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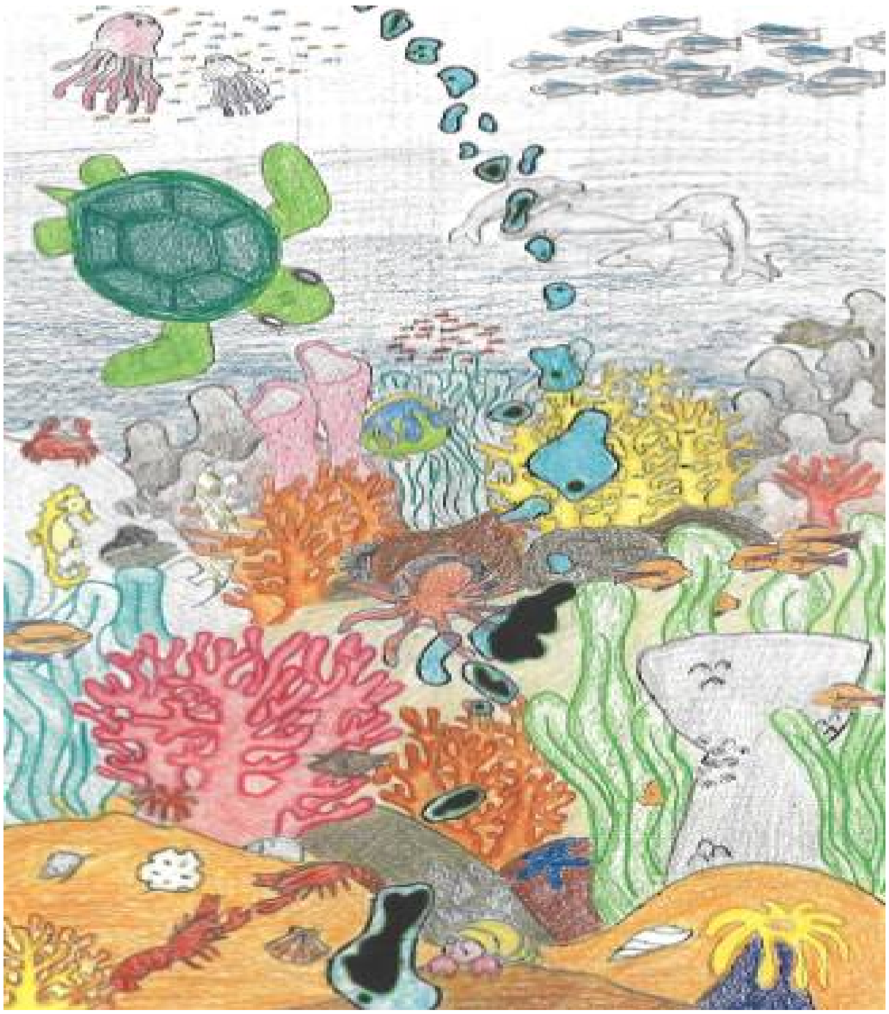
Fishery Ecosystem Plan for the Mariana Archipelago



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Cover Artwork Courtesy of SoJung Song, Saipan Community School, Susupe, Saipan, Northern Mariana Islands

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 Guam and the Commonwealth of the Northern Mariana Islands (CNMI).

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. This FEP, in conjunction with the Council's American Samoa Archipelago, Hawaii 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 reorganizes their associated regulations into a place-based structure aligned with the FEPs.

The Mariana 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 Guam and the CNMI. 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 Guam and the CNMI 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 and socioeconomic environment of these islands, they will be managed separately through the Pacific Pelagic FEP.

In addition, under the Mariana Archipelago FEP, the organizational structure for developing and implementing Fishery Ecosystem Plans explicitly incorporates community input and local knowledge into the management process. This FEP also identifies topics in ecosystem approaches to management and identifies 10 overarching objectives to guide the Council in further implementing ecosystem approaches to management.

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
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
DAWR:	Division of Aquatic and Wildlife Resources, Government of Guam
DFW:	Division of Fish and Wildlife, Government of CNMI
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
IQA	Information Quality Act
IRFA	Initial Regulatory Flexibility Analysis
Kg:	kilograms
Km:	kilometers
LOF	List of Fisheries
LORAN	Long Range Aid to Navigation
mt:	metric tons
MFMT:	Maximum Fishing Mortality Threshold
MHI:	Main Hawaiian Islands
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
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
SPR:	Spawning Potential Ratio
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.

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: Any person 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 under this FEP; 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 numbered 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.

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.

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

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°20' 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 the 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 Hawaiian 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 (PRIAs): 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 moundlike structure built by sedentary calcareous organisms and consisting mostly of their remains. It is wave-resistant and stands above the surrounding sediment. It is characteristically colonized by communities of encrusting and colonial invertebrates and calcareous algae.

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

Regulatory Discards: Any species caught that fishermen are required by regulation to discard 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 that 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]

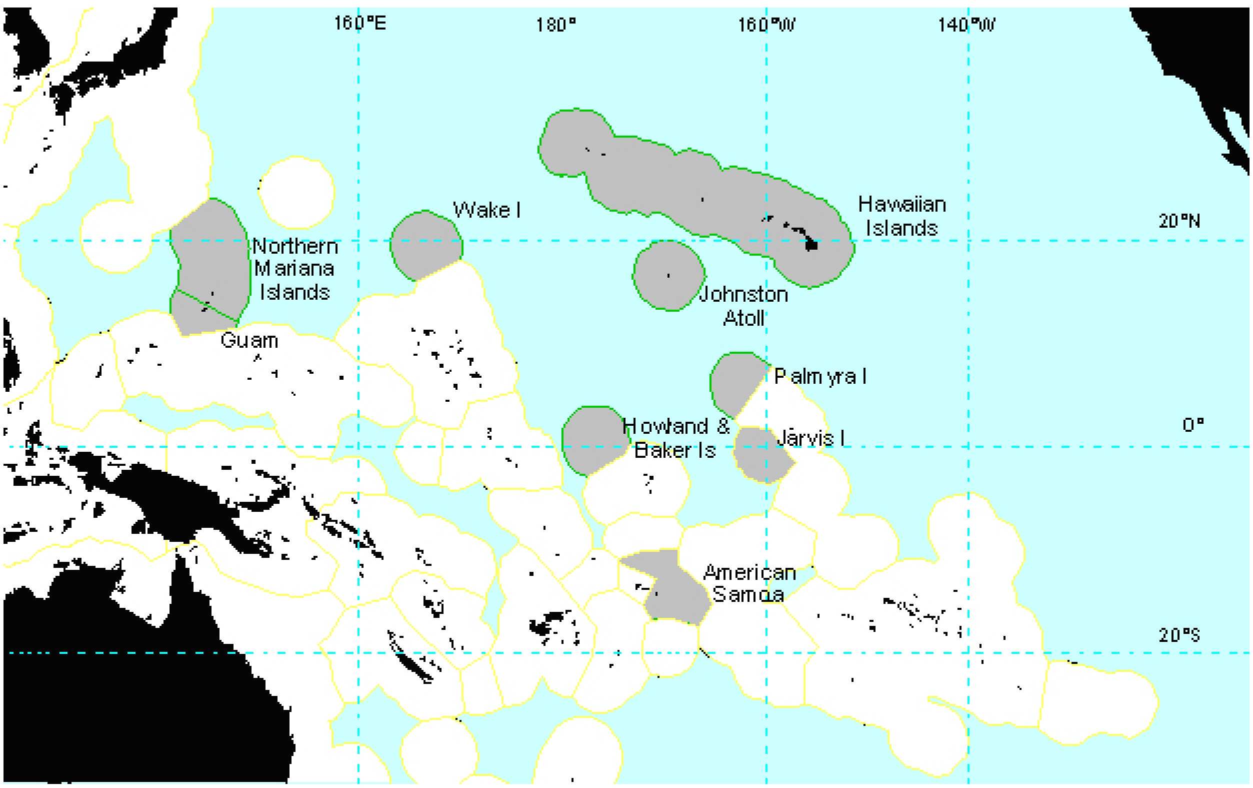

Figure 1. Western Pacific Region

[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, also 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. This remains true in today's modern period in which 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 establishing the Ecosystem Principles Advisory Panel (Panel; EPAP), which was responsible for assessing the extent to which ecosystem principles were being used in fisheries management and recommending how to further ecosystem principle use to improve the status and management of marine resources. The Panel was composed of members of academia, fishery and conservation organizations, and fishery management agencies.

The EPAP reached consensus that Fishery Ecosystem Plans (FEPs) should be developed and implemented to manage U.S. fisheries and marine resources (NMFS 1999). According to the EPAP, an 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 which 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.
- An ecosystem has 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, the 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).

In recognition of the Panel's findings, the Council recommended the initiation of an incremental shift toward an ecosystem approach for fisheries of the entire Western Pacific Region.[2]
Given the above, this document establishes an FEP for the non-pelagic fisheries of the Mariana Archipelago. In particular, it:

1. identifies the management objectives of the Mariana Archipelago FEP;
2. delineates the boundaries of the Mariana Archipelago FEP;
3. designates the management unit species included in the Mariana Archipelago FEP;
4. details the federal fishery regulations applicable under the Mariana Archipelago FEP; and

[2] At its 130th meeting held December 20, 2005, the Council took final action to recommend implementation of place-based FEPs for the Western Pacific Region.

5. establishes appropriate Council structures and advisory bodies to provide scientific and management advice to the Council regarding the Mariana Archipelago FEP.

In addition, this document provides the information and rationale for these measures; discusses the key components of the Mariana 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, Hawaii Archipelago, Pacific Remote Island Areas and Pacific Pelagic FEPs, incorporates by reference and replaces the Council's existing Bottomfish and Seamount Groundfish, Coral Reef Ecosystems, Crustaceans, Precious Corals and Pelagic Fishery Management Plans (and their amendments), 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 Mariana 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 Guam and the CNMI. 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 Guam and the CNMI 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 an Archipelagic 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 Mariana 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. 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 (NOAA 2004).

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' 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 Mariana Archipelago FEP boundary includes all waters and associated marine resources within the EEZ surrounding the Commonwealth of the Northern Mariana Islands (CNMI) and the Territory of Guam (Figure 2). Although this overlaps with the boundaries of the Council's Pacific Pelagic FEP for pelagic fisheries, the Mariana Archipelago FEP specifically manages those demersal resources and habitats associated with the federal waters of the Mariana 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.

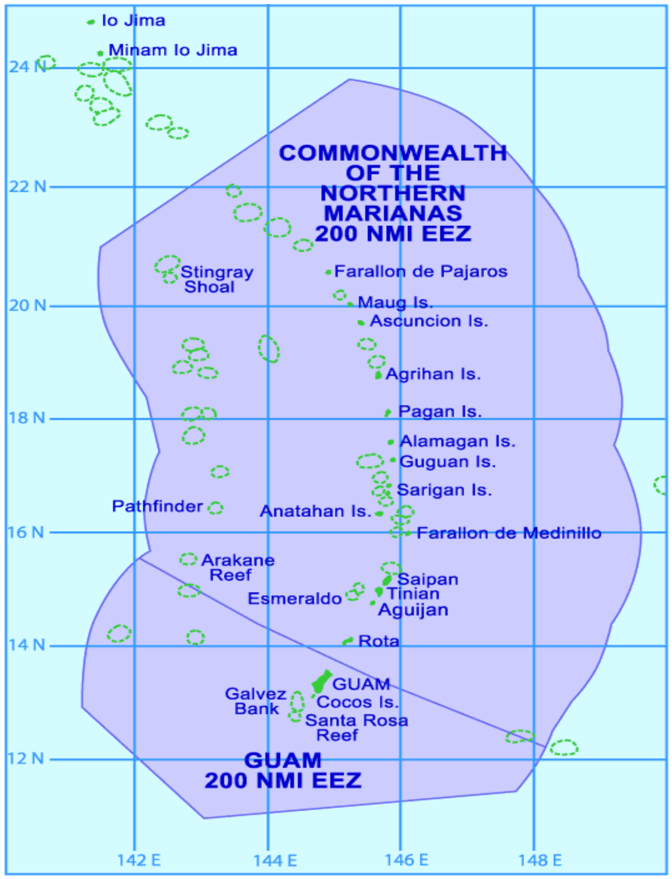

Figure 2. 200 Nautical Mile EEZ surrounding Guam and CNMI
Source: NMFS, Pacific Islands Fisheries Science Center, Western Pacific Fisheries Information Network

1.5 Mariana 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 Mariana Archipelago FEP - along with the Pacific Pelagic FEP, the American Samoa Archipelago FEP, the Hawaii Archipelago FEP and the Pacific Remote Island Areas FEP- represents the next step in the establishment and successful implementation of place-based FEPs for all of the fisheries within the Council's jurisdiction, which it will manage using an ecosystem-based approach.

The overall goal of the Mariana 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 Mariana 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 nongovernmental 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 Mariana Archipelago FEP Management Unit Species

Management unit species (MUS) are typically those species that are harvested in significant quantities to warrant conservation and management under each FEP. In the Mariana Archipelago, however, some of the fisheries are still in their infancy in terms of harvests in Federal waters and therefore some MUS, such as the coral reef ecosystem MUS, may not be currently harvested in a substantial quantity. However, should that occur in the future, this FEP will manage these species as well as those currently harvested in substantial quantities. The primary impact of including a species in a MUS list is that the species (i.e., the fishery targeting that species) can be directly managed. 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 Mariana

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 Mariana Archipelago. Although, certain pelagic MUS are known to occur within the boundary of the Mariana Archipelago FEP, they are managed under a separate Pacific Pelagic FEP.

Tables 1–5 list those 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 Mariana Archipelago 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 4.2.1.5, 4.2.2.5 (bottomfish MUS), 4.3.1.5, 4.3.2.5 (crustacean MUS), 4.4.1.5, 4.4.2.5 (precious coral MUS) and 4.5.1.5, 4.5.2.5 (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. Permitting and data collection measures 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.

In Tables 1-5, the local names of fish species are provided in Chamorro and Carolinian, the two native languages of the Mariana Archipelago. Where no local Chamorro or Carolinian name has identified for a particular species, the symbol NA (not applicable) is provided.

Table 1. Mariana Archipelago Bottomfish MUS

Scientific Name	English Common Name	Local Name Chamorro/Carolinian
*Aphareus rutilans**	red snapper/silvermouth	lehi/maroobw
*Aprion virescens**	gray snapper/jobfish	gogunafon/aiwe
*Caranx ignobilis**	giant trevally/jack	tarakitu/etam

Scientific Name	English Common Name	Local Name Chamorro/Carolinian
*C. lugubris**	black trevally/jack	tarakiton attelong/orong
*Epinephelus fasciatus**	blacktip grouper	gadao/meteyil
*Variola louti**	lunartail grouper	bueli/bwele
*Etelis carbunculus**	red snapper	buninas agaga/ falaghal moroobw
*E. coruscans**	red snapper	buninas/taighulupegh
*Lethrinus rubrioperculatus**	redgill emperor	mafuti/atigh
*Lutjanus kasmira**	blueline snapper	funai/saas
*Pristipomoides auricilla**	yellowtail snapper	buninas/falaghal-maroobw
*P. filamentosus**	pink snapper	buninas/falaghal-maroobw
*P. flavipinnis**	yelloweye snapper	buninas/falaghal-maroobw
*P. seiboldii**	pink snapper	NA
*P. zonatus**	snapper	buninas rayao amiriyu/ falaghal-maroobw
*Seriola dumerili**	amberjack	tarakiton tadong/meseyugh

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

Table 2. Mariana Archipelago Crustaceans MUS

Scientific Name	English Common Name	Local Name
Panulirus penicillatus	spiny lobster	mahongang
Family Scyllaridae	slipper lobster	pa‘pangpang
Ranina ranina	Kona crab	NA
Heterocarpus spp.	deepwater shrimp	NA

Table 3. Mariana Archipelago Precious Corals MUS

Scientific Name	English Common Name	Local Name Chamorro/Carolinian
Corallium secundum	pink coral (also known as red coral)	NA
Corallium regale	pink coral (also known as red coral)	NA
Corallium laauense	pink coral (also known as red coral)	NA
Gerardia spp.	gold coral	NA
Narella spp.	gold coral	NA
Calyptrophora spp.	gold coral	NA

Scientific Name	English Common Name	Local Name Chamorro/Carolinian
Lepidisis olapa	bamboo coral	NA
Acanella spp.	bamboo coral	NA
Antipathes dichotoma	black coral	NA
Antipathes grandis	black coral	NA
Antipathes ulex	black coral	NA

Table 4. Mariana Archipelago Coral Reef Ecosystem MUS, Currently Harvested Coral Reef Taxa

Family Name	Scientific Name	English Common Name	Local Name Chamorro/Carolinian
Acanthuridae (Surgeonfishes)	*Acanthurus olivaceus*	orange-spot surgeonfish	NA
	Acanthurus xanthopterus	yellowfin surgeonfish	hugupao dangulo/ mowagh
	Acanthurus triostegus	convict tang	kichu/limell
	Acanthurus dussumieri	eye-striped surgeonfish	NA
	Acanthurus nigroris	blue-lined surgeon	NA
	Acanthurus leucopareius	whitebar surgeonfish	NA
	Acanthurus lineatus	blue-banded surgeonfish	hiyok/filaang
	Acanthurus nigricauda	blackstreak surgeonfish	NA
	Acanthurus nigricans	whitecheek surgeonfish	NA
	Acanthurus guttatus	white-spotted surgeonfish	NA
	Acanthurus blochii	ringtail surgeonfish	NA
	Acanthurus nigrofuscus	brown surgeonfish	NA
	Acanthurus pyroferus	mimic surgeonfish	NA
	Zebrasoma flavescens	yellow tang	NA
Acanthuridae (Surgeonfishes)	*Ctenochaetus striatus*	striped bristletooth	NA
	Ctenochaetus binotatus	twospot bristletooth	NA
	Naso unicornus	bluespine unicornfish	tataga/igh-falafal
	Naso lituratus	orangespine unicornfish	hangon/bwulaalay
	Naso tuberosus	humpnose unicornfish	NA
	Naso hexacanthus	black tongue unicornfish	NA
	Naso vlamingii	bignose unicornfish	NA
	Naso annulatus	whitemargin unicornfish	NA
	Naso brevirostris	spotted unicornfish	NA
	Naso brachycentron	humpback unicornfish	NA
	Naso caesius	gray unicornfish	NA
Balistidae (Triggerfishes)	*Balistoides viridescens*	titan triggerfish	NA
	Balistoides conspicillum	clown triggerfish	NA

Family Name	Scientific Name	English Common Name	Local Name Chamorro/Carolinian
	Balistapus undulatus	orangstriped triggerfish	NA
	Melichthys vidua	pinktail triggerfish	NA
	Melichthys niger	black triggerfish	NA
	Pseudobalistes fuscus	blue triggerfish	NA
	Rhinecanthus aculeatus	Picassofish	NA
	Balistoides rectanulus	wedged Picassofish	NA
	Sufflamen fraenatus	bridled triggerfish	NA
Carangidae (Jacks)	*Selar crumenophthalmus*	bigeye scad	atulai/peti
	Decapterus macarellus	mackerel scad	NA
Carcharhinidae (Sharks)	*Carcharhinus amblyrhynchos*	grey reef shark	NA
	Carcharhinus albimarginatus	silvertip shark	NA
	Carcharhinus galapagensis	Galapagos shark	NA
	Carcharhinus melanopterus	blacktip reef shark	NA
	Triaenodon obesus	whitetip reef shark	NA
Holocentridae (Solderfish/ Squirrelfish	*Myripristis berndti*	bigscale soldierfish	saksak/mweel
	Myripristis adusta	bronze soldierfish	sagamelon
	Myripristis murdjan	blotcheye soldierfish	sagamelon
	Myripristis amaena	brick soldierfish	sagamelon
	Myripristis pralinia	scarlet soldierfish	sagamelon
	Myripristis violacea	violet soldierfish	sagamelon
	Myripristis vittata	whitetip soldierfish	sagamelon
	Myripristis chryseres	yellowfin soldierfish	sagamelon
	Myripristis kuntee	pearly soldierfish	sagamelon
	Sargocentron caudimaculatum	tailspot squirrelfish	sagamelon
	Sargocentron microstoma	file-lined squirrelfish	NA
	Sargocentron diadema	crown squirrelfish	chalak
	Sargocentron tiere	blue-lined squirrelfish	sagsag/leet
	Sargocentron spiniferum	saber or long jaw squirrelfish	sisiok
	Neoniphon spp.	spotfin squirrelfish	sagsag/leet
Kuhliidae (Flagtails)	*Kuhlia mugil*	barred flag-tail	NA
Kyphosidae (Rudderfish)	*Kyphosus biggibus*	rudderfish	guili
	Kyphosus cinerascens	rudderfish	guili/schpwul
	Kyphosus vaigienses	rudderfish	guilen puengi/reel
Labridae	*Cheilinus chlorourus*	floral wrasse	NA

