Plan. The reference points and control rules for species or species assemblages within those four FMPs are maintained in this FEP without change.

National Standard 2 states that conservation and management measures shall be based upon the best scientific information available.

The measures in the fisheries managed through this FEP are consistent with National Standard 2 because they are based on the best scientific information available. Stock assessments and data on catches, catch rates, and fishing effort are compiled by the NMFS' Pacific Islands Fisheries Science Center and have gone through rigorous review processes. In addition, management decisions have complied with environmental laws including NEPA, which ensures that the public is part of the data review process.

National Standard 3 states that, to the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination.

The measures in this FEP are consistent with National Standard 3 because they promote the coordinated management of the full range of demersal species known to be present within EEZ waters around the Hawaii Archipelago.

National Standard 4 states that conservation and management measures shall not discriminate between residents of different States. If it becomes necessary to allocate or assign fishing privileges among various United States fishermen, such allocation shall be (A) fair and equitable to all such fishermen; (B) reasonably calculated to promote conservation; and (C) carried out in such manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges.

The measures in this FEP are consistent with National Standard 4 because they do not discriminate between residents of different States or allocate fishing privileges among fishery participants.

National Standard 5 states that conservation and management measures shall, where practicable, consider efficiency in the utilization of fishery resources; except that no such measure shall have economic allocation as its sole purpose.

The measures in this FEP are consistent with National Standard 5 because they do not require or promote inefficient fishing practices nor is economic allocation among fishery participants their sole purpose.

National Standard 6 states that conservation and management action shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches.

The measures in this FEP are consistent with National Standard 6 because they establish a management structure that is explicitly place based to promote consideration of the local factors affecting fisheries, fishery resources, and catches.

National Standard 7 states that conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication.

The measures in this FEP are consistent with National Standard 7 because they encourage the development of management measures that are tailored for the specific circumstances existing in the Hawaii Archipelago.

National Standard 8 states that conservation and management measures shall, consistent with the conservation requirements of this Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities in order to (A) provide for the sustained participation of such communities, and (B) to the extent practicable, minimize adverse economic impacts on such communities.

The measures in this FEP are consistent with National Standard 8 because they include explicit mechanisms to promote the participation of fishing communities in the development and implementation of future management measures in the Hawaii Archipelago.

National Standard 9 states that conservation and management measures shall, to the extent practicable, (A) minimize bycatch and (B) to the extent bycatch cannot be avoided minimize the mortality of such bycatch.

The measures in this FEP are consistent with National Standard 9 because the bycatch provisions contained within the Council's previous FMPs which were previously determined to be consistent with National Standard 9 are maintained in this FEP without change, and no new measures have been added that would increase bycatch or bycatch mortality.

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

The measures in this FEP are consistent with National Standard 10 because they do not require or promote any changes to current fishing practices or increase risks to fishery participants.

8.3 Essential Fish Habitat

None of the measures in this FEP are expected to cause adverse impacts to EFH or HAPC for species managed under the Fishery Ecosystem Plans for Pacific Pelagics, the American Samoa Archipelago, the Hawaii Archipelago, the Mariana Archipelago, or the Pacific Remote Island Areas (Table 39). Implementation of the FEPs is not expected to significantly affect the fishing operations or catches of any fisheries, rather it would replace the FMPs with geographically defined ecosystem plans containing identical fishery regulations. Furthermore, the FEPs are not likely to lead to substantial physical, chemical, or biological alterations to the oceanic and coastal habitat, or result in any alteration to waters and substrate necessary for spawning, breeding, feeding, and growth of harvested species or their prey.

The predominant fishing gear types (hook-and-line, troll, traps) used in the western Pacific fisheries included in this FEP cause few fishing-related impacts to the benthic habitat of bottomfish, crustaceans, coral reefs, and precious corals. The current management regime protects habitat through prohibitions on the use of bottom-set nets, bottom trawls, explosives, and poisons. None of the measures in the FEP will result in a change in fishing gear or strategy, therefore, EFH and HAPC maintain the same level of protection.

Table 39: EFH and HAPC for MUS of the Western Pacific Region
All areas are bounded by the shoreline, and the seaward boundary of the EEZ, unless otherwise indicated.

MUS	EFH (Juveniles and Adults)	EFH (Eggs and Larvae)	HAPC
Pelagic	Water column down to 1,000 m	Water column down to 200 m	Water column down to 1,000 m that lies above seamounts and banks
Bottomfish	Water column and bottom habitat down to 400 m	Water column down to 400 m	All escarpments and slopes between 40–280 m and three known areas of juvenile opakapaka habitat
Seamount Groundfish	Water column and bottom from 80 to 600 m, bounded by 29° °–35° ° N and 171 ° E –179° ° W (adults only)	Epipelagic zone (0–200 nm) bounded by 29° °–35° ° N and 171° ° E -179° ° W (includes juveniles)	Not identified

MUS	EFH (Juveniles and Adults)	EFH (Eggs and Larvae)	HAPC
Precious Corals	Keahole, Makapuu, Kaena, Wespac, Brooks, and 180 Fathom gold/red coral beds, and Milolii, S. Kauai, and Auau Channel black coral beds	Not applicable	Makapuu, Wespac, and Brooks Bank beds, and the Auau Channel
Crustaceans	**Lobsters** Bottom habitat from shoreline to a depth of 100 m	Water column down to 150 m	All banks with summits less than 30 m
	Deepwater shrimp The outer reef slopes at depths between 300-700 m	Water column and associated outer reef slopes between 550 and 700 m	No HAPC designated for deepwater shrimp.
Coral reef ecosystem	Water column and benthic substrate to a depth of 100 m	Water column and benthic substrate to a depth of 100 m	All MPAs identified in the FMP, all PRIA, many specific areas of coral reef habitat (see Chapter 6)

8.4 Coastal Zone Management Act

The Coastal Zone Management Act requires a determination that a recommended management measure has no effect on the land or water uses or natural resources of the coastal zone or is consistent to the maximum extent practicable with the enforceable polices of an affected state's approved coastal zone management program. A copy of this document will be submitted to the appropriate state government agencies in Hawaii for review and concurrence with a determination that the recommended measures are consistent, to the maximum extent practicable, with the state coastal zone management program.

8.5 Endangered Species Act

The ESA requires that any action authorized, funded, or carried out by a federal agency ensure its implementation would not jeopardize the continued existence of listed species or adversely modify their critical habitat. Species listed as endangered or threatened under the ESA that have been observed, or may occur, in the Western Pacific Region are listed below (and are described in more detail in Chapter 3):

- All Pacific sea turtles including the following: olive ridley sea turtles (*Lepidochelys olivacea*), leatherback sea turtles (*Dermochelys coriacea*), hawksbill turtles (*Eretmochelys imbricata*), loggerhead (*Caretta caretta*), and green sea turtles (*Chelonia mydas*).

- The humpback whale (*Megaptera novaeangliae*), sperm whale (*Physeter macrocephalus*), blue whale (*Balaenoptera musculus*), fin whale (*B. physalus*), and sei whale (*B. borealis*). In addition, one endangered pinniped, the Hawaiian monk seal (*Monachus schauinslandi*).

ESA consultations were conducted by NMFS and the U.S. Fish and Wildlife Service (for species under their jurisdiction) to ensure ongoing fisheries operations —including the bottomfish and seamount groundfish fishery, the crustacean fishery, and the harvest of precious corals and coral reef species—are not jeopardizing the continued existence of any listed species or adversely modifying critical habitat. The results of these consultations, conducted under section 7 of the ESA, are briefly described below. Implementation of this FEP would not result in any additional measures not previously analyzed. Therefore, the Council believes that there would be no additional impacts to any listed species or habitat.

Section 7 Consultations

In a biological opinion issued in March 2002 NMFS concluded that the ongoing operation of the Western Pacific Region's bottomfish and seamount fisheries, as managed under the Bottomfish and Seamount Groundfish FMP, was not likely to jeopardize the continued existence of any threatened or endangered species under NMFS's jurisdiction or destroy or adversely modify any critical habitat (NMFS 2002a). This determination was made pursuant to section 7 of the ESA.