Family Name	Scientific Name	English Common Name	Local Name Chamorro/Carolinian
(Wrasses)	*Cheilinus undulates*	napoleon wrasse	tangison/maam
	Cheilinus trilobatus	triple-tail wrasse	lalacha mamate/porou
	Cheilinus fasciatus	harlequin tuskfish or red-breasted wrasse	NA
	Oxycheilinus unifasciatus	ring-tailed wrasse	NA
	Xyrichtys pavo	razor wrasse	NA
	Xyrichtys aneitensis	whitepatch wrasse	NA
	Cheilio inermis	cigar wrasse	NA
	Hemigymnus melapterus	blackeye thicklip	NA
	Hemigymnus fasciatus	barred thicklip	NA
	Halichoeres trimaculatus	three-spot wrasse	NA
	Halichoeres hortulanus	checkerboard wrasse	NA
	Halichoeres margaritacous	weedy surge wrasse	NA
	Thalassoma purpureum	surge wrasse	NA
	Thalassoma quinquevittatum	red ribbon wrasse	NA
	Thalassoma lutescens	sunset wrasse	NA
	Hologynmosus doliatus	longface wrasse	NA
	Novaculichthys taeniourus	rockmover wrasse	NA
Mullidae (Goatfishes)	*Mulloidichthys* spp.	yellow goatfish	NA
	Mulloidichthys vanicolensis	yellowfin goatfish	satmoneti/wichigh
	Mulloidichthys flavolineatus	yellowstripe goatfish	ti'ao (juv.) satmoneti (adult)
	Parupeneus spp.	banded goatfish	NA
	Parupeneus barberinus	dash-dot goatfish	satmonetiyo/failighi
	Parupeneus bifasciatus	doublebar goatfish	satmoneti acho/ sungoongo
	Parupeneus heptacanthus	redspot goatfish	NA
	Parupeneus ciliatus	white-lined goatfish	ti'ao (juv.) satmoneti (adult)
	Parupeneus cyclostomas	yellowsaddle goatfish	ti'ao (juv.) satmoneti (adult)
	Parupeneus pleurostigma	side-spot goatfish	ti'ao (juv.) satmoneti (adult)
	Parupeneus multifaciatus	multi-barred goatfish	ti'ao (juv.) satmoneti (adult)
	Upeneus arge	bantail goatfish	NA
Mugilidae (Mullets)	*Mugil cephalus*	striped mullet	aguas (juv.) laiguan (adult)

Family Name	Scientific Name	English Common Name	Local Name Chamorro/Carolinian
	Moolgarda engeli	Engel's mullet	aguas (juv.) laiguan (adult)
	Crenimugil crenilabis	fringelip mullet	aguas (juv.) laiguan (adult)
Muraenidae (Moray eels)	*Gymnothorax flavimarginatus*	yellowmargin moray eel	NA
	Gymnothorax javanicus	giant moray eel	NA
	Gymnothorax undulatus	undulated moray eel	NA
Octopodidae (Octopus)	*Octopus cyanea*	octopus	gamsun
	Octopus ornatus	octopus	gamsun
Polynemidae	*Polydactylus sexfilis*	threadfin	NA
Pricanthidae (Bigeye)	*Heteropriacanthus cruentatus*	glasseye	NA
	Priacanthus hamrur	bigeye	NA
Scaridae (Parrotfishes)	*Bolbometopon muricatum*	humphead parrotfish	atuhong/roow
	Scarus spp.	parrotfish	palakse/laggua
	Hipposcarus longiceps	Pacific longnose parrotfish	gualafi/oscha
	Calotomus carolinus	stareye parrotfish	palaksin chaguan
Scombridae	*Gymnosarda unicolor*	dogtooth tuna	white tuna/ayul
Siganidae (Rabbitfish)	*Siganus aregentus*	forktail rabbitfish	hiting/manahok/llegh
	Siganus guttatus	golden rabbitfish	hiting
	Siganus punctatissimus	gold-spot rabbitfish	hiting galagu
	Siganus randalli	Randall's rabbitfish	NA
	Siganus spinus	scribbled rabbitfish	hiting/sesyon/palawa
	Siganus vermiculatus	vermiculate rabbitfish	hiting
Sphyraenidae (Barracuda)	*Sphyraena helleri*	Heller's barracuda	NA
	Sphyraena barracuda	great barracuda	NA
Turbinidae (turban /green snails	*Turbo* spp.	green snails turban shells	aliling pulan/aliling tulompu

Table 5. Mariana Archipelago Coral Reef Ecosystem MUS, Potentially Harvested Coral Reef Taxa

Scientific Name	English Common Name	Local Name Chamorro/Carolinian
Labridae	wrasses (Those species not listed as CHCRT)	NA

Scientific Name	English Common Name	Local Name Chamorro/Carolinian
Carcharhinidae Sphyrnidae	sharks	NA
Dasyatididae Myliobatidae	rays and skates	NA
Serrandiae	groupers (Those species not listed as CHCRT or BMUS)	NA
Carangidae	jacks and scads (Those species not listed as CHCRT or BMUS)	NA
Holocentridae	solderfishes and squirrelfishes (Those species not listed as CHCRT)	NA
Mullidae	goatfishes (Those species not listed as CHCRT)	NA
Acanthuridae	surgeonfishes (Those species not listed as CHCRT)	NA
Ephippidae	batfishes	NA
Monodactylidae	monos	NA
Haemulidae	sweetlips	NA
Echeneidae	remoras	NA
Malacanthidae	tilefishes	NA
Lethrinidae	emperors (Those species not listed as CHCRT)	NA
Pseudochromidae	dottybacks	NA
Plesiopidae	prettyfins	NA
Muraenidae Chlopsidae Congridae Ophichthidae	eels (Those species not listed as CHCRT)	NA
Apogonidae	cardinalfishes	NA
Zanclidae	moorish idols	NA

Scientific Name	English Common Name	Local Name Chamorro/Carolinian
Aulostomus chinensis	trumpetfish	NA
Fistularia commersoni	cornetfish	NA
Chaetodontidae	butterfly fishes	NA
Pomacanthidae	angelfishes	NA
Pomacentridae	damselfishes	NA
Scorpaenidae	scorpionfishes	NA
Caracanthidae	coral crouchers	NA
Anomalopidae	flashlightfishes	NA
Clupeidae	herrings	NA
Engraulidae	anchovies	NA
Gobiidae	gobies	NA
Blenniidae	blennies	NA
Sphyraenidae	barracudas (Those species not listed as CHCRT)	NA
Lutjanidae	snappers (Those species not listed as CHCRT or BMUS)	NA
Balistidae	trigger fishes (Those species not listed as CHCRT)	NA
Siganidae	rabbitfishes (Those species not listed as CHCRT)	NA
Pinguipedidae	sandperches	NA
Gymnosarda unicolor	dog tooth tuna	NA
Kyphosidae	rudderfishes (Those species not listed as CHCRT)	NA
Bothidae Soleidae	flounders and soles	NA
Ostraciidae	trunkfishes	NA

Scientific Name	English Common Name	Local Name Chamorro/Carolinian
Caesionidae	fusiliers	NA
Cirrhitidae	hawkfishes	NA
Antennariidae	frogfishes	NA
Syngnathidae	pipefishes and seahorses	NA
Tetradontidae	puffer fishes and porcupine fishes	NA
Heliopora	blue corals	NA
Tubipora	organpipe corals	NA
Azooxanthellates	ahermatypic corals	NA
Echinoderms	sea cucumbers and sea urchins	NA
Mollusca	(Those species not listed as CHCRT)	NA
Gastropoda	sea snails	NA
Trochus spp.		NA
Opistobranchs	sea slugs	NA
Pinctada margaritifera	black lipped pearl oyster	NA
Tridacnidae	giant clam	NA
Other Bivalves	other clams	NA
Fungiidae	mushroom corals	NA
	small and large coral polyps	NA
Millepora	fire corals	NA
	soft corals and gorgonians	NA
Actinaria	anemones	NA
Zoanthinaria	soft zoanthid corals	NA
Hydrozoans and Bryzoans		NA
Tunicates	sea squirts	NA
Porifera	sponges	NA
Cephalopods	octopi	NA

Scientific Name	English Common Name	Local Name Chamorro/Carolinian
Crustaceans	lobsters, shrimps/mantis shrimps, true crabs and hermit crabs (Those species not listed as CMUS)	NA
Stylasteridae	Lace corals	NA
Solanderidae	Hydroid corals	NA
Algae	Seaweed	NA
Annelids	Segmented worms	NA
Live rock		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. FEP Advisory Panel members are representatives from various fishery sectors that are selected by the Council and serve two-year terms.

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-paned**	**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. 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.

The Archipelagic Plan Team meets at least once annually and comprises individuals from local and federal marine resource management agencies and non-governmental organizations. Members of the Plan teams are selected by the Council and serve indefinite terms. The Archipelagic Plan Team is led by a Chair who is appointed by the Council Chair after consultation with the Council's Executive Standing Committee. The Plan Teams monitor the performance of the FEP through the 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 Teams also make recommendations for conservation and management adjustments under framework procedures to better achieve management objectives. The Archipelagic Plan Team's findings and recommendations are reported to the Council at its regular meetings.

Science and Statistical Committee

The Scientific and Statistical Committee (SSC) is composed of scientists from local and federal agencies, academic institutions, and other organizations. 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. 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 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 FEP 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 interests 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.

A conference series was initiated by the Council in the Hawaii Archipelago to engage the Kanaka Maoli (Native Hawaiian) community in the development of the Hawaii Archipelago FEP and to increase their participation in the management of fisheries. This endeavor was continued by the Council in order to take the ahupuaa concept (Hawaiian land and water resource management) to the next level through 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 including the Mariana Archipelago. 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 and Research

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 agreements made by the Inter-American Tropical Tuna Commission (of which the U.S. is a member) and the Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Central and Western Pacific Region (of which the U.S. is a member). 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 between adjacent countries.

EEZ waters around the Mariana Archipelago are adjacent to the EEZ of the Federated States of Micronesia (FSM). The ecosystems of these areas likely share ecological connections, but the degree of connectivity of the demersal resources between Guam and FSM is unknown. International research and managagement will be necessary to appropriately manage this international ecosystem.

CHAPTER 2: TOPICS IN ECOSYSTEM APPROACHES TO MANAGEMENT

2.1 Introduction

An overarching goal of an ecosystem 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 1935). 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). The EPAP (1999) 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). Under this FEP, as increased information and an improved understanding of the managed ecosystem become available, the adaptive management process inherent in the MSA will continue to support 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. This FEP contains a framework for place-based management, which facilitates obtaining the necessary information to comprehensively assess, interpret, and manage these inter-relationships.

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.

Of particular importance to successful implementation of this FEP is the continued participation of local communities in providing information on the importance of fishing, participation levels, and concerns regarding community development. Other information that may be useful includes ecosystem data (trophic level studies, indicator species, food web data), stock assessments including those on less important commercial species, and information on the ecological effects of fishing and non-fishing activities.

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; NMFS 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. Consistent with Objective 10 of this FEP (to improve the quantity and quality of available information to support marine ecosystem management), the development of applicable indicators and models will likely be an area of future research and collaboration among scientists, fishery managers, and communities in the Mariana Archipelago.

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). This FEP maintains single species management (by stocks and/or multispecies stock complexes) under a place-based approach. Future amendments may consider adding MUS within various trophic levels to facilitate multi-species management within the ecosystem.

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 2005a). 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. Under this FEP, MPAs are considered a management tool which could be used to address various resource management issues.

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. This FEP includes the Mariana Archipelago Regional Ecosystem Advisory Committee which is composed of representatives of various local and federal agencies as well as non-governmental organizations and community groups.

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 Mariana Archipelago FEP. For more information, please see the Council's FMPs and FMP amendments and associated annual reports. Additional information is also available[3], in a 2008 environmental assessment for the Crustaceans FMP (WPRFMC 2008a), a 2001 Final EIS for the Coral Reef Ecosystems FMP (WPRFMC 2001), 2007 and 2008 environmental assessments for the Precious Corals FMP (WPRFMC 2007a, WPRFMC 2008a), a 2005 Final EIS to the Bottomfish FMP (WPRFMC 2005b), a 2007 Final Supplemental EIS to the Bottomfish FMP (WPRFMC 2007b), and a 2006 environmental assessment under the Bottomfish, Crustaceans and Precious Corals FMPs prepared in association with the inclusion of the CNMI into the management area of those FMPs (WPRFMC 2006a), which are incorporated here by reference. Although this FEP will not manage the Western Pacific Region's pelagic resources, successful ecosystem-based fisheries management requires considerations of interactions between the pelagic and demersal environments, and thus both are discussed here.

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, Philippine 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

[3] 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.[4] 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).[5] 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.

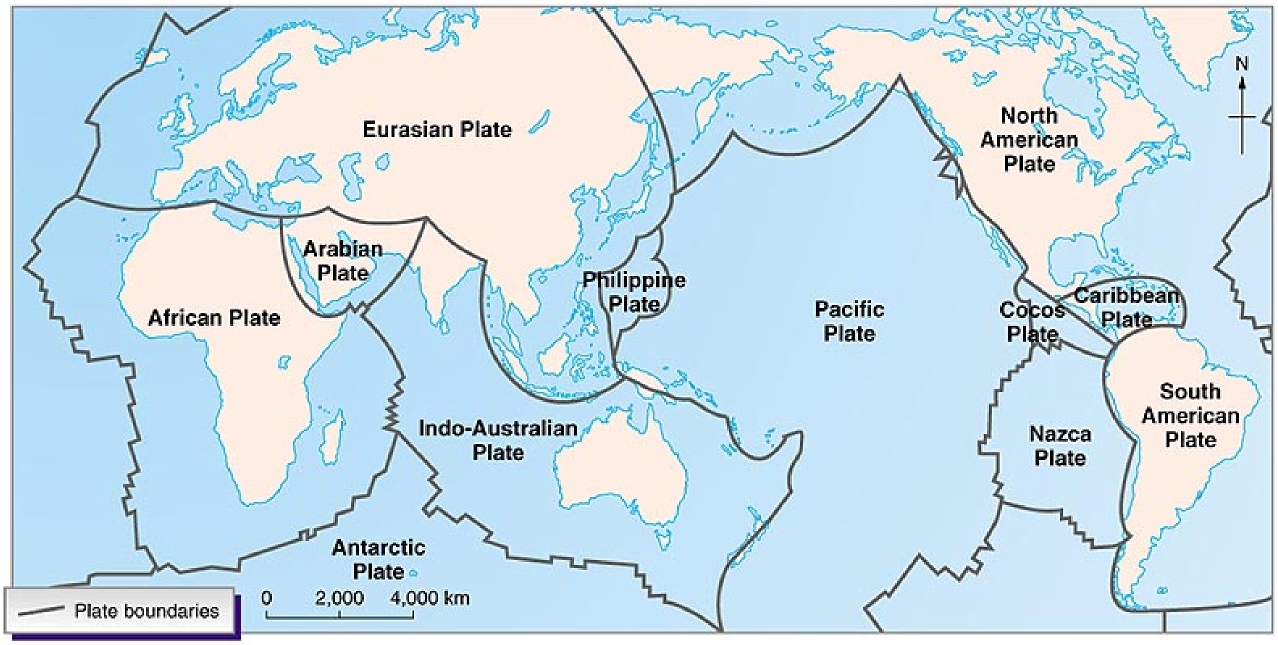

Figure 3. Schematic Diagram of the Earth's Lithospheric Plates
Source: Dr. C.H. Fletcher III, UH Dept. of Geology and Geophysics, personal communication

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[6] 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.[7]

[4] http://academic.reed.edu/chemistry/courses/chem391/401/earth.pdf (accessed January 2007).

[5] http://www.physicalgeography.net/fundamentals/8o.html (accessed January 2007)
[6] http://www.washington.edu/burkemuseum/geo_history_wa/The Restless Earth v.2.0.htm (accessed July 2006)
[7] Ibid (accessed July 2006)

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 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 resulted in the formation of the Marianas Trench which at nearly 11 km (~36,000 ft) is the deepest point of the seafloor.[8] 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.[9] 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.[10] Although less common, hot spots can also be found at mid-ocean ridges, exemplified by the Galapagos Islands in the Pacific Ocean.[11]

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).

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[8] http://www.soest.hawaii.edu/coasts/chip/ch02/ch_2_7.asp (accessed July 2005)
[9] Ibid (accessed July 2005)
[10] http://pubs.usgs.gov/publications/text/Hawaiian.html (accessed July 2005)
[11] http://pubs.usgs.gov/publications/text/hotspots.html#anchor19620979 (accessed July 2005)

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 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 great deal 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 (Tomczack 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 of bacterial decomposition of organic matter (Tomczack 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 due to differences in water density, causing vertical salinity gradients (Bigg 2003). See Figure 4 for a generalized representation of salinity profiles at various ocean depths.

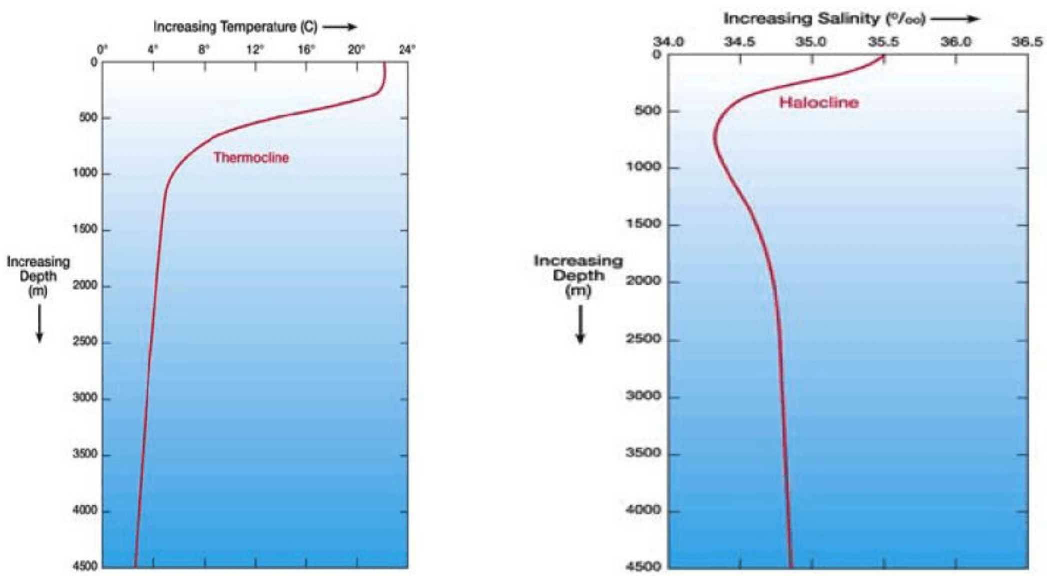


Figure 4. Temperature and Salinity Profile of the Ocean

Source: 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) abyssalpelagic, 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 a 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 abyssalpelagic 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.