A biological opinion issued in March 2008 examined the impacts of MHI bottomfish fisheries and concluded that they are likely to adversely affect up to two green sea turtles each year but are not likely to jeopardize the species or adversely affect any other ESA-listed species or critical habitat (NMFS 2008).

The management and conservation measures contained in this FEP for targeting bottomfish or seamount groundfish species are being carried forth from the Bottomfish and Seamount Groundfish FMP and no additional measures are proposed at this time. Therefore, the Council believes that the proposed bottomfish and seamount groundfish fishing activities under this FEP are not likely to jeopardize the continued existence of any threatened or endangered species under NMFS's jurisdiction or destroy or adversely modify critical habitat.

A biological opinion issued by NMFS in May 1996 concluded that the ongoing operation of the Western Pacific Region's crustacean fisheries were not likely to jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify critical habitat (NMFS 1996).

An informal consultation completed by NMFS in April 2008 concluded that Hawaii Archipelago crustacean fisheries are not likely to adversely affect any ESA-listed species or critical habitat.

The management and conservation measures contained in this FEP for targeting crustacean species are being carried forth from the Crustaceans FMP and no additional measures are proposed at this time. Therefore, the Council believes that the proposed crustacean fishing activities under this FEP not likely to jeopardize the continued existence of any threatened or endangered species under NMFS's jurisdiction or destroy or adversely modify critical habitat.

In a biological opinion issued in October 1978, NMFS concluded that the ongoing operation of the Western Pacific Region's precious coral fisheries was not likely to jeopardize the continued existence of any threatened or endangered species under NMFS's jurisdiction or destroy or adversely modify critical habitat (NMFS 1978).

An informal consultation completed by NMFS in February 2008 concluded that Hawaii Archipelago precious coral fisheries are not likely to adversely affect any ESA-listed species or critical habitat.

The management and conservation measures contained in this FEP for targeting precious corals are being carried forth from the Precious Corals FMP and no additional measures are proposed at this time. Therefore, the Council believes that the proposed precious coral fishing activities under this FEP not likely to jeopardize the continued existence of any threatened or endangered species under NMFS's jurisdiction or destroy or adversely modify critical habitat.

An informal consultation completed by NMFS on March 7, 2002 concluded that that fishing activities conducted under the Coral Reef Ecosystems FMP are not likely to adversely affect endangered or threatened species or critical habitat under NMFS's jurisdiction (NMFS 2002b). On May 22, 2002, the USFWS concurred with the determination of NMFS that the activities conducted under the Coral Reef Ecosystems FMP are not likely to adversely affect listed species under USFWS's exclusive jurisdiction (i.e., seabirds and terrestrial plants) and listed species shared with NMFS (i.e., sea turtles).

The management and conservation measures contained in this FEP for targeting coral reef species are being carried forth from the Coral Reef Ecosystems FMP and no additional measures are proposed at this time. Therefore, the Council believes that the proposed coral reef fishing activities under this FEP not likely to jeopardize the continued existence of any threatened or endangered species under NMFS's jurisdiction or destroy or adversely modify critical habitat.

8.6 Marine Mammal Protection Act

Under section 118 of the Marine Mammal Protection Act (MMPA), NMFS must publish, at least annually, a List of Fisheries (LOF) that classifies U.S. commercial fisheries into one of three categories. These categories are based on the level of serious injury and mortality of marine mammals that occurs incidental to each fishery. Specifically, the MMPA mandates that each fishery be classified according to whether it has frequent, occasional, or a remote likelihood of or no-known incidental mortality or serious injury of marine mammals.

NMFS uses fishery classification criteria, which consist of a two-tiered, stock-specific approach.

This two-tiered approach first addresses the total impact of all fisheries on each marine mammal stock and then addresses the impact of individual fisheries on each stock. This approach is based on the rate, in numbers of animals per year, of incidental mortalities and serious injuries of marine mammals due to commercial fishing operations relative to a stock's Potential Biological Removal (PBR) level. The PBR level is defined in 50 CFR 229.2 as the maximum number of animals, not including natural mortalities that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population.