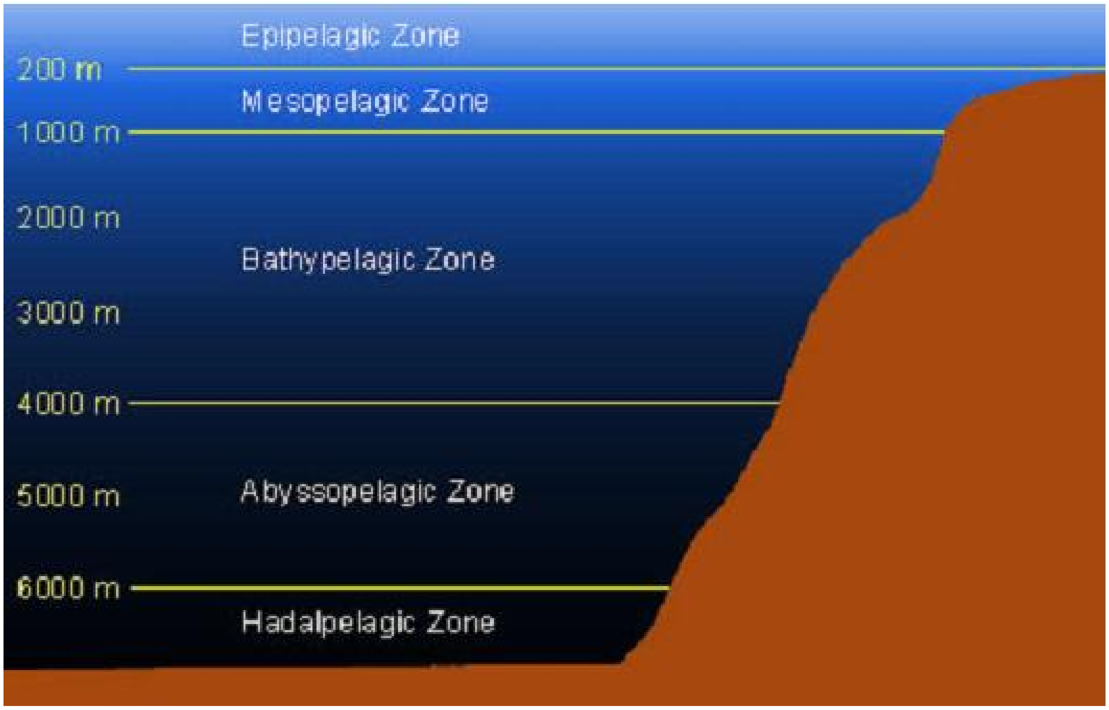


Figure 5. Depth Profile of Ocean Zones
Source: Concept from http://www.seasky.org/monsters/sea7a4.html (accessed July 2005).

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 (Tomczack 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 (Tomczack and Godfrey 2003). Figure 6 shows the major surface currents of the Pacific Ocean.

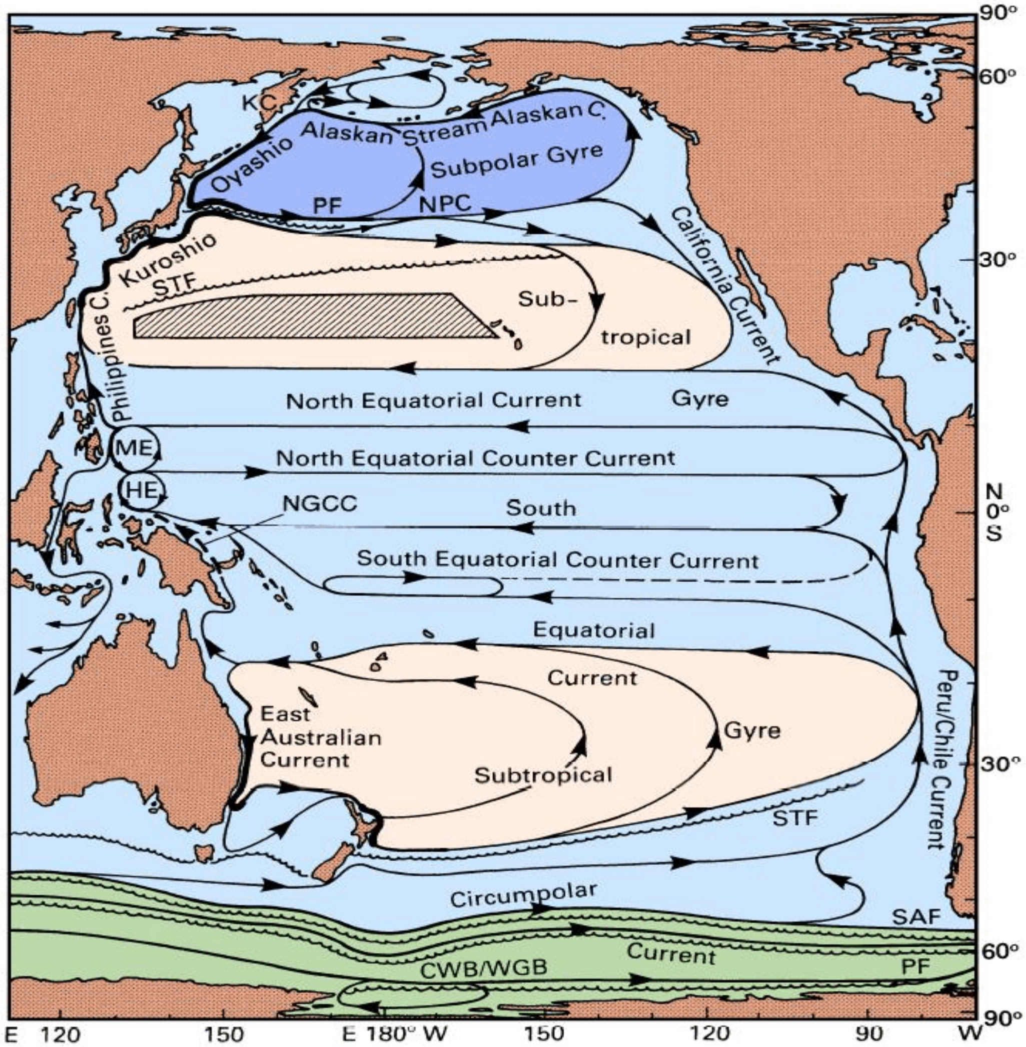


Figure 6. Major Surface Currents of the Pacific Ocean

Source: Tomczack 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 (Tomczack and Godfrey 2003).

Generally, the major surface current affecting CNMI is the North Equatorial Current (see Figure 6), which flows westward through the islands; however, the Subtropical Counter Current affects the Northern Islands and generally flows in a easterly direction. Depending on the season, sea surface temperatures near the Northern Mariana Islands vary between 80.9 –84.9° F. The mixed layer extends to depths of 300–400 feet (Eldredge 1983).

The major surface current affecting Guam is the North Equatorial Current (see Figure 6), which flows westward through the islands. Sea–surface temperatures off Guam vary between 80.9° and 84.9° F, depending on the season. The mixed layer extends to depths of 300–400 feet (Eldredge 1983).

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.

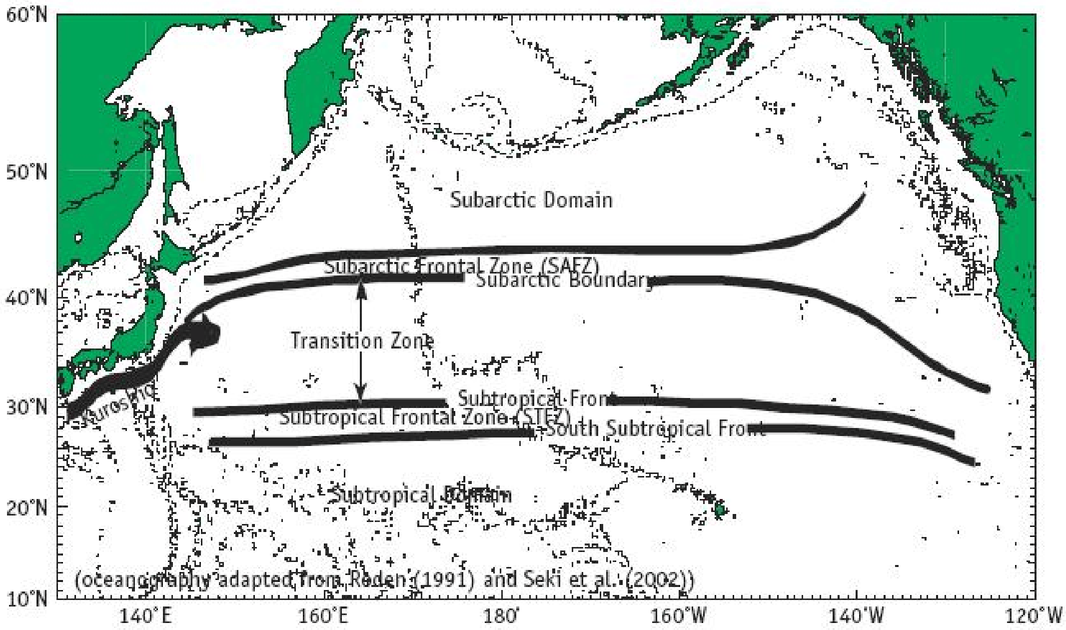


Figure 7. North Pacific Transition Zone
Source: http://www.pices.int/publications/special_publications/NPESR/2005/File_12_pp_201_210.pdf (accessed July 2005)

3.2.10 Deep-Ocean Currents

As described in Tomczack and Godfrey (2003), deep-ocean currents, or thermohaline movements, result from the effects of salinity and temperature on the density of seawater. 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.

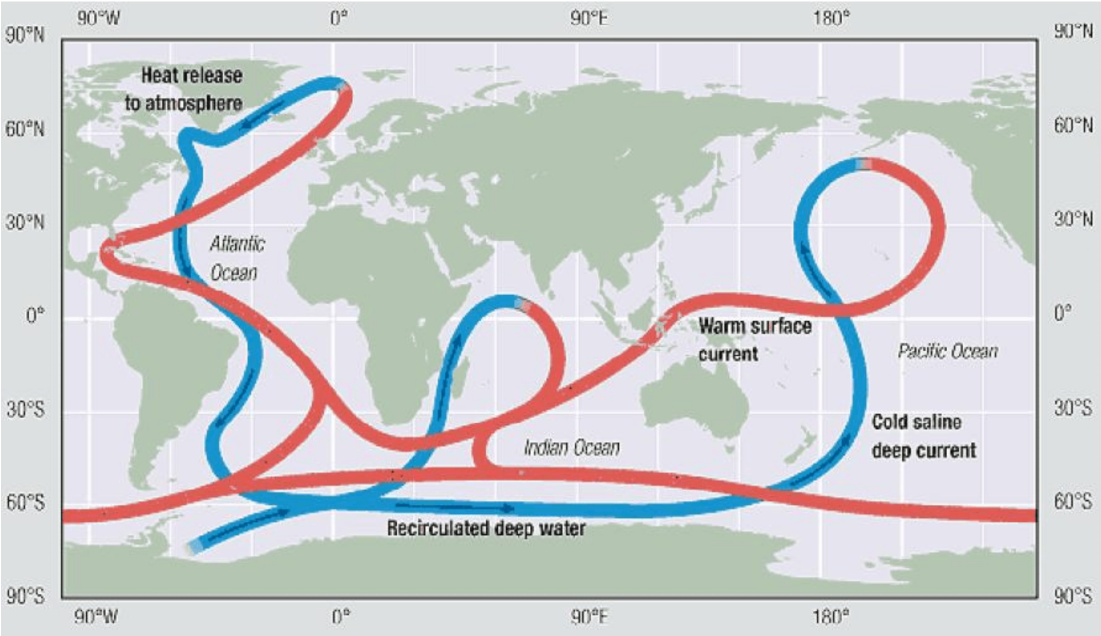


Figure 8. Deep-Ocean Water Movement
Source: U.N. GEO Yearbook 2004

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 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).

The effects of prominent meteorological features on the ecosystems and marine resources of the Mariana Archipelago are unclear, but will likely attract more focus under an ecosystem approach to management.

3.2.12 Pacific Island Geography

The following sections briefly describe the island areas of the Western and Central Pacific Ocean to provide background on the diversity of island nations and the corresponding physical and political geography surrounding the Mariana 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. [12]

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 including the: (a) Caroline Islands, (b) Marshall Islands, (c) Mariana Islands, (d) Gilbert Islands, (e) Line Islands, and (f) Phoenix Islands. Wake Island is geologically a part of the Marshall Islands archipelago.

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 into two chains: the southeastern Ratak Chain and the northwestern Ralik Chain.

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 CNMI, situated between 14–21° N latitude and 144–146° E longitude, is oriented along a north–south axis stretching over a distance of 400 nautical miles (740 km) from Rota northward to Uracas (also known as Farallon de Pajaros; Micronesian Environmental Services 1997). The islands can be divided into two sections based on age and geology. The northern island complex stretches from Esmeralda Bank west of Tinian to Uracas Bank north of Uracas. In the CNMI, the southern island complex encompasses the islands and banks from Rota to the Sonome Reef

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

complex north of Farallon de Medinilla and east of Anatahan. The total land area of the CNMI is approximately 179 square miles (463 km^2).

The island of Guam, located at 13° 28' N latitude and 144° 45 E longitude, is the southernmost island in the archipelago, and with a total land area of 560 square kilometers is also the largest (NOAA 2005b).

In addition to the islands, a distinct chain of submerged seamounts are located approximately 120 nautical miles west of the CNMI, also in a north–south pattern. Several banks are also located southwest of Guam with Galvez and Santa Rosa Bank being the largest. The islands and seamounts which make up this island chain were formed approximately 43 million years ago by the subduction of the Pacific tectonic plate under the Philippine plate (Paulay 2003). A unique feature created at this subduction zone is the Mariana Trench. Located east of the island chain and running in a north–south pattern, the Mariana Trench is the deepest location on earth with its deepest point, the Challenger Deep, at 11,000 meters.

Since their formation, the islands in the Mariana archipelago have undergone complex changes which included periods of volcanism, submarine and subaerial uplift, subsidence, and rifting, all of which have contributed to its heterogeneous surface composition, primarily flat uplifted limestone plateaus.

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 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), Vanuatu Islands, and (f), Maluku 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 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.

The Maluku Islands (east of New Guinea) and the Torres Strait Islands (between Australia and New Guinea) 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.

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) Cook Islands, (e) Tuvalu, (f) Tokelau , (g) the Territory of French Polynesia, (h) Pitcairn Islands, (i) Easter Island (Rapa Nui), and (j) 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.

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.

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.

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 ecosystem and ecosystem concepts that must be considered when managing the fisheries of the Mariana 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).

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.

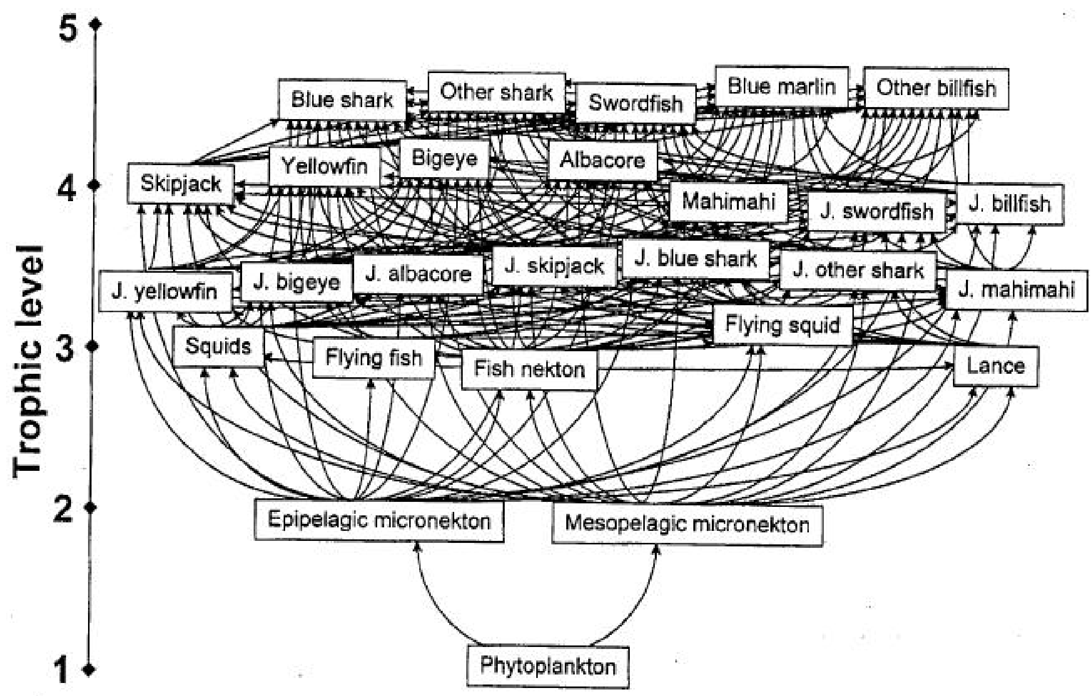


Figure 9. Central Pacific Pelagic Food Web
Source: Kitchell et al. 1999

Species and links of the central Pacific pelagic food web. This tangled "bird's nest" represents interactions at the approximate trophic level of each pelagic species, with increasing trophic level toward the top of the 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).

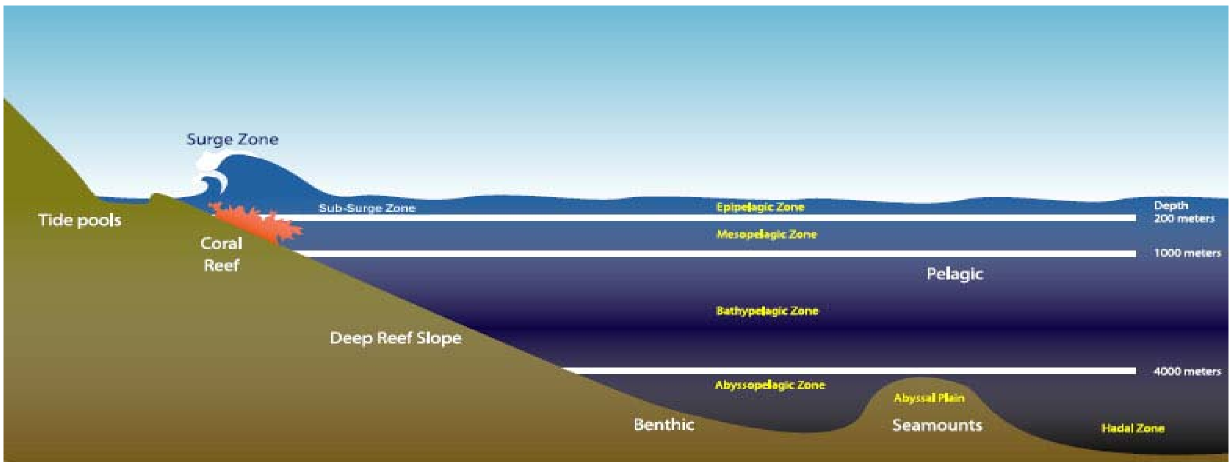


Figure 10. Benthic Environment

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) and rabbitfishes (Siganidae). Seagrasses are also important sources of nutrition for higher vertebrates such as dugongs and green turtles. A concise summary of the seagrass species found in the western tropical South Pacific is given by Coles and Kuo (1995). From the fisheries perspective, the fishes and other organisms harvested from the 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. 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, although the red mangrove (*Rhizophora mangle*) was introduced into Hawaii in 1902, and has become the dominant plant within a number of large protected bays and coastlines on both Oahu and Molokai (Gulko 1998). Apart from the usefulness of the wood for building, charcoal, and tannin, mangrove forests stabilize areas where sedimentation is occurring and are important as nursery grounds for peneaeid shrimps and some inshore fish species. They also provide a habitat for some commercially valuable crustaceans.

Guam’s mangroves are extensive and diverse and include *Rizophora mucronata, R. apiculata, Bruguiera gymnorrhiza, Avicennia marina, Lumnitzera litttorea, Nypa fruticans, Xylocarpus moluccensis, Heritiera littoralis, Hibiscus tiliaceus* and *Acrostichum arueum*[13]. The young of many kinds of reef fishes live in the lower, more saline parts of estuaries before migrating to coral reef habitats. Other kinds of fishes and crustaceans remain in estuaries throughout their adults lives. Mangrove crabs live in burrows among the roots of riverbank trees. Many of Guam's native freshwater fishes and shrimps live in the sea as either eggs or larvae and migrate back to rivers, passing through estuaries as tiny young.