Tier 1:
If the total annual mortality and serious injury across all fisheries that interact with a stock is less than or equal to 10 percent of the PBR level of this stock, all fisheries interacting with this stock would be placed in Category III. Otherwise, these fisheries are subject to the next tier of analysis to determine their classification.

Tier 2:
Category I: Annual mortality and serious injury of a stock in a given fishery is greater than or equal to 50 percent of the PBR level.
Category II: Annual mortality and serious injury of a stock in a given fishery is greater than 1 percent and less than 50 percent of the PBR level.
Category III: Annual mortality and serious injury of a stock in a given fishery is less than or equal to 1 percent of the PBR level.

All of the demersal fisheries conducted in waters around the Hawaii Archipelago are listed as Category III (73 FR 73032, December 1, 2008). Fisheries managed under this FEP are not expected to change their historical fishing operations or patterns as a result of implementation of the FEP. Therefore, no increased impacts on marine mammals that occur in the waters around the Hawaii Archipelago are expected. The regulations governing Category III fisheries (found at 50 CFR 229.5) are listed below:

§ 229.5 Requirements for Category III fisheries.

- (a) *General.* Vessel owners and crew members of such vessels engaged only in Category III fisheries may incidentally take marine mammals without registering for or receiving an Authorization Certificate.
- (b) *Reporting.* Vessel owners engaged in a Category III fishery must comply with the reporting requirements specified in §229.6.
- (c) *Disposition of marine mammals.* Any marine mammal incidentally taken must be immediately returned to the sea with a minimum of further injury unless directed otherwise by NMFS personnel, a designated contractor, or an official observer, or authorized otherwise by a scientific research permit in the possession of the operator.
- (d) *Monitoring.* Vessel owners engaged in a Category III fishery must comply with the observer requirements specified under §229.7(d).
- (e) *Deterrence.* When necessary to deter a marine mammal from damaging fishing gear, catch, or other private property, or from endangering personal safety, vessel owners and crew members engaged in commercial fishing operations must comply with all

deterrence provisions set forth in the MMPA and any other applicable guidelines and prohibitions.

- (f) *Self-defense.* When imminently necessary in self-defense or to save the life of a person in immediate danger, a marine mammal may be lethally taken if such taking is reported to NMFS in accordance with the requirements of §229.6.
- (g) *Emergency regulations.* Vessel owners engaged in a Category III fishery must comply with any applicable emergency regulations.

NMFS has concluded that Hawaii Archipelago commercial bottomfish, crustacean, precious corals, and coral reef fisheries will not affect marine mammals in any manner not considered or authorized under the Marine Mammal Protection Act.

8.7 National Environmental Policy Act

To comply with the National Environmental Policy Act, a Programmatic Environmental Impact Statement (PEIS) has been prepared to analyze the proposed action to implement this FEP. A Draft PEIS (dated October 27, 2005) was circulated for public review from November 10, 2005 to December 26, 2005 (70 FR 68443). The draft FEPs accompanied the Draft PEIS.

Subsequent to the circulation of the 2005 Draft PEIS for public review, it was decided to expand the document to contain analyses of impacts related specifically to the approval and implementation of fishery ecosystems plans in the Western Pacific Region. As a result, NMFS' Pacific Islands Regional Office and Council staff revised the Draft PEIS that was released in October 2005 and published a notice of availability of a new Draft PEIS in the Federal Register on April 13, 2007 (72 FR 18644). The public comment period for the revised Draft PEIS ended on May 29, 2007, and responses to the comments received have been incorporated into a Final PEIS and this document where applicable.

8.8 Paperwork Reduction Act (PRA)

The purpose of the Paperwork Reduction Act (PRA) is to minimize the burden on the public by ensuring that any information requirements are needed and are carried out in an efficient manner (44 U.S.C. 350191(1)). None of the measures contained in this FEP have any new public regulatory compliance or other paperwork requirements and all existing requirements were lawfully approved and have been issued the appropriate OMB control numbers.