[13] Information from: Guam DAWR 2005 citing Fosberg 1960; Moore et al. 1977 retrieved from: http://ramsar.wetlands.org/Portals/15/GUAM.pdf and http://www.guamdawr.org/learningcenter/factsheets/habitats/mangrove_html

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 Holocene transgression over the past 10,000 years, 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 coral (about 50 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 Northern Mariana Islands

The total coral reef area in CNMI is 124 square kilometers (within the 10 fathom curve) and 476 square kilometers (within the 100 fathom curve; Rohmann et al. 2005). The older southern islands have fringing and/or barrier reefs, while the volcanically active, northern islands have relatively little coral reef (Eldredge1983).

The southern islands are relatively old (> 35 million years) and support a variety of marine habitat types (Asakura et al. 1994a). Saipan's potential coral reef area within the 10 fathom contour is 58 square kilometers and includes fringing reefs, inshore, and offshore patch reefs, and a well-developed barrier reef–lagoon system along most of the leeward coast (Eldredge 1983, Donaldson 1995; Gourley 1997; Rohman et al. 2005). Saipan Lagoon also comprises some large areas of well-developed seagrass beds, as well as a small area of mangroves (Donaldson 1995; Gourley 1997).

The corals reefs within the 10 fathom curve of Rota (12 km^2), Tinian and Agrijan (18 km^2) are less well developed than those on Saipan, and are generally restricted to small fringing reef systems (Donaldson 1995; Eldredge 1983; Gourley 1997; Rohmann et al. 2005). A study of the reefs adjacent to beaches on Tinian reported that coral reefs are present around much of the island and, in general, reefs on the eastern (leeward) coastline are better developed and have greater species diversity than those on the western coast (PSDA 1997). Rota also has some well-developed reefs, especially in Sasanhaya Bay on the south side, and some offshore reefs on the north and west sides of the island (Donaldson 1995; PSDA 1997).

Farallon de Medinilla (FDM) is an uninhabited island with 2.4 square kilometers of potential coral reef area within the 10-fathom curve (Rohmann et al. 2005). The island has been used as a military bombardment range for the last 30 plus years (Eldredge 1983; PSDA 1997; Starmer et al. 2005). There is no fringing reef or shallow coastal zone at FDM, because deepwater surrounds much of the island and the submarine slope appear to be very steep (PSDA 1997). The combination of this vertical profile and wave action on the windward side of the island probably explains the limited coral reef biota in shallow water on that side (PSDA 1997). As such, marine resources are mostly concentrated on the leeward side of the island, where the substrate drops gradually seaward (PSDA 1997). FDM is near a large shallow bank about 18 meters deep that is located a mile north of the island (PSDA 1997).

The northern islands are relatively young (1–1.5 million years) and include active volcanoes on the islands of Pagan (erupted in 1981), Anatahan (erupted in 2003), Guguan, Asuncion, Agrihan and Uracas (Asakura et al. 1994a; Sturman et al 2005). In general, reef development is poor or nonexistent on the Northern Islands (Eldredge 1983), with Pagan having the greatest area of potential coral reef area at 11 square kilometers with the 10 fathom curve (Rohmann et al. 2005). Most of the reefs that do exist tend to be narrow, rocky reefs on steep slopes with coral communities growing on volcanic substrata and little true coral reef development (Birkeland 1997b; Donaldson 1995 Eldredge et al. 1977a; Eldredge 1983). However, there are a few small "embryonic" or "apron" reefs on these islands, which may have some reef formation but do not reach sea level (Birkeland 1997b). These include areas at depths exceeding 25 meters at western Anatahan, southern Sarigan, and parts of Pagan (; Donaldson 1995; Donaldson et al. 1994). Eldredge et al. (1977a) also reported a well-developed fringing reef on the west side of Maug.

The differences in the development of reefs throughout the Mariana Archipelago appear to be related to the age and geology of the islands since coral growth is just as vigorous in both the north and south (Birkeland 1997b). For example, geological faulting of large areas in the older Southern Mariana Islands (e.g., west coast of Saipan) have created large, oblique, shallow-water surfaces that have supported extensive reef growth and the development of reef flats and lagoons over time (Birkeland 1997b). In contrast, the islands in the north are younger with quite vertical profiles that do not provide the basis for extensive reef development (Birkeland 1997b). Another significant factor in coral reef development in the northern islands is the volcanic nature of these islands. Anatahan, an active volcanic island is a prime example of the dynamic nature of these reefs.

The crown of thorns starfish were believed to have been responsible for coral mortality on some reefs around Saipan over the past two decades. This includes areas in Saipan Lagoon (Duenas and Swavely 1985; Richmond and Matson 1986), the Obyan–Naftan area (Randall et al. 1988) and Laulau Bay (PBEC 1984; Randall et al. 1991). However, the starfish do not appear to be abundant at present, and local divers report that starfish are only seen occasionally at the primary dive sites (e.g., Obyan and Laulau Bay; J. Comfort, personal communication)

Starfish outbreaks have also been recorded on the other islands including occasional, small-scale outbreaks on Rota since the 1980s (CRM 1996; Mark Michael, personal communication,). There have also been reports of starfish causing damage to reefs on the northern islands of CNMI, including Maug (Eldredge et al. 1977a in Irimura et al. 1994), and Alamagan (Eldredge 1983). However, these starfish have evolved to feed on corals and their presence in low to moderate numbers should not be viewed as a problem.

CNMI's coral reefs have experienced some damage from the frequent typhoons in the area, and coral bleaching occurred in 1994, 2001, and 2003. In addition, coral reefs in some locations appear to have been affected by human activities, including fishing, sedimentation and nutrient loading (Starmer et al. 2005).

Available information suggests that the current condition of the coral reefs in the southern islands of CNMI is quite variable (Starmer et al. 2005). Most appear to be in good condition, except in some heavily populated areas where the reefs have been degraded by human activities.

The current area of most concern is the reef at Saipan Lagoon, because this area encompasses nearly all of the commonwealth's population, tourism industry, commercial activity, subsistence fishing, and water-oriented recreation (Duenas and Swavely 1985).

In general, it appears that the reefs in the Northern Islands are also in good condition, because of their isolation from human population centers (Birkeland 1997b). The exceptions are localized areas that may have been affected by volcanic or military activities (e.g., Pagan and FDM).

Coral Reefs of Guam

Approximately 50 percent of Guam's 153 kilometer shoreline is surrounded by well-developed coral reefs (Myers 1997; Randall and Myers 1983). Most of the reefs are fringing reefs (up to 600 meters wide), except for the broad barrier reef enclosing the shallow Cocos Lagoon at the southwest tip of the island (Eldredge 1983; Randall and Myers 1983). A raised barrier reef (Cabras Island), a greatly disturbed barrier reef (Luminao Reef), and a coral bank (Calalan Bank) enclose the deep lagoon of Apra Harbor (Randall and Myers 1983). Patch reefs are also associated with Anae Island on the southwest coast and at Pugua Patch Reef (or Double Reef) on the northwest coast (Randall and Myers 1983). All of the reef flats, lagoons, patch reefs, and outer reef slopes surrounding Guam are located within territorial waters (Hunter 1995; Myers 1997).

The potential coral reef area around Guam is estimated at 108 square kilometers (within 10 fathom curve) and 276 square kilometers (within 100 fm curve), respectively (Rohmann et al. 2005). Most of the reefs are located in territorial waters (0–3 nautical miles), while reefs located at the offshore banks are in federal waters.

The health of Guam's coral reefs varies considerably, with impacts ranging from anthropogenic and natural sources. Coral bleaching events have not been major threat to Guam's coral reefs as only two have been observed since 1970 (NOAA 2005b).

Typhoons are frequent on Guam, with up to five major typhoons per year (Birkeland 1997b; Eldredge 1983; USDA 1995), which cause some damage to the reefs (Birkeland 1997b; Randall and Eldredge 1977). However, the reefs on Guam tend to experience less physical damage from these storms than is the case in other areas, because corals in exposed locations are "adapted" to these rough conditions and grow in low-profile growth forms (Birkeland 1997b; Randall and Eldredge 1977). As such, severe typhoon damage to the reefs on Guam tends to be localized in areas that are usually protected from heavy wave action by the shape of the coastline (Birkeland 1997b).

Several outbreaks of the crown-of-thorns starfish have also occurred on Guam over the past few decades (Birkeland 1997b). One outbreak in the 1960s caused severe catastrophic mortality (90 percent) of reef slope corals along 38 kilometers of Guam's northwest coast (Colgan 1981, 1982; Chesher 1969; Randall 1971, 1973). By 1981, however, the reefs had started to recover from the starfish invasion and coral cover had increased to 65 percent (Colgan 1987). Occasional earthquakes and El Niño events have also been known to cause substantial damage to the reefs on Guam (Birkeland 1997b). However, the biggest threat to Guam's reefs appears to be from anthropogenic effects, including overfishing and habitat degradation due to poor land use practices, urbanization, and development (Myers 1997). Sedimentation and overfishing are probably the most serious problems causing coral reef degradation on Guam (Birkeland 1997b; Myers 1997). For example, Birkeland (1997b) reported that the rates of coral replenishment have been substantially reduced on Guam over the past 20 years, possibly as a result of increased sedimentation and the overfishing of herbivores (Birkeland 1997b). As a result of the loss of living cover and the lack of replenishment of these reefs, coral cover on the island has declined substantially over time (Birkeland 1997b). This effect has been most pronounced on the reef slopes, and coral cover is still reasonably high in some places on the reef flat (Birkeland 1997b). Other anthropogenic impacts that may have affected coral reef health on Guam include industrial pollution, nonpoint source pollution, oil spills, sewage, and coastal construction (Myers 1997).

Current opinion is that coral reef health varies around the island of Guam. In general many of the reefs on the southern part of the island tend to be in poor condition, because of the high population base, extensive coastal development, good reef access, and high runoff of sediments onto the reefs from large rivers (Myers 1997; NOAA 2005b). One example is the reef between Facpi Point and Umatac on the southwest side of the island, which has been buried by sediment in recent years (R. Myers, R. Richmond, and S. Amesbury, personal communication). By contrast, the reefs on the northern part of the island (e.g., Ritidian Point and Pati Point) tend to be in better condition because there are fewer people, less development, less access to the reef, and no major rivers (R. Myers, C. Birkeland, S. Amesbury, and R. Sakomoto, personal communication)

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 continental 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 2,000 to 3,500 millimeters 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 4,300 millimeters 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 (planktotrophic) into the pelagic environment to feed on various types of plankton (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, therefore, 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 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.

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 fish and marine mammals. Compared with shallower benthic areas (e.g., coral reefs), benthic deep-slope 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 (thus considered primary producers) on which a variety of organisms either feed or contain in their bodies within special organs called “trophosomes.” Types of organisms found near these thermal vents include crabs, limpets, tubeworms, and bivalves (Levington 1995).

3.3.2.8 Benthic Species of Economic Importance

Coral Reef Associated Species

The most harvested species from coral reefs in the CNMI include the emperors (Lethrinidae), groupers (Serranidae), rabbitfish (Siganidae), and rudderfish (Kyphosidae). Other commonly harvested species of coral reef associated organisms include surgeonfishes (Acanthuridae), triggerfishes (Balistidae), jacks (Carangidae), parrotfishes (Scaridae), soldierfishes/squirrelfishes (Holocentridae), wrasses (Labridae), octopus (*Octopus cyanea, O. ornatus*), goatfishes (Mullidae), giant clams (Tridacnidae), trochus (Trochidae) and sea cucumbers (Holothuroidea).

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) suggested that the average maximum stainable yield (MSY) for Pacific reefs is in the region of 16 t km^{-2} yr^{-1} based on 43 yield estimates where the proxy for fishing effort was population density.

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

Another important aspect of the yield question is the resilience of reefs to fishing, and recovery potential when overfishing or high levels of fishing effort have been conducted on coral reefs. Evidence from a Pacific atoll where reefs are regularly fished by community fishing methods, such as leaf sweeps and spearfishing, 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 et al. 1996) indicate that reef fish populations in relatively small areas have the potential to recover rapidly from depletion in the absence of further fishing. Conversely, Birkeland (1997b) cited the example of a pinnacle reef off Guam fished down over a period of six months in 1967 that has still not recovered to pre-exploitation levels.

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 habitats 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* shelter differently from one another (MacDonald and Stimson 1980). Similarly, juvenile and adult *P. penicillatus* also share the same habitat (Pitcher 1993).

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. 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. At night, *P. penicillatus* moves onto reef flat to forage. Spiny lobsters are nocturnal predators (Pitcher 1993).

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* sp.) are dioecious (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 1981). In *Panulirus* sp., the fertilization of the eggs occurs externally (Uchida et al. 1980). The female lobster scratches and breaks the mass, releasing the spermatozoa (WPRFMC 1981). Simultaneously, ova are released from the female's oviduct and are then fertilized and attach to the setae of the female's pleopods (WPRFMC 1981). At this point, the female lobster is ovigerous, or "berried" (WPRFMC 1981). The fertilized eggs hatch into phyllosoma larvae after 30–40 days (MacDonald 1986; Uchida and Uchiyama 1986). Spiny lobsters are very fecund (WPRFMC 1981). 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 "leaf-like" larvae (or phyllosoma) enter a planktonic phase (WPRFMC 1981). The duration of this planktonic phase varies depending on the species and geographic region (WPRFMC 1981). The planktonic larval stage may last from 6 months to 1 year from the time of the hatching of the eggs (WPRFMC 1981, 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), jacks (Carangidae), and emperors (Lethrinidae). Distinct depth associations are reported for certain species of emperors, snappers, and groupers. Many snappers and some groupers are restricted to feeding in deep water (Parrish 1987). The emperor family (Lethrinidae) is comprised of bottom-feeding carnivorous fish found usually in shallow coastal waters on or near reefs, with some species observed at greater depths (e.g., *L. rubrioperculatus*). Lethrinids are not reported to be territorial, but may be solitary or form schools. The snapper family (Lutjanidae) is largely confined to continental shelves and slopes, as well as corresponding depths around islands. Adults are usually associated with the bottom. The genus *Lutjanus* is the largest of this family, consisting primarily of inhabitants of shallow reefs. 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

During the 1970s, surveys for precious coral in the waters surrounding CNMI were performed (Grigg and Eldridge 1975). The study focused on the presence of pink and red corals (*Corallium* spp.) and black coral (*Antipathes* spp.). Very little precious coral resources were found in these surveys. 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, which in turn affects the presence and abundance of the pelagic predator species.

Additional 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 2001). 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 2001). 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 2001). 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 2001). Understanding these linkages is an essential component of successful ecosystem-based fishery management.

Phytoplankton, which contribute to more than 95 percent of primary productivity in the marine environment (Valiela 1995), represent several different types of microscopic organisms that require sunlight for photosynthesis. Phytoplankton, which primarily live in the upper 100 meters of the euphotic zone of the water column, include organisms such as diatoms, dinoflagellates, coccolithophores, silicoflagellates, and cyanobacteria. Although some phytoplankton have structures (e.g., flagella) that allow them some movement, generally phytoplankton distribution is controlled by current movements and water turbulence.

Diatoms can be either single celled or form chains with other diatoms. They are mostly found in areas with high nutrient levels such as coastal temperate and polar regions. Diatoms are the largest contributor to primary production in the ocean (Valiela 1995). Dinoflagellates are unicellular (one-celled) organisms that are often observed in high abundance in subtropical and tropical regions. Coccolithophores, which are also unicellular, are mostly observed in tropical pelagic regions (Levington 1995). Cyanobacteria, or blue-green algae, are often found in warm nutrient-poor waters of tropical ocean regions.

Oceanic pelagic fish such as skipjack and yellowfin tuna and blue marlin prefer warm surface layers, where the water is well mixed by surface winds and is relatively uniform in temperature and salinity. Other fish such as albacore, bigeye tuna, striped marlin, and swordfish prefer cooler, more temperate waters, often meaning higher latitudes or greater depths. Preferred water temperature often varies with the size and maturity of pelagic fish, and adults usually have a wider temperature tolerance than subadults. Thus, during spawning, adults of many pelagic species usually move to warmer waters, the preferred habitat of their larval and juvenile stages.

Large-scale oceanographic events (such as El Niño) change the characteristics of water temperature and productivity across the Pacific, and these events have a significant effect on the habitat range and movements of pelagic species. Tuna 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 water and warmer oceanic water masses (NMFS 2001).

These frontal zones are also 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 sp., both of which are likely to be concentrated by the weak downwelling associated with frontal zones (Polovina et al. 2000). Data from on-board observers in the Hawaii-based longline fishery indicate that incidental catch of loggerheads occurs along the 17° C front during the first quarter of the year, and along the 20° C front in the second quarter of the year. The interaction rate, however, is substantially greater along the 17° C front (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. Morphometric studies of yellowfin tuna also support the hypothesis that populations from the eastern and western Pacific derive from relatively distinct substocks in the Pacific. The stock structure of bigeye in the Pacific is poorly understood, but a single Pacific-wide population is assumed. The movement of the cooler water tuna (e.g., bluefin, albacore) is more predictable and defined, with tagging studies documenting regular, 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 (Olsen et al. 1994).

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) believed to be present in the Western Pacific Region. Information on Endangered Species Act consultations and findings for the fisheries covered in this FEP is presented in Section 8.6.

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).

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 1998a). 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 1998a). Because of the low nutrient 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, Costa Rica 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 2004a). In Mexico, the nesting season generally extends from November to February, although some females arrive as early as August (Sarti et al. 1989). 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 1989), 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 and USFWS 1998a). 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 2004a).

Leatherback Sea Turtles in the Mariana Archipelago

There have been occasional sightings of leatherback turtles around Guam (Eldredge 2003); however, to what extent (i.e., preferred location, abundance, seasonality) leatherback turtles are present around Guam and CNMI is unknown.

Loggerhead Sea Turtles

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).

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 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).

Loggerhead Sea Turtles in the Mariana Archipelago

There are no known reports of loggerhead turtles in waters around the Mariana Archipelago.

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 (NMFS1998). 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 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 lesser 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 1998b).

In a review of sea turtle sighting records from northern Baja California to Alaska, Stinson (1984, in NMFS and USFWS 1998b) determined that the green turtle was the most commonly observed sea turtle on the U.S. Pacific coast, with 62 percent reported in a band from southern California and southward. The northernmost (reported) year-round resident population of green turtles occurs in San Diego Bay, where about 30–60 mature and immature turtles concentrate in the warm water effluent discharged by a power plant. These turtles appear to have originated from east Pacific nesting beaches, on the basis of morphology and preliminary genetic analysis (NMFS and USFWS 1998b). California stranding reports from 1990–1999 indicate that the green turtle is the second most commonly found stranded sea turtle (48 total, averaging 4.8 annually; J. Cordaro, NMFS, personal communication, April 2000, NMFS 2004a).

Stinson (1984) found that green turtles will appear most frequently in U.S. coastal waters when temperatures exceed 18° C. An east Pacific green turtle was tracked along the California coast by a satellite transmitter that was equipped to report thermal preferences of the turtle. This turtle showed a distinct preference for waters that were above 20° (S. Eckert, unpublished data). Subadult green turtles routinely dive to 20 meters for 9–23 minutes, with a maximum recorded dive of 66 minutes (Lutcavage et al. 1997).

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. 1995).

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 and USFWS 1998b).

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).

Green Sea Turtles in the Mariana Archipelago

Based on nearshore surveys conducted jointly between the CNMI–DFW and the NMFS around the Southern Islands (Rota and Tinian 2001; Saipan 1999), an estimated 1,000 to 2,000 green sea turtles forage in these areas (NOAA 2005b). The green sea turtle is a traditional food of the native population and although harvesting them is illegal, divers have been known to take them at sea and others have been taken as nesting females (NMFS and USFWS 1998b). Turtle eggs are also harvested in the CNMI. Nesting beaches and seagrass beds on Tinian and Rota are in good condition but beaches and seagrass beds on Saipan have been impacted by hotels, golf courses and general tourist activities.

Nesting surveys for green sea turtles have been done on Guam since 1973 with the most consistent data collected since 1990. There have been up to 60 nesting females observed annually, with a generally increasing trend over the past 12 years aerial surveys done in 1999–2000 also found an increase in green sea turtle sightings around Guam (Cummings 2002).

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 and USFWS 1998c). 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 rapidly approaching extinction primarily due to the harvesting of the species for its meat, eggs, and shell, as well as the destruction of nesting habitat by human occupation and disruption. Along the 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 Sea Turtles in the Mariana Archipelago

Although hawksbill turtles have occasionally been sighted in the past around the CNMI they were not observed in a detailed assessment conducted in 1999, nor were they observed in 10 aquatic surveys along the shores of Tinian in 1995. According to the 1998 Pacific Sea Turtle Recovery Team Recovery Plan for the hawksbill turtle (NMFS and USFWS, 1998b), there are no reports of nesting in the CNMI. This does not rule out the possibility of a few hawksbill nests, as nesting surveys on small pocket beaches in remote areas of CNMI have never been done. A single hawksbill sighting occurred in 1996 during the detonation of an unexploded ordinance off of Rota. The turtle was recovered near the explosion sight and subsequently died, apparently from internal injuries incurred from the blast (Trianni, 1998a). One hawksbill sea turtle nest was found in November 1991 on Guam (NMFS and USFWS 1998c); however this was highly unusual as nesting individuals are otherwise virtually unknown on Guam (Eldredge 2003)**.**

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 USFWS1998d). 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. 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 2004a). At least one olive ridley was reported in Micronesia (Yap) in 1973 (Falanruw et al. 1975).

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).

Olive Ridley Sea Turtles in the Mariana Archipelago
There are no known reports of olive ridley turtles in waters around the Mariana Archipelago.

3.3.4.2 Marine Mammals

Cetaceans listed as endangered under the ESA that have been observed in Mariana Archipelago comprise the humpback whale (*Megaptera novaeangliae*), sperm whale (*Physeter macrocephalus*), and sei whale (*B. borealis*).

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. At least six well-defined breeding stocks of humpback whales occur in the Southern Hemisphere 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). The humpbacks that winter in the Mariana Archipelago are believed to be part of the "Asian" stock, which migrate from the Bonin (Ogasawara) Islands (Eldregde 2003). Humpback whales have been sighted around Guam and CNMI (Eldredge 2003), however the number of whales that winter in the Mariana Archipelago each year is unknown.

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).

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). The International Whaling Commission considers there to be 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).

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. Sightings of sperm whales were made during May–July in the 1980s around Guam, and in recent years stranding of dwarf and pygmy sperm whales have been reported on Guam (Reeves et al. 1999).

The world population of sperm whales had been estimated to be approximately two million. However, the methods used to make this estimate are in dispute, and there is considerable uncertainty over the remaining number of sperm whales. The world population is at least in the hundreds of thousands, if not millions.

Other Marine Mammals

Table 7 lists known non-ESA listed marine mammals that have been observed in the Mariana Archipelago.

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

Common Name	Scientific Name
Bottlenose dolphin	*Tursiops truncatus*
Bryde's whale	*Balaenoptera edeni*
Cuvier's beaked whale	*Ziphius cavirostris*
Dwarf sperm whale	*Kogia simus*
Killer whale	*Orcinus orca*
Melon-headed whale	*Peponocephala electra*
Short-finned pilot whale	*Globicephala macrorhynchus*
Spinner dolphin	*Stenella longirostris*
Spotted dolphin	*Stenella attenuata*
Striped dolphin	*Stenella coeruleoalba*
Pygmy sperm whale	*Kogia breviceps*
Risso's dolphin	*Grampus griseus*
Rough-toothed dolphin	*Steno bredanensis*

Source: Eldredge 1991; Eldredge 2003

A single dugong (*Dugon dugong*) was observed in Cocos Lagoon, Guam in 1975 (Randall et al 1975). Dugongs are members of the Sirenia order, which include sea cows and manatees, and have a distribution from the east African coast to islands in the southwestern Pacific. Several sightings were reported in 1985 on the southeastern side of Guam (Eldredge 2003). Since that time, however no reports of dugong sightings have been made. No observations of dugongs have been reported for CNMI.

3.3.4.3 Seabirds[14]

The following seabirds are considered residents of the NMI: wedge-tailed shearwater (*Puffinus pacificus*), white-tailed tropicbird (*Phaethon lepturus*), red-tailed tropicbird (*Phaethon lepturus*),

[14] The USFWS is the primary federal agency with authority and responsibility to manage ESA listed seabirds.

masked booby (S*ula dactylatra*), brown booby (*Sula leucogaster*), red-footed booby (*Sula sula*), white tern (*Gygis alba),* sooty tern (*Sterna fuscata*), brown noddy (*Anous stolidus*), black noddy (*Anous minutus*)*, and* the great frigatebird (*Fregata minor*). There are no known interactions between seabirds and any of the Northern Mariana Islands and Guam demersal fisheries covered in this FEP.

The following seabirds have been sighted and are considered visitors (some more common than others) to CNMI; short-tailed shearwater (*Puffinus tenuirostris;* common visitor), Newell's shearwater (*Puffinus auricularis;* rare visitor), Audobon's shearwater (*Puffinus iherminieri*), Leach's storm-petral (*Oceanodroma leucorhoa*), Matsudaira's storm-petral (*Oceanodroma matsudairae*), and the red-footed booby (*Sula sula*). Of these, only the Newell's shearwater is listed as endangered. There have been no sightings of the endangered short-tailed albatross (*Diomedea albatrus*) in the CNMI although the CNMI is within the range of the only breeding colony at Tora Shima, Japan.

According to Wiles (2003), the only resident seabirds on Guam are the brown noddy and the white tern. Common visitors to Guam include the following seabirds: black noddy the short-tailed shearwater. Other less common or rare visitors include: brown and red-footed boobies, wedge-tailed shearwater, Matsudaira's storm-petral, white-tailed and red-tailed tropicbirds, great frigatebird, gulls, and terns.

3.4 Social Environment

This section contains general descriptions of social and economic characteristics of the Northern Mariana Islands and Guam. A broad overview of the population, economy, political history, and fisheries is provided.

3.4.1 Commonwealth of the Northern Mariana Islands

The CNMI consists of 14 islands, five of which are inhabited, with a total land area of 176.5 square miles spread over about 264,000 square miles of ocean. The Northern Mariana Islands became part of the Pacific Trust Territory administered by the U.S. under a mandate granted in 1947. The covenant that created the commonwealth and attached it to the U.S. was fully implemented in 1986, pursuant to a Presidential Proclamation that terminated the Trust Territory of the Pacific Islands as it applied to the Northern Mariana Islands.

Because participants in CNMI's fisheries are not concentrated in specific locales but rather reside in towns throughout the islands (Hamnett et al. 1998), an omnibus amendment to the Council's FMPs identified the islands of CNMI as a single fishing community (64 FR 19067, April 19, 1999). However, CNMI's history, culture, geography and relationship with the U.S. are vastly different from those of the typical fishing community in the continental U.S. The sections below describe in more detail contemporary CNMI fishing community.

Per capita income in the CNMI in 1999 was $9,151. The median household income for the CNMI as whole was $22,898. For Saipan, the median household income was $19,698 in the first quarter of 1999, as compared with $21,457 in 1990. The Commonwealth had an unemployment rate in 1999 of 5.5 percent. Forty-six percent of the CNMI population was at or below poverty in 1999 (Census 2000).

In 2000, CNMI had a total population of 69,221, with 20,378 men ages 16 and over in the available labor force, of whom 96 percent were employed. There were 24,093 women ages 16 and over in the available labor force, 97 percent of whom were employed (Census 2000). Ninety percent of CNMI residents reported being of a single ethnicity or race, with approximately 26 percent identifying themselves as Filipino, 22 percent as Chinese, 21 percent as Chamorro, 4 percent as Carolinian, 3 percent as Korean, 2 percent as Palauan, and 2 percent as Chuukese. Of the 10 percent who reported being of more than one race or ethnicity, 6 percent reported one of these groups as Chamorro, four percent Asian, and 3 percent Carolinian. The majority of fishermen in the offshore fisheries around CNMI are either Chamorro or Carolinian (Hamnett et al. 1998).

The economy of the CNMI has historically benefited substantially from financial assistance from the United States, but in recent years this assistance has declined as locally generated government revenues have grown. Between 1988 and 1996, tourism was the Commonwealth's largest income source. During that period tourist traffic to the CNMI tripled from 245,505 to 736,117 (BOH 1999). Total tourist expenditures in the CNMI were estimated to be a record $587 million in 1996. In 1997 and 1998, however, the loss of air service between the CNMI and Korea, together with the impact of the Asian financial crisis on both Korean and Japanese travelers, caused tourist arrivals in the CNMI to drop by one third (BOH 1999a).

More recently garment production has been an important industry, with shipments of $1 billion to the U.S. under duty and quota exemptions during 1999 (BOH 1999a). The garment industry is credited with preventing an economic depression in the Commonwealth following the decline of its tourist industry, but the future of the CNMI's garment manufacturers is uncertain. When the commonwealth was created it was granted an exemption from certain U.S. immigration, naturalization, and labor laws. These economic advantages are now a matter of national political debate centered on what some regard as unfair labor practices in the CNMI's garment industry. The two main advantages for manufacturing garments in the CNMI are low-cost foreign labor and duty-free sale in the U.S. The controversy over labor practices in the CNMI may cause the commonwealth to lose these unique advantages, forcing garment makers to seek alternative low-cost production sites. The end of the quota on foreign textiles in 2005 may cause garment manufacturers to move to China, which has some competitive advantages (BOH 2004).

In the early 1980s, U.S. purse seine vessels established a transshipment operation at Tinian Harbor. The CNMI is exempt from the Jones Act, which requires the use of U.S.-flag and U.S built vessels to carry cargo between U.S. ports. The U.S. purse seiners took advantage of this exemption by offloading their catch at Tinian onto foreign vessels for shipment to tuna canneries in American Samoa. In 1991, a second type of tuna transshipment operation was established on Saipan (Hamnett and Pintz 1996).This operation transships fresh tuna caught in the Federated States of Micronesia from air freighters to wide-body jets bound for Japan. The volume of fish flown into and out of Saipan is substantial, but the contribution of this operation to the local economy is minimal (Hamnett and Pintz 1996).

With the exception of the purse seine support base on Tinian (now defunct for economic reasons), the CNMI has never had a large infrastructure dedicated to commercial fishing. The majority of boats in the local fishing fleet are small, outboard engine-powered vessels.

Fishing in the CNMI continues to be important not only in terms of contributing to the subsistence needs of the Chamorro people but also in terms of preserving their history and identity. Fishing has assisted in perpetuating the traditional knowledge of marine resources and maritime traditions of the Chamorro (and Carolinian) cultures and has helped them maintain their connection to the sea and its resources.

3.4.2 Guam

The island of Guam was ceded to the U.S. following the Spanish–American War of 1898 and has been an unincorporated territory since 1949. The main income sources on Guam include tourism, national defense, and trade and services. Per capita income in Guam was $12,722 in 1999, up from $10,152 in 1991. Median household income was $39,317 in 1999, up from $31,118 in 1991. Twenty-three percent of the population in 1999 was at or below poverty level (Guam Census 2000).

The Guam Department of Labor estimated the number of employees on payroll to be 64,230 in 1998, a decrease of 3.8 percent from the 1997 figure. Of the 64,230 employees, 44,780 were in the private sector and 19,450 were in the public sector. The Federal government employs 7.6 percent of the total work force, while the Government of Guam employs 22.7 percent. Guam had an unemployment rate of 15.2 percent in 1999. As of 2000, Guam had 39,143 men age 16 and over in the labor force, of whom 81 percent were employed and 29,751 women age 16 and over in the labor force, of which 86 percent were employed (Guam Census 2000).

The major economic factor in Guam for most of the latter part of the twentieth century was the large-scale presence of the U.S. military (BOH 1999b). In the 1990s, however, the military's contribution to Guam's economy has waned and been largely replaced by Asian tourism. Guam's macroeconomic situation exhibited considerable growth between 1988 and 1993 as a result of rapid expansion of the tourist industry. In fact, Guam's economy has become so dependent on tourists from Asia, particularly Japan, that any significant economic, financial and foreign exchange development in the region has had an immediate impact on the territory (BOH 1999b). During the mid- to late-1990s, as Japan experienced a period of economic stagnation and cautious consumer spending, the impact was felt just as much in Guam as in Japan. Visitor arrivals in Guam dropped 17.7 percent in 1998. Despite recent efforts to expand the tourist market, Guam's economy remains dependent on Japanese tourists.

The Government of Guam has been a major employer on Guam for many years. However, recent deficits have resulted from a steady rise in government spending at the same time that tax bases have not kept up with spending demands. Many senior government workers have been offered and have accepted early retirement to reduce the payroll burden.

In the 1990s, after three decades of troop reductions, the military presence on the island diminished to the lowest level in decades, but with the post–9/11 emphasis on homeland security, the war in Iraq, and repositioning of military assets from Asia and the mainland U.S., military spending on Guam has rebounded significantly, and the effects have been felt throughout the economy including in employment and housing prices (Los Angeles Times, July 25, 2004).

The importance of commercial fishing in Guam lies mainly in the territory's status as a major regional fish transshipment center and resupply base for domestic and foreign tuna fishing fleets. Among Guam's advantages as a home port are well-developed and highly efficient port facilities in Apra Harbor, an availability of relatively low-cost vessel fuel, a well-established marine supply/repair industry, and recreational amenities for crew shore leave (Hamnett and Pintz 1996). In addition, the territory is exempt from the Nicholson Act, which prohibits foreign ships from landing their catches in U.S. ports. Initially, the majority of vessels calling in Apra Harbor to discharge frozen tuna for transshipment were Japanese purse seine boats and carrier vessels. Later, a fleet of U.S. purse seine vessels relocated to Guam, and since the late 1980s, Guam has become an important port for Japanese and Taiwanese longline fleets. The presence of the longline and purse seine vessels has created a demand for a range of provisioning, vessel maintenance and gear repair services.

By the early 1990s, an air transshipment operation was also established on Guam. Fresh tuna is flown into Guam from the FSM and elsewhere on air cargo planes and out of Guam to the Japanese market on wide-body passenger planes (Hamnett and Pintz 1996). A second air transshipment operation that began in the mid-1990s is transporting to Europe fish that do not meet Japanese sashimi market standards.

Guam is an important resupply and transshipment center for the international tuna longline fleet in the Pacific. However, the future of home port and transshipment operations in Guam depends on the island's ability to compete with neighboring countries that are seeking to attract the highly mobile longline fleet to their own ports. Trends in the number of port calls made in Guam by various fishing fleets reflect the volatility of the industry. The number of vessels operating out of Guam decreased by almost half from 1996 to 1997, and further declined in 1998 (Hamnett and Anderson 2000).

The Guam Department of Commerce reported that fleet expenditures in Guam in1998 were about $68 million, and a 1994 study estimated that the home port and transshipment industry employed about 130 people (Hamnett and Pintz 1996). This industry constitutes an insignificant percentage of the gross island product, which was about $2.99 billion in 1996, and is of minor economic importance in comparison to the tourist or defense industries (Hamnett and Anderson 2000). Nevertheless, home port and transshipment operations make an important contribution to the diversification of Guam's economy (Hamnett and Pintz 1996). As a result of fluctuations in the tourism industry and cuts in military expenditures in Guam, the importance of economic diversification has increased.

CHAPTER 4: DESCRIPTION OF MARIANA ARCHIPELAGO FISHERIES

4.1 Introduction

Chapter 4 describes the fisheries of the Mariana Archipelago and provides information on catches, landings, participation, and bycatch for each fishery managed under this FEP. For further information, please see the Council's FMPs, FMP amendments and associated annual reports. Additional information is also available in a 2008 environmental assessment for the Crustaceans FMP (WPRFMC 2008a), a 2001 Final EIS for the Coral Reef Ecosystems FMP (WPRFMC 2001), 2007 and 2008 environmental assessments for the Precious Corals FMP (WPRFMC 2007a, WPRFMC 2008b), a 2005 Final EIS to the Bottomfish FMP (WPRFMC 2005b), and a 2007 Final Supplemental EIS to the Bottomfish FMP (WPRFMC 2007b), and a 2006 environmental assessment under the Bottomfish, Crustaceans and Precious Corals FMPs prepared in association with the inclusion of CNMI into the management area of those FMPs (WPRFMC 2006a).

4.2 Bottomfish Fisheries of the Mariana Archipelago

The Fishery Management Plan (FMP) for Bottomfish and Seamount Groundfish Fisheries in the Western Pacific Region became effective on August 27, 1986 (51 FR 27413). Initial bottomfish fishery management measures prohibited certain destructive fishing techniques, including explosives, poisons, trawl nets, and bottom-set gillnets; established a moratorium on the commercial harvest of seamount groundfish stocks at the Hancock Seamounts, and implemented a permit system for fishing for bottomfish EEZ waters around the Northwestern Hawaiian Islands (NWHI). The plan also established a management framework that provided for regulatory adjustments to be made, such as catch limits, size limits, area or seasonal closures, fishing effort limitations, fishing gear restrictions, access limitations, permit and/or catch reporting requirements, as well as a rules-related notice system. EEZ waters around CNMI were not included in the Bottomfish FMP until a final rule implementing an omnibus amendment to the Bottomfish, Crustaceans and Precious Corals FMPs was published on October 2006 (71 FR 56305).

Other amendments to the plan which affected the Mariana Archipelago's bottomfish fisheries are described below:

AMENDMENT 1 became effective on November 11, 1987 (52 FR 38102, October 14, 1987) and established a system to allow implementation of limited access systems for bottomfish fisheries in EEZ waters around American Samoa and Guam within the framework measures of the FMP.

AMENDMENT 3, which became effective on January 16, 1991 (56 FR 2503) defined recruitment overfishing as a condition in which the ratio of the spawning stock biomass per recruit at the current level of fishing to the spawning stock biomass per recruit that would occur in the absence of fishing is equal to or less than 20%. Amendment 3 also delineated a process by which overfishing would be monitored and evaluated.

AMENDMENT 6 addressed new requirements under the 1996 Sustainable Fisheries Act (SFA). Portions of the amendment that were immediately approved include designations of essential fish habitat and descriptions of some fishing communities. Those provisions became effective on February 3, 1999 (64 FR 19067). Remaining portions that were approved on August 5, 2003 (68 FR 46112) were provisions regarding Hawaii fishing communities, overfishing definitions, and bycatch.

AMENDMENT 8 became effective on October 2006 (71 FR 56305). As discussed above, this amendment brought EEZ waters around CNMI into the FMP. In doing so it subjected them to the FMP's prohibitions on the use of destructive gear types or poisons.

AMENDMENT 9 became effective December 4, 2006 (71 FR 64474) and closed nearshore waters around Guam to bottomfishing by vessels more than 50 ft in length overall to reduce the potential for local depletion in the nearshore waters that small-scale fishermen rely upon. It also implemented Federal permitting and reporting requirements for bottomfishing vessels over 50 ft in length overall.

AMENDMENT 10 became effective January 12, 2009 (73 FR 75615) and closed nearshore areas around CNMI's southern islands as well as around the Alamagan fishing station in the northern islands, to commercial bottomfishing by vessels more than 40 ft in length overall. This amendment reduced the potential for local depletion in the nearshore waters that small-scale commercial, recreational and subsistence fishermen rely upon. It also implemented Federal permit and reporting requirements for all vessels fishing commercially for bottomfish in EEZ waters around CNMI.