8.9 Regulatory Flexibility Act (RFA)

In order to meet the requirements of the Regulatory Flexibility Act (RFA), 5 U.S.C. 601 et seq. requires government agencies to assess the impact of their regulatory actions on small businesses and other small entities via the preparation of regulatory flexibility analyses. The RFA requires government agencies to assess the impact of significant regulatory actions on small businesses and other small organizations. The basis and purpose of the measures contained in this FEP are described in Chapter 1, and the alternatives considered are discussed in the EIS prepared for this action. Because none of the alternatives contain any regulatory compliance or paperwork requirements, the Council believes that this action is not significant (i.e., it will not have a significant impact on a substantial number of small entities) for the purposes of the RFA, and no Initial Regulatory Flexibility Analysis has been prepared.

8.10 Executive Order 12866

In order to meet the requirements of Executive Order 12866 (E.O. 12866), NMFS requires that a Regulatory Impact Review be prepared for all regulatory actions that are of public interest. This review provides an overview of the problem, policy objectives, and anticipated impacts of the proposed action, and ensures that management alternatives are systematically and comprehensively evaluated such that the public welfare can be enhanced in the most efficient and cost effective way. In accordance with E.O. 12866, the following is set forth by the Council: (1) This rule is not likely to have an annual effect on the economy of more than $100 million or to adversely affect in a material way the economy, a sector of the economy, productivity, jobs, the environment, public health or safety, or state, local, or tribal governments or communities; (2) This rule is not likely to create any serious inconsistencies or otherwise interfere with any action taken or planned by another agency; (3) This rule is not likely to materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights or obligations of recipients thereof; (4) This rule is not likely to raise novel or policy issues arising out of legal mandates, or the principles set forth in the Executive Order; (5) This rule is not controversial. The measures contained in this FEP are anticipated to yield net economic benefits to the nation by improving our ability to maintain healthy and productive marine ecosystems, and foster the long-term sustainable use of marine resources in an ecologically and culturally sensitive manner that relies on the use of a science-based ecosystem approach to resource conservation and management.

8.11 Information Quality Act

This information complies with the Information Quality Act and NOAA standards (NOAA Information Quality Guidelines, September 30, 2002) that recognize information quality is composed of three elements: utility, integrity, and objectivity. Central to the preparation of this regulatory amendment is objectivity that consists of two distinct elements: presentation and substance. The presentation element includes whether disseminated information is presented in an accurate, clear, complete, and unbiased manner and in a proper context. The substance element involves a focus on ensuring accurate, reliable, and unbiased information. In a scientific, financial, or statistical context, the original and supporting data shall be generated, and the analytic results shall be developed, using sound statistical and research methods.

At the same time, however, the federal government has recognized that "information quality comes at a cost." In this context, agencies are required to weigh the costs and the benefits of higher information quality in the development of information, and the level of quality to which the information disseminated will be held" (OMB Guidelines, pp. 8452–8453).

One of the important potential costs in acquiring "perfect" information (which is never available), is the cost of delay in decision- making. While the precautionary principle suggests that decisions should be made in favor of the environmental amenity at risk (in this case, marine ecosystems), this does not suggest that perfect information is required for management and conservation measures to proceed. In brief, it does suggest that caution be taken but that it not lead to paralysis until perfect information is available. This document has used the best available information and made a broad presentation of it. The process of public review of this document provides an opportunity for comment and challenge to this information, as well as for the provision of additional information. A draft of this FEP was distributed for public review along with a revised draft of the Final Programmtic Environmental Impact Statement (see Section 8.7).