4.2.1 CNMI Bottomfish Fisheries

4.2.1.1 History and Patterns of Use

CNMI's bottomfish fishery consists primarily of small-scale (less than 25 ft) local boats engaged in local commercial and subsistence fishing within a 50 mile radius of Saipan, with only a few (generally less than five) larger vessels (30 to 60 ft) sporadically participating in the deepwater bottomfish fishery. The bottomfish fishery can be broken down into two sectors: deepwater greater than 500 ft) and shallow-water (100 to 500 ft) fisheries. The deepwater fishery is primarily commercial, targeting snappers and groupers. The snappers targeted include members of *Etelis* and *Pristipomoides,* whereas the eight-band grouper (*Epinephelus octofasciatus*) is the only targeted grouper. The shallow-water fishery targeting the redgill emperor (*Lethrinus rubrioperculatus*) is mostly commercial but also includes subsistence fishermen. These fishermen harvest bottomfish as well as reef fishes. Hand lines, home-fabricated hand reels and electric reels are commonly used for small-scale fishing operations, whereas electric reels and hydraulics are used by the larger vessels. Historically, some trips have lasted for more than a day, but currently, effort is defined and calculated on a daily trip basis. Fishing trips are often restricted to daylight hours, with vessels presumed to return before or soon after sunset, unless fishing in the northern islands.

Bottomfish fishing requires more technical skill than pelagic trolling, including knowledge of the location of specific bathymetric features. Presently, bottomfish fishing can still be described as “hit or miss” for most of the smaller (12 to 29 ft) vessels. Without fathometers or nautical charts, the majority of fishermen utilizing smaller vessels often rely on land features for guidance to a fishing area. This type of fishing is inefficient and usually results in a lower catch-per-unit-effort (CPUE) in comparison with pelagic trolling. These fishermen tend to make multi-purpose trips—trolling on their way to reefs where they fish for shallow-water bottomfish and reef fish. Larger sized (30 ft and larger) vessels typically utilize Global Positioning System (GPS), fathometers, and electric reels, resulting in a more efficient operation. Reef fishes are now commanding a consistently higher price than in previous years and this appears to be reflected in an increased number of fishermen using small vessels focusing on reef and/or pelagic species over bottomfish.

Fishermen targeting deepwater bottomfish, if successful, tend to fish for 1–4 years before leaving the fishery, whereas the majority of fishermen targeting shallow-water bottomfish tend to leave the fishery after the first year. The overall participation of fishermen in the bottomfish fishery tends to be very short term (less than 4 years). The slight difference between the shallow-water fishermen and the deepwater fishermen likely reflects the greater skill and investment required to participate in the deepwater bottomfish fishery. In addition, these tend to be larger ventures that are more buffered from the vagaries of an individual’s choices and are usually dependent on a skilled captain/fisherman. Overall, the long-term commitment to hard work, maintenance and repairs, and staff retention appear to be difficult, if not impossible for CNMI bottomfish fishermen to sustain more than a few years. In 1997, two large vessels began fishing for deepwater bottomfish in the Northern Islands. In 1998, both ventures continued to fish but by the end of 1999, two of the three left the fishery. Four vessels entered the fishery in 2000 and four to six vessels over 40 ft fished for bottomfish around CNMI each year between 2000 and 2006.

4.2.1.2 Bottomfish Fishery Statistics

The following section is drawn from Council’s 2005Annual Report on the Bottomfish and Seamount Groundfish Fisheries of the Western Pacific Region and represents the best available information on the CNMI bottomfish fishery (WPRFMC 2006b). For additional information on these fisheries please see the Council’s annual reports.

CNMI’s bottomfish fishery occurs primarily around the islands and banks from Rota Island to Zealandia Bank north of Saipan. However, available data are limited to the catches landed on Saipan, which is by far the largest market. Total reported Saipan landings (in pounds) and revenues are inflated by 30% to represent CNMI as a whole (assuming 60% coverage of the commercial sales on Saipan, and that Saipan is 90% of the CNMI market).

Data collection occurs primarily through the Commercial Purchase Database (CPD). This is a voluntary program in which all buyers of fish are requested report the weight of each species of fish purchased, the date, fisher’s and dealer’s names and price per pound by submitting invoices. “Trip tickets” with this information are completed by fish buyers and submitted to DFW personnel. These data are considered reliable since 1983. This data collection system is dependent upon voluntary participation by first-level purchasers of local fresh fish to accurately record all fish purchases by species categories on specially designed sales invoices. DFW staff routinely collected and distributed invoice books to 27 participating local fish purchasers in 2004; which include the majority of the fish markets, stores, restaurants, hotels, government agencies, and roadside vendors (fish-mobiles).

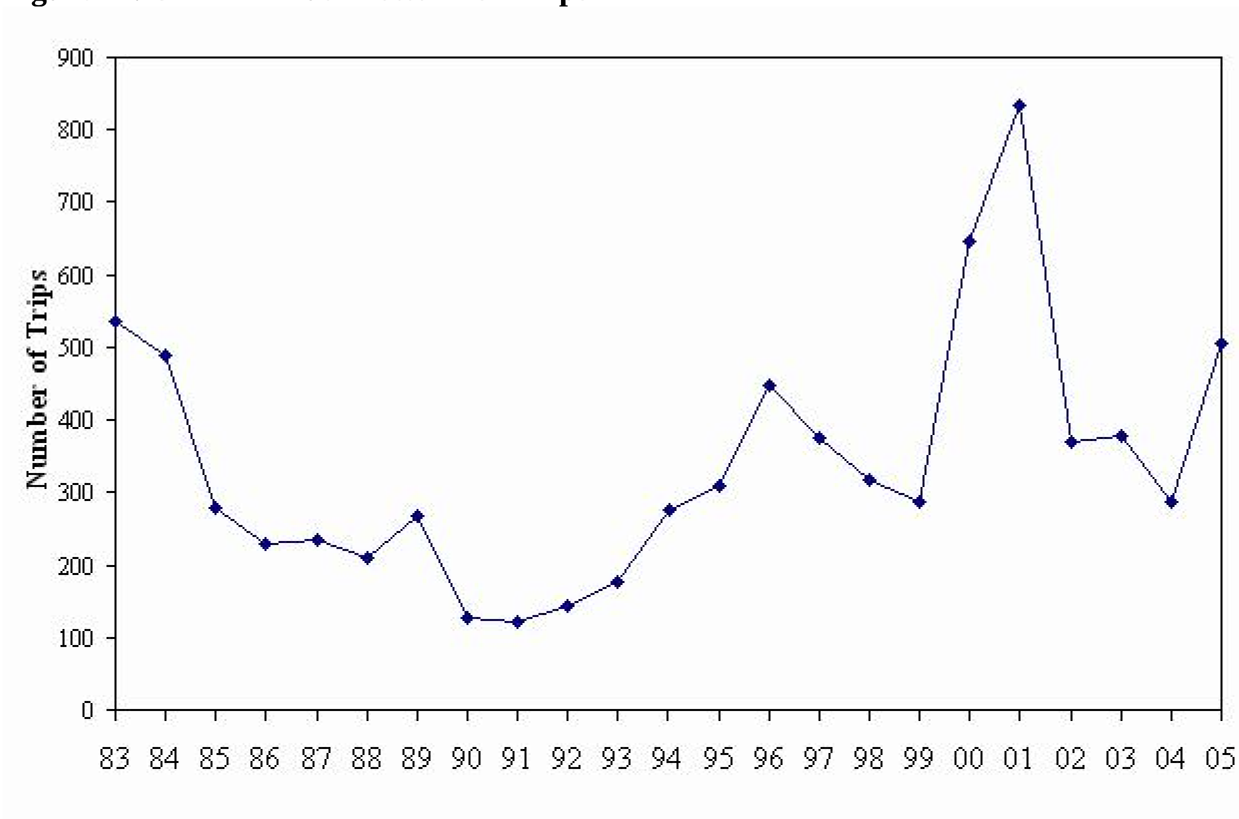
As shown in Table 8 and Figures 12 and 13, taken as a whole the total pounds of bottomfish sold in CNMI in 2005 increased by 29% from 2004. This includes BMUS as well as other species caught on bottomfishing gear. Part of this is due to an increase in landings of shallow-water bottom fish, mostly emperors. Overall in 2005, the number of fishermen landing bottomfish in CNMI was above the 23-year mean.

Table 8. CNMI Bottomfish Fishery Catch, Effort, Revenue, Prices and Participants

Year	Landings Total (Lbs)	CPUE (Lbs/Trip)	CPI	CPI Adjusted Revenue ($)	CPI Adjusted Price ($/Lb)	Number of Fishermen
1983	28,529	43	140.90	97,052	3.40	90
1984	42,664	70	153.20	131,265	3.08	101
1985	40,975	117	159.30	117,717	2.87	62
1986	29,911	104	163.50	93,538	3.13	55
1987	49,715	169	170.70	142,838	2.87	46
1988	47,313	181	179.60	130,336	2.75	28
1989	24,438	73	190.20	73,965	3.03	31
1990	12,927	81	199.33	42,354	3.28	33
1991	7,093	47	214.93	25,281	3.56	19
1992	10,598	59	232.90	30,877	2.91	36
1993	18,461	84	243.18	52,235	2.83	20
1994	25,469	74	250.00	76,905	3.02	32
1995	36,101	93	254.48	128,991	3.57	34
1996	66,387	119	261.98	230,216	3.47	71
1997	64,143	137	264.95	217,078	3.38	68
1998	59,022	148	264.18	206,111	3.49	50
1999	55,991	156	267.80	204,633	3.65	53
2000	45,258	56	273.23	128,120	2.83	72
2001	71,256	68	271.01	218,462	3.07	74
2002	46,765	101	271.55	135,146	2.89	53
2003	41,903	89	268.92	120,315	2.87	59
2004	54,474	104	271.28	142,362	2.61	43
2005	70,034	76	271.90	189,478	2.71	62
Average	41,279	98		127,908	2.60	52
Standard Deviation	19,101	39		61,905	0.61	22

Source: WPRFMC 2006b

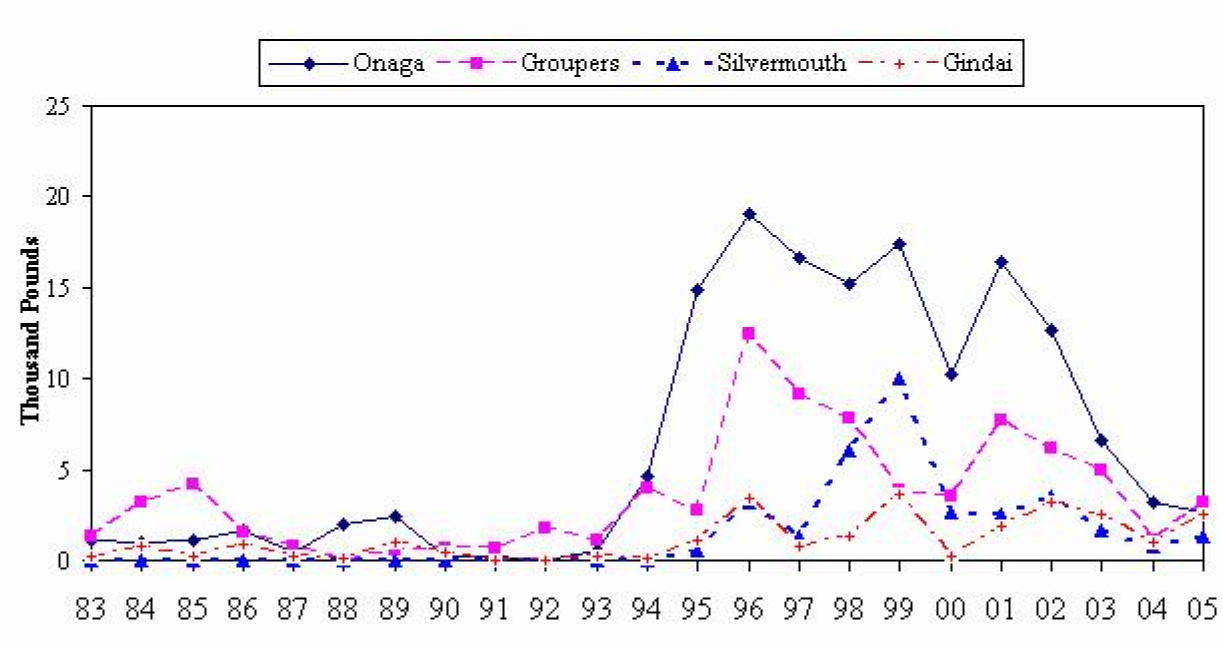
Figure 11. CNMI Annual Bottomfish Trips



Source: WPRFMC 2006b

The overall number of commercial bottomfish trips was fairly high from 1983 through 1989 as a result of large vessel deep-water fishing activity centered on the island of Farallon de Medinilla. This fishery largely ceased in 1990, resulting in a drop in bottomfish trips in the early 1990s. In 1994, consistent fishing activity in the northern islands began once more and the number of bottomfish trips more than doubled in 2000 and 2001 to reach the highest levels in 18 years. During this time, smaller vessels increased their focus on reef fishes, and although bottomfish were still being caught and sold, they were no longer the largest (or most valuable) part of the catch. The number of commercial trips decreased in 2002 and remained low in 2003 and 2004. The number of commercial bottomfish fishing trips reported for 2004 decreased below the 23-yr mean partly due to rough sea conditions throughout the year and likely partly due to decreased participation in the commercial sales invoice program. However, the 2005 trips increased by 75% possibly due to the troll fishermen conducting more bottomfishing. The increasing fuel cost has caused many fishermen to conduct a multiple method trip (trolling and bottomfishing) in order to lower their fuel consumption and cost.

Figure 12. CNMI Commercial Landings of Deep-water Species

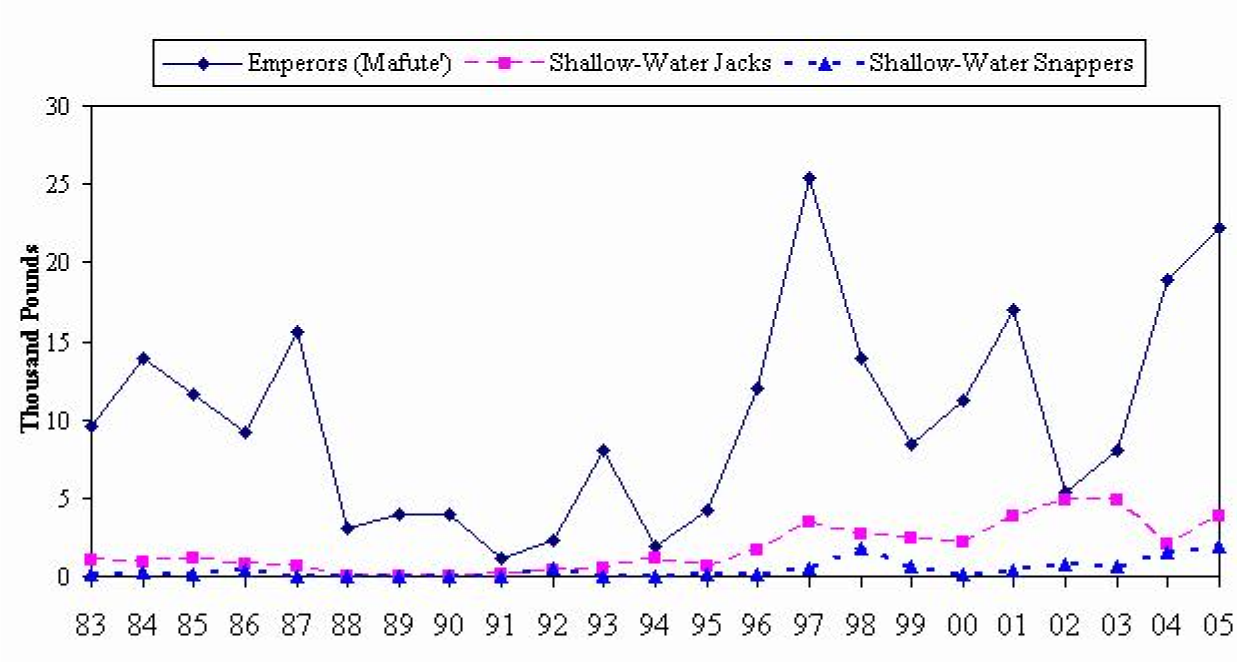


Source: WPRFMC 2006b

Until 1995 bottomfish categorized as "assorted bottomfish" were the largest portion of the CNMI commercial bottomfish landings. The use of additional species names on sales invoices now allows many of these to be more precisely identified. Commercial deep-water bottomfish landings increased significantly in 1995 and remained fairly high until 2001. This was likely the result of an increase in the number of large vessels participating in the deep-water bottomfish fishery that were capable of fishing the islands and banks north of Farallon de Medinilla. Note however, that deep-water bottomfish are still caught near Saipan.

In 2004 commercial landings of deep-water bottom fish declined drastically because there was little fishing effort in the northern islands. However, in 2005, landings of some deep-water bottomfish increased by 40 percent. Commercial landings of onaga (*Etelis coruscans* and some *Etelis radiosus*) fell steeply in 2003, 2004 and 2005 to below the 23-year mean. This is in part to this sector's high turnover rate, with even successful onaga fishermen often leaving the fishery after 1–4 years. Commercial landings of grouper (primarily *Epinephelus octofasciatus*, but almost certainly including shallow-water BMUS species such as *Variola louti* and *E. fasciatus*) have varied widely over the last 10 years with a 20.3% decrease in landings in 2002 from 2001, a 21.6% decrease in landings in 2003 and a sharper decrease of 78% in 2004. However in 2005, a significant increase of 193% occurred. Most of these landings were from the smaller vessels fishing near the main island of Saipan. Silvermouth (*Aphareus rutilans*) have been reported since 1995, and commercial landings have fluctuated considerably with 2005 landings below the 23 year mean. Commercial opakapaka (*Pristipomoides zonatus*, and likely some *P. flavipinnes*) landings have varied somewhat in the last 10 years, with the 2004 landings down 62% and 2005 up 55%. Ehu (*Etelis carbunculus*) landings increased by 16 percent between 2004 and 2005. Ehu are commonly caught around Saipan by the smaller fishing vessels. Kalikali (*Pristipoimoides auricilla* and *P. sieboldii*) appeared in the sales invoice for the first time in 2002; 2003 landings were an order of magnitude greater than previous year's, 2004 landings were up 5% and 2005 landings were up another 15%.

Figure 13. CNMI Commercial Landings of Shallow-water Species



Source: WPRFMC 2006b

Commercial landings of shallow-water bottomfish appear to have peaked between 1996 and 2001 and were again headed upwards in 2004 and 2005. It is likely that there was a comparable peak in landings between 1984 and 1987, but this result is difficult to discern because of the large number of bottomfish that were categorized as "assorted bottomfish" during the earlier period. Commercial landings of emperor (mafute' of the family Lethrinidae) have fluctuated widely over the last 20 years, and particularly over the last eight years. In 2002, commercial landings of mafute' fell below the 20-year mean to their lowest level since 1995. In 2003 they increased slightly but remained below the 21-year mean. In 2004 commercial mafute' landings increased by 136% from 2003 and they increased again by 18% in 2005.

Commercial landings of jacks fished in shallow areas (itemized as *"jacks," amberjack (Seriola dumerili), giant trevally (Caranx ignobilis), brassy trevally (*C. papuenis), and black jack (*C. lugubris*) on the sales invoices) appear to have slowly increased over the last 10 years, with the highest landings reported in 2003. Commercial landings of jacks were up 0.57% in 2002 but were down 87% by 2004. However 2005 landings increased by 313%. The category "jacks" includes any carangids sold, both BMUS species and *Carangoides orthogrammus*, *Caranx melampygus*, *C. papuensis*, and *C. sexfasciatus*. Commercial landings of amberjack were slightly lower in 2005 than the previous year. Giant trevally and black jack were reported in 2002 for the first time and brassy trevally was reported in 2003 for the first time, both likely as a result of being added to the new sales invoice.

Jobfish (*Aprion virescens*) have been reported in eight of the last 20 years, and 2004 commercial landings were the highest ever reported surpassing the previous year by 100 percent. Commercial uku landings were down slightly in 2005 and landings of blueline snapper (*Lutjanus kasmira*) and humpback snapper (*Lutjanus gibbus*) were much higher than last year, but these species are often lumped within assorted reef fishes and so this increase may be overstated.