8.12 Executive Order 13112

Executive Order 13112 requires agencies to use authorities to prevent introduction of invasive species, respond to, and control invasions in a cost effective and environmentally sound manner, and to provide for restoration of native species and habitat conditions in ecosystems that have been invaded. Executive Order 13112 also provides that agencies shall not authorize, fund, or carry out actions that are likely to cause or promote the introduction or spread of invasive species in the U.S. or elsewhere unless a determination is made that the benefits of such actions clearly outweigh the potential harm, and that all feasible and prudent measures to minimize the risk of harm will be taken in conjunction with the actions. The Council has adopted several recommendations to increase the knowledge base of issues surrounding potential introductions of invasive species into waters included in this FEP. The first recommendation is to conduct invasive species risk assessments by characterizing the shipping industry, including fishing, cargo, military, and cruise ships for each FEP's geographic area. This assessment will include a comparative analysis of the risk posed by U.S. fishing vessels in the western Pacific with other vectors of marine invasive species.

The second recommendation is to develop a component in the Council's existing education program to educate fishermen on invasive species issues and inform the fishing industry of methods to minimize and mitigate the potential for inadvertent introduction of alien species to island ecosystems.

The measures contained in this document are not expected to result in changes to current fishing operations and therefore are not expected to the risk or actual introduction of alien species to the Hawaii Archipelago or elsewhere.

8.13 Executive Order 13089

In June 1998 President Clinton signed an Executive Order for Coral Reef Protection, which established the Coral Reef Task Force (CRTF) and directed all federal agencies with coral reef-related responsibilities to develop a strategy for coral reef protection. Federal agencies were directed to work cooperatively with state, territorial, commonwealth, and local agencies; non-governmental organizations; the scientific community; and commercial interests to develop the plan. The Task Force was directed to develop and implement a comprehensive program of research and mapping to inventory, monitor, and address the major causes and consequences of degradation of coral reef ecosystems. The Order directs federal agencies to use their authorities to protect coral reef ecosystems and, to the extent permitted by law, prohibits them from authorizing, funding, or carrying out any actions that will degrade these ecosystems.

Of particular interest to the Council is the implementation of measures to address: (1) fishing activities that may degrade coral reef ecosystems, such as overfishing, which could affect ecosystem processes (e.g., the removal of herbivorous fishes leading to the overgrowth of corals by algae) and destroy the availability of coral reef resources (e.g., extraction of spawning aggregations of groupers); (2) destructive fishing techniques, which can degrade EFH and are thereby counter to the Magnuson-Stevens Act; (3) removal of reef substrata; and (4) discarded and/or derelict fishing gear, which can degrade EFH and cause ghost fishing."

To meet the requirements of Executive Order 13089, the Coral Reef Task Force issued the National Action Plan to Conserve Coral Reefs in March 2000. In response to the recommendations outlined in the Action Plan, President Clinton announced Executive Order 13158, which is designed to strengthen and expand Marine Protected Areas.

8.14 Papahanaumokuakea Marine National Monument

In June, 2006, President Bush issued a proclamation establishing the Northwestern Hawaiian Islands Marine National Monument, since renamed Papahanaumokuakea Marine National Monument, a status which significantly affects the NWHI commercial fishing operations. The National monument designation superseded the proposed NWHI National Marine Sanctuary.

The President's proclamation calls for the closure of commercial fisheries, including the limited entry crustacean fishery within the Monument's boundaries immediately and of the NWHI bottomfish fishery by June 15, 2011. Native Hawaiian cultural practices, including sustenance fishing may, however, be permitted to continue. Although the commercial bottomfish and associated pelagic fishing operations in the NWHI may continue over the five-year period, they are subject to landing limits of 350,000 pounds of bottomfish and 180,000 pounds of pelagic fish which may be landed within a given year. Furthermore, until June 15, 2011 when commercial fishing will be prohibited in the monument, all bottomfish fishing operations in the NWHI must comply with new monument regulations including area closures, vessel monitoring and reporting requirements in addition to existing regulations.

CHAPTER 9: STATE, LOCAL AND OTHER FEDERAL AGENCIES

9.1 Introduction

This chapter provides information on current fishery management authorities for the Hawaii Archipelago that are relevant to ecosystem fishery management.