As shown in Tables 9 and 10 total commercial landings of identified (those that were specifically itemized on the sales receipts) dropped to a low in 1991 and then generally climbed through 2001. They then declined again in 2002, and have been moving upwards since then.
This report only represents the commercial fishery as reported on sales invoices in the CNMI. Data from charter vessels that do not sell their catch, and private boat recreational and subsistence catches are not available.

Table 9. CNMI Commercial Landings (lbs) of Deep-water BMUS by Species

Year	Onaga	Lehi	Paka	Gindai	Ehu	Kali	Total
1983	1,118	0	2,022	267	0	0	3,407
1984	1,026	0	1,639	798	0	0	3,463
1985	1,117	0	681	208	0	0	2,223
1986	1,598	0	987	874	0	0	3,822
1987	472	0	1,146	271	0	0	1,889
1988	2,001	0	326	85	0	0	2,413
1989	2,478	0	538	1,006	0	0	4,021
1990	253	0	628	393	0	0	1,273
1991	175	0	606	0	0	0	781
1992	21	0	136	0	0	0	607
1993	593	0	898	232	0	0	1,722
1994	4,578	0	824	58	0	0	5,476
1995	14,910	521	1,019	1,114	0	0	17,736
1996	19,093	3,179	6,570	3,452	0	0	32,446
1997	16,631	1,375	2,780	821	0	0	22,133
1998	15,158	6,028	2,729	1,295	197	124	27,593
1999	17,351	9,986	1,772	3,686	821	6	34,648
2000	10,199	2,659	1,633	214	45	0	14,968
2001	16,358	2,585	3,951	1,916	8	0	25,264
2002	12,655	3,479	3,932	3,157	263	410	24,518
2003	6,649	1,624	2,262	2,550	729	3,090	17,988
2004	3,160	737	849	1,042	1,137	3,242	12,872
2005	2,625	1,293	1,317	2,495	1,324	3,725	15,780
Avg	6,531	1,455	1,706	1,128	197	461	12,045
Std	6,888	2,434	1,493	1,171	397	1,153	11,257

Source: WPRFMC 2006b

Table 10. CNMI Commercial Landings (lbs) of Shallow-water BMUS by Species

Year	Emperors	Amber jack	Giant trevally	Black trevally/jack	Uku	Taape	Total
1983	9,555	0	0	0	0	0	9,555
1984	13,925	0	0	0	0	0	13,925
1985	11,676	135	0	0	81	0	11,892
1986	9,250	0	0	0	363	0	9,613
1987	15,568	0	0	0	0	0	15,568
1988	3,078	0	0	0	0	0	3,078
1989	3,963	0	0	0	0	0	3,963
1990	4,021	0	0	0	0	0	4,021
1991	1,212	0	0	0	0	0	1,212
1992	2,338	0	0	0	450	0	2,788
1993	8,083	0	0	0	0	0	8,083
1994	1,870	0	0	0	16	0	1,886
1995	4,276	0	0	0	171	0	4,447
1996	11,990	0	0	0	152	0	12,142
1997	25,445	0	0	0	526	0	25,971
1998	13,853	317	0	0	1,746	0	15,916
1999	8,419	343	0	0	683	0	9,445
2000	11,223	28	0	0	190	0	11,441
2001	16,987	21	0	0	425	0	17,433
2002	5,364	184	48	0	389	352	6,337
2003	7,999	322	26	138	597	75	9,157
2004	18,889	488	91	931	1,194	102	21,695
2005	22,240	411	84	1,405	1,102	758	26,000
Avg	10,053	98	11	108	352	56	10,677
Std	6,650	160	27	343	463	171	

Source: WPRFMC 2006b

4.2.1.3 Review of Bycatch

Almost all fishes caught in the CNMI are considered food fishes, including many that show a high incidence of ciguatera (e.g., lyretail grouper (*Variola louti*) and red snapper (*Lutjanus bohar*). Bycatch estimates for CNMI bottomfish fisheries (Table 11) are derived from interviews of fishermen during boat-based creel surveys. The interviews are divided into vessels engaged in non-charter (including commercial, noncommercial, and subsistence fishermen) and charter fishing. All bycatch were released alive.

Table 11. Bycatch in the CNMI Bottomfish Fishery

Species Name	Interview with Bycatch	All Interview	Released Alive	Total Catch	Bycatch Percentage
Non-Charter	**2**	**220**			0.91%
Dogtooth Tuna			1	18	5.56%
Blueline Snapper			4	213	1.88%
Blackjack			1	29	3.45%
All Species with Bycatch			**6**	**260**	**2.31%**
Compared with All Caught				**5,756**	**.10%**
Charter	**12**	**84**			14.29%
Redgill Emperor			6	240	2.50%
Triggerfish (misc.)			55	165	33.33%
Emperor (mafute/misc.)			7	129	5.43%
Red Snapper			5	9	55.56%
Blueline Snapper			3	64	4.69%
Lyretail Grouper			5	19	26.32%
Flagtail Grouper			4	116	3.45%
Maitai (blk-tipped Grper)			4	139	2.88%
Jobfish (uku)			1	5	20.00%
All Species with Bycatch			**90**	**886**	**10.16%**
Compared with All Caught				**1,247**	**7.22%**

Source: WPRFMC 2006b

4.2.1.4 Status of Fishery

To date, CNMI's bottomfish fishery has not been determined to be overfished or subject to overfishing.

4.2.1.5 CNMI Bottomfish MSY

A Resource Assessment Investigation of the Mariana Archipelago (RAIOMA) was conducted in 1982-1984 to assess the bottomfish and other resources of the Mariana Archipelago (Polovina et al. 1985). Sampled areas were divided into three regions: the Northern Islands, the Southern Islands and the Western Seamounts. These studies resulted in several publications describing the bottomfish complexes and included maximum sustainable yield (MSY) estimates for deep-slope bottomfish species in each area as presented in Table 12. There are no estimates available of the MSY for shallow-water bottomfish around CNMI.

Table 12. Annual MSY Estimates for Deep-slope Bottomfish

Area	MSY (pounds)
Northern Islands: Maug, Asuncion, Agrihan, Pagan, Alamagan, Guguan, Sarigan, Anatahan, 38-fathom, Esmeralda	64,577
Southern Islands: Farallon de Medinilla, Saipan, Tinian, Aguijan, Rota	110,641
Western Seamounts: Bank C, Bank D, Pathfinder, Arakane, Bank A	9,036
Total	184,254

Source: Polovina et al. 1985

4.2.1.6 CNMI Bottomfish Optimum Yield

Optimum Yield (OY) for CNMI's bottomfish fishery is defined as the amount of bottomfish that will be caught by fishermen, fishing in accordance with applicable fishery regulations in this plan, in the EEZ and adjacent waters around CNMI. This definition is consistent with that contained in the Council's Bottomfish and Seamount Groundfish FMP.

4.2.1.7 CNMI Bottomfish Domestic Processing Capacity

Bottomfish harvested in CNMI 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.

4.2.1.8 CNMI Bottomfish Total Allowable Level of Foreign Fishing

The domestic fleets of CNMI have sufficient harvesting capacity to take the entire OY, therefore, the total allowable level of foreign fishing (TALFF) appears to be zero.

4.2.1.9 Surplus Production Model Stock Assessment

Scientists at NMFS' Pacific Islands Fisheries Science Center (PIFSC) assessed the status of the bottomfish complex in CNMI in 2005 using a dynamic surplus production model (Moffitt et al. 2007). The index-based assessment results indicated that CNMI's bottomfish complex has not been overfished and has not experienced overfishing during 1986-2005. In this stock assessment, MSY is only for the deepwater species and therefore this value is conservative. Potential problems with this stock assessment and its use of fishery-dependent data include that the estimates of total fishery removals may be incomplete or otherwise inaccurate due to the voluntary nature of fishery catch reporting, changes in data collection protocols, or misidentification of species which could, in turn, affect the results (Moffitt et al. 2007).

4.2.2 Guam Bottomfish Fishery

The following section is drawn from Council's 2001 and 2005 Annual Reports on the Bottomfish and Seamount Groundfish Fisheries of the Western Pacific Region and represents the best available information on Guam's bottomfish fishery (WPRFMC 2003, WPRFMC 2006b). For additional information on this fishery please see the Council's annual reports.

4.2.2.1 History and Patterns of Use

There are two distinct bottomfish fisheries on Guam that can be separated by depth and species composition. The shallow water complex (< 500 feet) makes up a larger portion of the total bottomfish effort and usually the harvest, comprising primarily reef-dwelling snappers, groupers, and jacks of the genera *Lutjanus*, *Lethrinus*, *Aprion*, *Epinephelus*, *Variola*, *Cephalopholis,* and *Caranx*. The deepwater complex (> 500 feet) consists primarily of groupers and snappers of the genera *Pristipomoides*, *Etelis*, *Aphareus*, *Epinephelus*, and *Cephalopholis*.

Bottomfishing on Guam is a combination of recreational, subsistence, and small-scale commercial fishing. The majority of the participants in the bottomfish fishery operate vessels less than 25 feet long and primarily target the shallow-water bottomfish complex (WPRFMC 2003). The shallow-water component is the larger of the two in terms of participation because of the lower expenditure and relative ease of fishing close to shore (Myers 1997). Participants in the shallow-water component seldom sell their catch because they fish mainly for recreational or subsistence purposes (WPRFMC 2003). The commercially oriented highliner vessels tend to be longer than 25 feet, and their effort is usually concentrated on the deep-water bottomfish complex. Most fishermen troll for pelagic fish to supplement their bottomfishing effort and most of those who sell their catch also hold jobs outside the fishery (WPRFMC 2003).

Smaller vessels (< 25 ft) target mostly the shallow-water bottomfish complex and fish for a mix of recreational, subsistence, and small-scale commercial purposes. Some vessels fishing the offshore banks—particularly the few relatively large vessels (> 25 feet) that fish primarily for commercial purposes—target the deep-water bottomfish complex. At least one such vessel has been engaged in a venture that exports deep-slope species – particularly *onaga* – to Japan. It is possible that some vessels fishing on the banks around Guam land their catches in the CNMI (WPRFMC 2002a). In 1997, a highliner vessel made several bottomfishing trips to a seamount located 117 miles west of Guam (WPRFMC 2003).

The Agana Boat Basin is centrally located on the western leeward coast and serves as the island's primary launch site for boats fishing areas off the central and northern leeward coasts and the northern banks. The Merizo boat ramp, Seaplane Ramp in Apra Harbor, Umatac boat ramp, and Agat Marina are boat launch sites that provide access to the southern coast, Apra Harbor, Cocos Lagoon, and the southern banks. The Agat Marina, in particular, located between the Agana Boat Basin and the Merizo boat ramp, provides trailered boats from the northern and central areas of the island a closer and more convenient launch site to the southern fishing grounds. At Ylig Bay, a paved parking area and maintenance of the brush along the highway has helped increased the number of boats accessing the east side of the island.

Guam's bottomfish fishery can be highly seasonal, with effort significantly increasing when sea conditions are calm, generally during the summer months. During these periods, bottomfishing activity increases substantially on the offshore banks (in Federal waters), as well as on the east side of the island (in territorial waters), a more productive fishing area that is inaccessible to small boats during most of the year due to rough seas. Historical data on Guam bottomfish landings is provided in Figure 12.

According to Myers (1997), less than 20 percent of the total shallow-water marine resources harvested in Guam are taken outside 3 miles, primarily because the offshore banks are less accessible. Most offshore banks are deep, remote, have high shark densities, and subject to strong currents. Generally, these banks are only accessible during calm weather in the summer months (May to August/September). Galvez Bank is the closest and most accessible and, consequently, fished most often. In contrast, the other banks (White Tuna, Santa Rose, Rota) are remote and can only be fished during exceptionally good weather conditions (Green 1997). Local fishermen report that up to ten commercial boats, with two to three people per boat, and some recreational boats, use the banks when the weather is good (Green 1997). The banks are fished using two methods: bottomfishing by hook-and-line and jigging at night for bigeye scad (*Selar crumenophthalmus*; Myers 1997). Catch composition of the shallow-bottomfish complex (or coral reef species) is dominated by lethrinids. Other important components of the bottomfish catch include lutjanids, carangids, serranids, and sharks. Holocentrids, mullids, labrids, scombrids, and balistids are minor components. It should be noted that at least two of these species (*Aprion virescens* and *Caranx lugubris*) also range into deeper water and some of the catch of these species occurs in the deepwater fishery.

Participants in small-scale offshore fisheries live throughout the island of Guam and are not concentrated in specific locales. Recent surveys of fishery participants found that these individuals reside throughout the island (Rubinstein 2001). With the small size of Guam, the dispersal of fishery participants and extensive community networks for sharing locally caught fish, it is likely that the social benefits of fishing are widely shared by most of the island's long-term residents (WPRFMC 2003).

Charter fishing has been a substantial component of the fishery since 1995, accounting for about 15–20 percent of all bottomfishing trips from 1995 through 2004 (WPRFMC 2006b). Charter vessels typically make multiple two-to-four hour trips on a daily basis. The charter fleet includes both vessels that engage in both trolling and bottomfishing trips and larger bottomfishing-only vessels that can accommodate as many as 35 patrons per trip. These larger vessels consistently fish in the same general area and release most of their catch, primarily small triggerfish, small groupers, and small goatfish. They occasionally keep larger fish and use a portion of the catch to serve as sashimi for their guests.

Guam's bottomfish datasets are from two voluntary creel surveys conducted year-round by DAWR personnel. The offshore creel survey obtains fishery information from boat-based participants, who are primarily trolling for pelagic species, bottomfishing, or jigging. However, methods not considered boat-based are often employed by fishermen who use boats to access remote shorelines, lagoons and reef margins to do spearing, gillnetting, and shoreline castnetting. The inshore creel survey obtains fishery information from shore-based participating, primarily employing hook-and-line, nets (gillnets, castnets, surround nets, etc.) and shore-based spearing. Both boat-based and shore-based methods harvest BMUS species.

4.2.2.2 Bottomfish Fishery Statistics

In general, 2005 landings and associated revenue of bottomfish were down due to reduced effort levels (Tables 13 and Figures 14-17). Significant increases in the price of fuel and in increase in bad weather days may have contributed to this decline.

Table 13. Guam Bottomfish Fishery Catch, Effort, Revenue, Prices and Participants

Year	Landings* Total (Lbs)	CPUE (Lbs/Hour)	CPI	Adjusted Revenue ($)	Adjusted Price ($/Lb)	Number of Boats
1980			134.0	48,454	5.14	
1981			161.4	65,681	6.20	
1982	37,639	7.1	169.7	44,514	6.41	154
1983	47,119	6.2	175.6	214,911	5.81	106
1984	58,095	7.4	190.9	130,429	5.60	144
1985	88,113	5.7	198.3	148,563	5.30	161
1986	36,774	5.2	203.7	60,412	4.99	118
1987	45,924	5.9	212.7	62,364	4.93	139
1988	62,273	5.0	223.8	75,052	4.71	198
1989	82,756	5.5	248.2	107,472	5.47	223
1990	78,349	4.5	283.5	100,301	5.30	226
1991	69,619	4.8	312.5	57,129	5.07	246
1992	82,682	5.8	344.2	49,660	4.66	236
1993	95,815	4.2	372.9	44,585	4.37	360
1994	103,046	5.5	436.0	135,823	4.47	298
1995	103,344	2.5	459.2	55,004	3.98	402
1996	138,621	4.1	482.0	22,812	3.09	408
1997	100,105	3.6	491.4	36,082	3.40	332
1998	100,736	2.7	488.9	55,031	3.73	354
1999	117,067	3.2	497.9	124,485	4.05	411
2000	138,398	3.7	508.1	85,841	3.92	312
2001	117,177	3.9	501.2	95,539	3.63	337
2002	68,289	3.0	504.5	62,597	3.42	351
2003	92,880	4.7	521.4	39,450	3.36	481
2004	72,844	4.0	563.2	73,466	2.93	347
2005	**61,601**	**4.8**	**563.2**	**69,186**	**3.18**	**233**
Average	83,303	4.7	355.7	79,417	4.50	274
Standard Deviation	28,806	1.3	149.1	43,083	1.00	106

*Landings by boat-based bottomfishing activity only and includes both deep-water and shallow-water bottomfish.

Source: WPRFMC 2006b

Guam’s bottomfish landings are dominated by onaga, with uku, ehu and other species far behind.

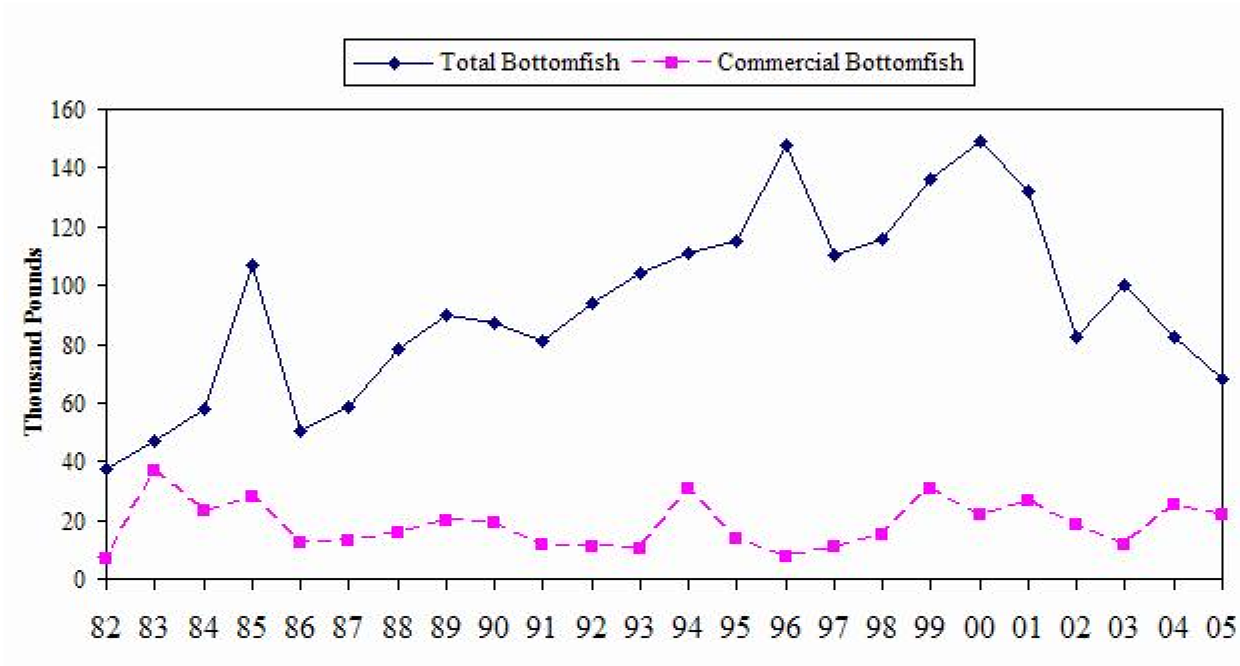
Table 14. Guam 2005 BMUS Catch Composition

Management Unit Species	Harvest (Pounds)
BMUS	
Onaga (*E. coruscans)*	15,309
Uku (*A. virescens)*	4,791
Ehu (*E. carbunculus)*	3,488
Lyretail Grouper (*V. louti)*	2,479
Redgill Emperor (*L. rubrioperculatus)*	2,214
Lehi (*A. rutilans)*	2,090
Blacktip Grouper (*E. fasciatus)*	1,495
Yellowtail Kalekale (*P. auricilla)*	1,069
Gindai (*P. zonatus)*	637
Black Jacks (*C. lugubris)*	482
Ta'ape (*L. kasmira)*	479
Opakapaka (*P. filamentosu)*	458
Amberjack (*S. dumerili)*	288
Yelloweye Opakapaka (*P. flavipinnis)*	265
Giant Trevally (*C. ignobilis)*	217
BMUS Total	**35,761**
Non-BMUS Bottomfish	
Other Snappers	1,558
Other Jacks	7,718
Other Groupers	6,778
Other Emperors	8,804
Non-BMUS Bottomfish Total	**24,858**
Non-Specific Bottomfish*	
Misc Bottomfish	0
Shallow Bottomfish	975
Deep Bottomfish	6
Non-Specific Bottomfish Total	**981**
Bottomfish Total	**61,601**

*These three (3) generic categories are used when fisheries staff are unable to survey bottomfish catches. This occurs when the fisherman is in a rush or declines for his catch to be surveyed, yet providing information on effort and participation. The catch information required in this situation is whether the fisherman was targeting the deep, shallow, or mixed complexes.