9.2 State of Hawaii

The State of Hawaii consists of all islands, together with their appurtenant reefs and territorial waters, which were included in the Territory of Hawaii under the Organic Act of 1900. Under the Admissions Act of 1959, Congress granted to Hawaii the status of statehood and all amenities of a state, which included the reversion of title and ownership of the lands beneath the navigable waters from the mean high-tide line seaward, out to a distance of three miles, as stated by the Submerged Lands Act of 1953. Congress excluded Palmyra Atoll Kingman Reef, and Johnston Atoll, including Sand Island, from the definition of the State of Hawaii in 1959. The federal government also retained 1,765 acres of emergent land in the NWHI, which had been set aside by Executive Order 1019 in 1909, establishing the Hawaiian Islands Reservation (HIR).The HIR was later renamed the Hawaiian Islands National Wildlife Refuge (HINWR) after it was transferred from the Department of Agriculture to the Department of Interior in 1939 (Yamase 1982). Kure Atoll was originally included in Executive Order 1019 but was returned to the State of Hawaii in 1952 by Executive Order 10413 (Yamase, 1982). 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) such that the authority of the MSA begins at three miles from the shoreline around the Main Hawaiian Islands.

Department of Land and Natural Resources, Division of Aquatic Resources

The management responsibility of marine resources in the State of Hawaii is vested in the Department of Land of Natural Resources through the Hawaii Division of Aquatic Resources.

The mission of HDAR is to manage, conserve and restore the state's unique aquatic resources and ecosystems for present and future generations. HDAR manages the State's aquatic resources and ecosystems through programs in commercial fisheries and resource enhancement; aquatic resources protection, habitat enhancement and education; and recreational fisheries. Major program areas include projects to manage or enhance fisheries for long-term sustainability of the resources, protect and restore the aquatic environment, protecting native and resident aquatic species and their habitat, and providing facilities and opportunities for recreational fishing.

HDAR utilizes a range of fishery management tools to conserve and manage the state's marine resources and ecosystem including gear restrictions, size and bag limits, closed seasons, permit and reporting requirements, and an array of marine managed areas (i.e., Regulated Fishing Areas, Public Fishing Areas, Marine Life Conservation Districts, and Marine Refuges) among other measures. Regulations governing fishing activities and harvest of marine resources can be found in the Hawaii Revised Statutes, Title 13, Subtitle 4, Fisheries.

9.3 U.S. Fish and Wildlife Refuges and Units

The USFWS has been given authority to manage National Wildlife Refuges (NWR) within the Hawaii Archipelago.

Executive Order 1019 reserved and set apart the islands reefs and atolls from Nihoa to Kure Atoll, excluding Midway, "as a preserve and breeding ground for native birds" to be administered by the Department of Agriculture. The Hawaiian Islands Reservation was transferred to the Department of the Interior in 1939 and in 1940 renamed the Hawaiian Islands NWR through Presidential Proclamation 2466, with control transferred to the USFWS.

Midway Atoll NWR, established under Executive Order 13022 in 1996, is located in the NWHI and identifies a refuge boundary of approximately 12 miles seaward from the shoreline (the exact boundary is disputed). The Navy established a Naval Air Facility at Midway in 1941 and the USFWS established an overlay refuge in 1988 to manage fish and wildlife on the atoll. Through the Base Alignment Closure Act of 1990, as amended, the Naval Air Facility closed in 993 and the property was transferred to the USFWS in 1996 (USFWS 1999a). The mission of the refuge is to protect and restore biological diversity and historic resources of Midway Atoll, while providing opportunities for compatible recreational activities, education and scientific research (Shallenberger 2000). USFWS regulations governing access and uses within National Wildlife Refuges can be found in 50 CFR Part 32.

In accordance with the MSA, any regulations proposed by the Council would be consistent with the Act and any other applicable law. Currently, the Council recognizes state waters in the NWHI from 0-3 miles and asserts management authority over fishery resources in all federal waters (3-200 miles), except at Midway where it asserts authority from 0-200 miles (Gillman 2000).

9.4 Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve

In May 2000, then President Clinton issued a Memorandum to implement a U.S. Coral Reef Task Force recommendation and comprehensively protect the coral reef ecosystem of the NWHI. The Memorandum directed the Secretaries of Interior and Commerce, in cooperation with the State of Hawaii, and in consultation with the WPRFMC, to develop recommendations for a new, coordinated management regime to increase protection for the NWHI coral reef ecosystem and provide for sustainable use. After considering their recommendations and comments received during the public visioning process on this initiative, President Clinton issued Executive Order 13178 on December 4, 2000, establishing the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve, pursuant to the National Marine Sanctuaries Amendments Act of 2000 (NMSA). The Executive Order was revised and finalized by Executive Order 13196, issued January 18, 2001. Pursuant to Executive Order 13178 and the NMSA, NOAA was initiating the process to designate the Reserve as a national marine sanctuary (66 FR 5509, January 19, 2001) when on June 15, 2006, President George W. Bush signed Presidential Proclamation No. 8031 establishing the Northwestern Hawaiian Islands Marine National Monument. Section 8.14 discusses compliance with the Monument.

Papahanaumokukea Marine National Monument

On June 15, 2006, President George W. Bush signed Presidential Proclamation No. 8031 establishing the Northwestern Hawaiian Islands Marine National Monument (NWHI monument, since renamed the Papahanaumokukea Marine National Monument). The proclamation set apart and reserved the Northwestern Hawaiian Islands for the purpose of protecting the historic objects, landmarks, prehistoric structures and other objects of historic or scientific interest that are situated upon lands owned and controlled by the federal Government of the United States. Proclamation No. 8031 directs the Secretary of Commerce and the Secretary of the Interior (the Secretaries) to prohibit access into the NWHI monument unless authorized, and limit or regulate virtually all activities in the area through a permit and zoning system, among other measures.

In establishing the NWHI monument, Proclamation No. 8031 assigns primary management responsibility of marine areas to the Secretary of Commerce, through NOAA, in consultation with the Secretary of the Interior. The proclamation assigns the Secretary of the Interior, through the USFWS, with sole responsibility for management of the areas of the monument that overlay the Midway Atoll National Wildlife Refuge, the Battle of Midway National Memorial and the Hawaiian Islands National Wildlife Refuge, in consultation with the Secretary of Commerce. Proclamation No. 8031 also requires the Secretary of Commerce to manage the NWHI monument in consultation with the Secretary of the Interior and the State of Hawaii and directs the Secretaries to promulgate any additional regulations needed for the proper care and management of the monument objects identified above, to the extent authorized by law.

Proclamation No. 8031 allows the Secretary of Commerce and the Secretary of Interior (Secretaries) to issue permits for the following activities: (1) research activities; (2) educational activities; (3) conservation and management activities; (4) Native Hawaiian practices: (5) special ocean uses; and (6) recreational activities. Proclamation No. 8031 directs the Secretaries to allow all permitted vessels to conduct subsistence fishing while in the monument and, directs the Secretaries to prohibit commercial fishing in the monument five years from the date of the monument designation. Federal regulations for monument activities were published on August 26, 2006 (71 FR 51134), and can be found at 50 CFR Part 404. The prohibitions for Monument access do not apply to activities and exercises of the Armed Forces (including those carried out by the United States Coast Guard) or for emergencies threatening life, property, or the environment, or to activities necessary for law enforcement purposes.

9.5 Hawaiian Islands Humpback Whale National Marine Sanctuary

The Hawaiian Islands Humpback Whale National Marine Sanctuary is located within waters from the shoreline to the 100 fathom isobath around the islands of Hawaii, Maui, Molokai, Lanai, and parts of Oahu and Kauai. The primary purpose of the sanctuary is to protect humpback whales and their habitat. This sanctuary's designation document does not provide for the management of fishing operations at this time (NOAA 1997).

9.6 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 the Naval Defensive Sea Areas (NDSA) around Johnston and Midway Atolls. 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. In 1996 Executive Order 13022 rescinded the Midway Atoll NDSA.

The Navy exerts jurisdiction over Ka‘ula Rock in the MHI, which is used as a military bombing range. The Navy also exerts jurisdiction over a variety of waters offshore from military ports and air bases in the Hawaii Archipelago.

CHAPTER 10: PROPOSED REGULATIONS

In preparation

CHAPTER 11: REFERENCES

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