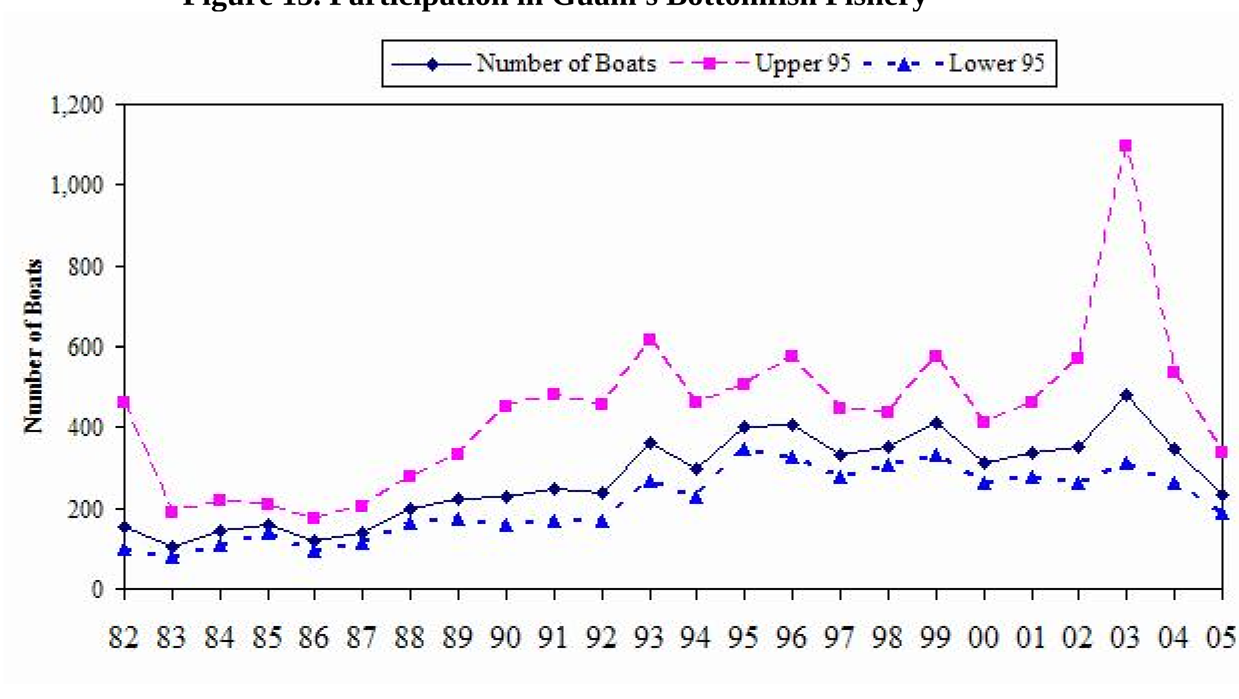
Source: WPRFMC 2006b

Figure 14. Guam Bottomfish Landings



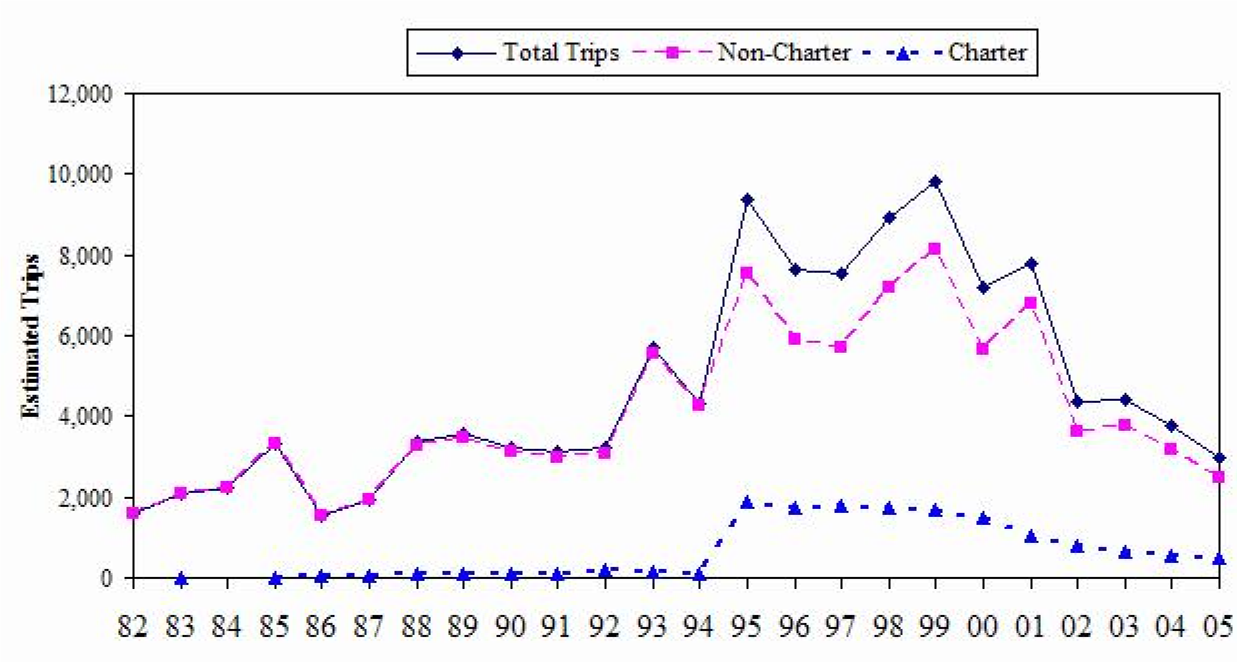
Source: WPRFMC 2006b

Figure 15. Participation in Guam's Bottomfish Fishery



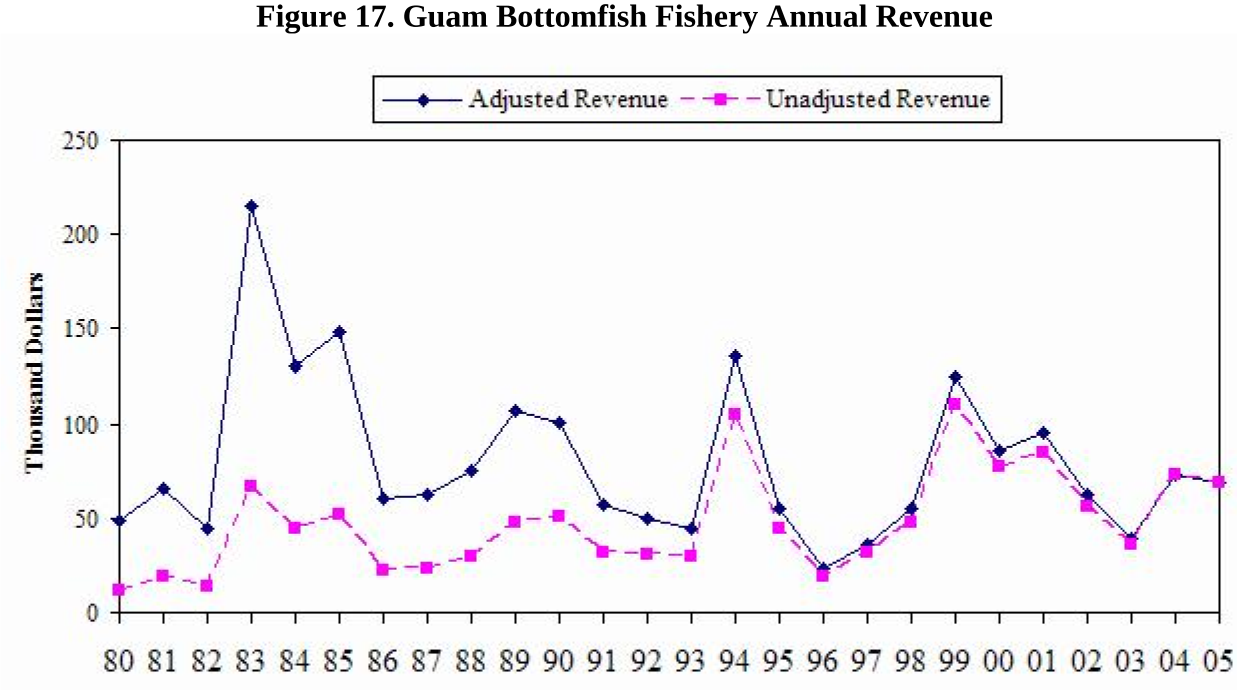
Source: WPRFMC 2006b

Figure 16. Guam Annual Bottomfishing Trips



Source: WPRFMC 2006b

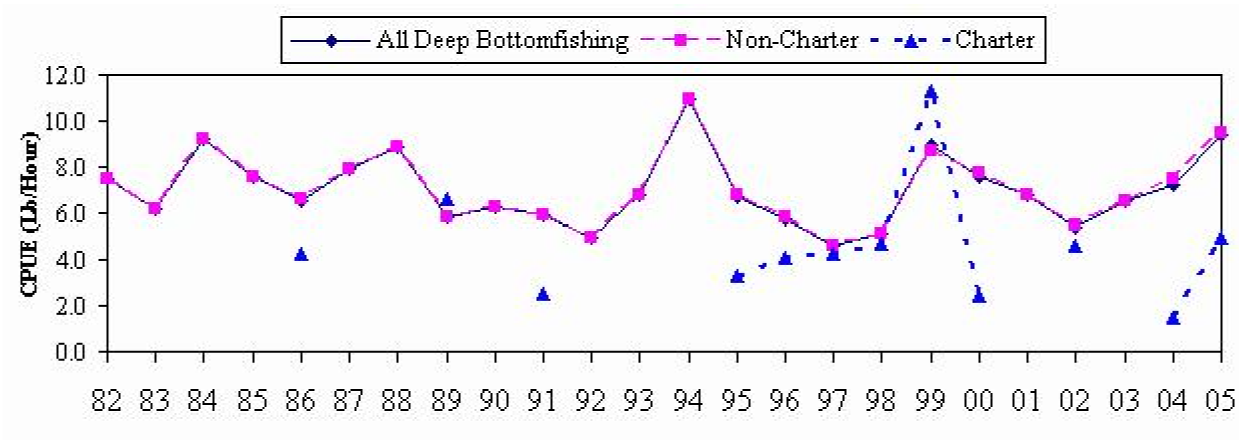
Figure 17. Guam Bottomfish Fishery Annual Revenue



Source: WPRFMC 2006b

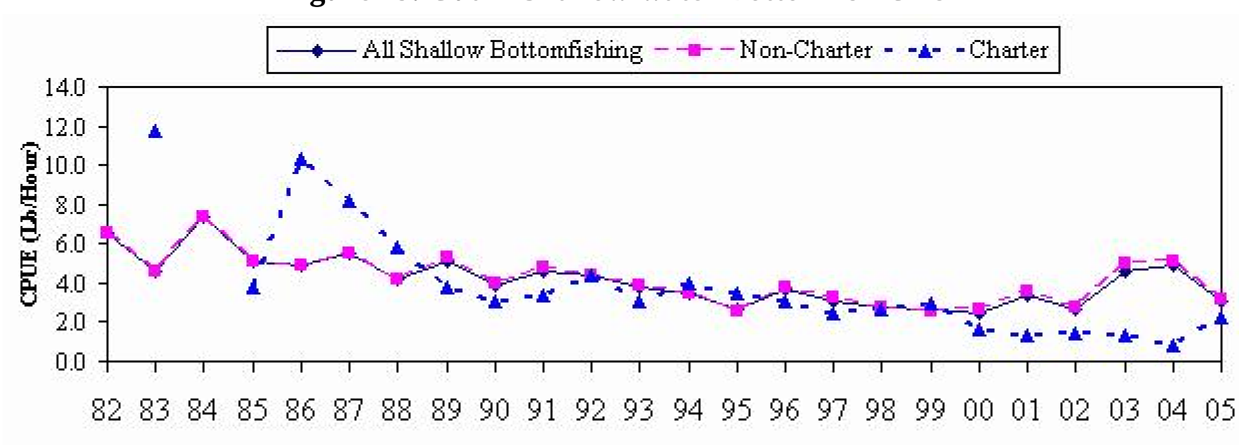
Prior to 1999, the CPUE for bottomfishing was reported as a single value. In 1999 the charter and non-charter components were separated so as to provide more accurate information on each sector. Historically bottomfishing CPUE fluctuated between 4-6 pounds per hour fished. In 1995 and 1998, the overall and non-charter CPUE fell below 2.8 pounds per hour due to an increase in the number of recreational and subsistence-type vessels entering the fishery, mostly targeting shallow-water bottomfish. All deep-water bottomfishing CPUE values increased in 2005 (Figure 18). Overall and non-charter shallow-water CPUE values both declined (Figure 19), perhaps due to local stress on stocks.

Figure 18. Guam Deep-water Bottomfish CPUE



Source: WPRFMC 2006b

Figure 19. Guam Shallow-water Bottomfish CPUE



Source: WPRFMC 2006b

4.2.2.3 Review of Bycatch

With an overall bycatch (discard) rate of less than 4% most fish caught in the Guam bottomfish fishery are kept, regardless of size or species (Table 15). However, the charter fishing sector commonly practices catch-and-release fishing, resulting in an overall bycatch rate of 26.8 percent (WPRFMC 2006b). All bycatch were released alive.

Table 15. Guam 2005 Bottomfish Fishery Bycatch

Species Name	Number Released			Total Caught	Bycatch (%)
	Alive	Dead or Injured	Both		
Non-Charter					
Epinephelus howlandi	2		2	3	66.67
Epinephelus merra	1		1	20	5.00
Non-Charter Bycatch Total	3		3	23	13.04
Comparison with All Species Caught				1,434	0.21
Charter					
Serranidae	3		3	3	100.00
Epinephelus fasciatus	6		6	23	26.09
Mullidae	16		16	16	100.00
Mulloidichthys flavolineatus	8		8	8	100.00
Parupeneus multifasciatus	10		10	11	90.91
Balistidae	4		4	5	80.00
Melichthys vidua	10		10	10	100.00
Odonus niger	5		5	5	100.00
Rhinecanthus rectangulus	1		1	1	100.00
Charter Bycatch Total	63		63	82	76.83
Comparison with All Species Caught				235	26.81
All Bycatch Total	66		66	105	62.85
Comparison with All Species				1,669	3.95

Source: WPRFMC 2006b

Trends in bycatch rates for Guam's bottomfish fishery are illustrated in Table 16. These rates have been declining since 2001.

Table 16. Guam Bottomfish Bycatch 2001-2005

Year	Released alive	Released dead/injured	Total Number Released	Total Number Landed	Percent Bycatch*	Interviews with Bycatch	Total Number of Interviews	Percent of Interviews with Bycatch
2001	620	3	623	3,896	16.0	58	183	31.7
2002	356	0	356	2,504	14.2	33	137	24.1
2003	191	0	191	1,888	10.1	14	101	13.9
2004	122	0	122	1,795	6.8	11	100	11
2005	66	0	66	1,669	3.95	6	103	5.82

*"Percent Bycatch" is the number of fish that were discarded compared to the total number of bottomfish that were landed. The bycatch information is from unexpanded data, taken only from actual interviews that reported bycatch.

Source: WPRFMC 2006b

4.2.2.4 Status of Guam Bottomfish Fishery

To date, Guam's bottomfish fishery has not been determined to be overfished or subject to overfishing**.**

4.2.2.5 Guam Bottomfish Fishery MSY

MSY for Guam's deep-water bottomfish fishery has been estimated at 56,863 lbs (Polovina and Ralston 1985). There are no estimates available of the MSY for shallow-water bottomfish around Guam.

4.2.2.6 Guam Bottomfish Optimum Yield

OY defined as is the amount of bottomfish that will be caught by fishermen, fishing in accordance with applicable fishery regulations in this plan, in the EEZ and adjacent waters around Guam. This definition is consistent with that contained in the Bottomfish and Seamount Groundfish FMP.

4.2.2.7 Guam Bottomfish Domestic Processing Capacity

Bottomfish harvested in Guam 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.

4.2.2.8 Guam Bottomfish TALFF

The domestic fleets of Guam have sufficient harvesting capacity to take the entire OY. Therefore the TALFF appears to be zero.

4.2.2.9 Surplus Production Model Stock Assessment

Scientists at PIFSC assessed the status of the bottomfish complex in Guam in 2005 using a dynamic surplus production model (Moffitt et al. 2007). The index-based assessment results indicated that Guam bottomfish complex has not been overfished since 1982 and has not been experiencing overfishing except perhaps in 2000. Estimates of relative biomass indicate that the Guam bottomfish complex has been above B_{MSY} during the 1982-2005 period and estimates of the relative exploitation rate indicate the annual harvest rate has been below H_{MSY} since 1982 with the exception of 1982. In this stock assessment, MSY is only for the deepwater species and therefore this value is conservative. Potential problems with this stock assessment and its use of fishery-dependent data include that the estimates of total fishery removals may be incomplete or otherwise inaccurate due to the voluntary nature of fishery catch reporting, changes in data collection protocols, or misidentification of species which could, in turn, affect the results (Moffitt et al. 2007).

4.2.2.10 Potential for Protected Species Interactions

From October 2003 – June 2005, the Hawaii-based bottomfish NWHI fishery was monitored under a mandatory NMFS observer program. Data for seven calendar quarters are available on the PIRO website. From the fourth quarter of 2003 through the second quarter of 2005, observer coverage in the bottomfish fleet averaged 21.4 percent, and there were no observed interactions with sea turtles or marine mammals. There were a total of six observed seabird interactions, including two unidentified boobies, one brown booby, one black-footed albatross and two Laysan albatrosses. Only the black-footed albatross interaction occurred during bottomfish fishing operations. All of the other interactions were observed in transit during trolling operations. Due to the type of fishing gears and methods used (hook-and-line fishing from largely stationary vessels), interactions between seabirds and bottomfishing operations around the Mariana Archipelago are believed to occur rarely if at all.

There have been no reported or observed physical interactions with any species of sea turtle and whales in any of the bottomfish fisheries based out of Hawaii, including during the NMFS 1990–1993 NWHI bottomfish vessel observer program[15] (Nitta 1999) and the more recent 2003-2005 observer program. It was concluded in the 2002 Biological Opinion that the probability of an encounter between any of these species and the bottomfish fishery is extremely low and that the fishery, as managed under the FMP, is not likely to adversely affect these species (NMFS 2002).

There are no observer data available for the Guam and CNMI fisheries, however based on the above information they are not expected to interact with any listed species in Federal waters around Guam or CNMI. There are no specific regulations currently in place which are aimed at protected species interaction mitigation, however, prohibitions on certain destructive gear types are in place as described in Section 5.3.2.

Following consultations under section 7 of the ESA, NMFS has determined that the bottomfish

[15] 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".

fisheries will not adversely affect any ESA-listed species or critical habitat in the Mariana Archipelago. The management and conservation measures contained in this FEP for targeting bottomfish or seamount groundfish species are being carried forth (i.e., maintained without change) from the Bottomfish and Seamount Groundfish FMP.

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

4.3 Crustacean Fisheries of the Mariana Archipelago

4.3.1 CNMI Crustacean Fisheries

4.3.1.1 History and Patterns of Use

Lobsters around the CNMI do not appear to go into traps and have not been found in waters deeper than 13 meters (M. Trianni, personal communication). The CNMI fishery primarily targets spiny lobster in nearshore waters with reported catches taken almost exclusively within the 0–3-nautical mile zone of the inhabited southern islands, by hand harvesters with scuba or free diving. Beyond 3 nautical miles, the topography in most locations drops off steeply. These lobster habitats are relatively small and access is difficult. Anecdotal information indicates that in the northern islands on reef surrounding FDM, bottomfish fishermen anchored for the night occasionally dive for lobsters. Anchoring and diving at FDM occurs exclusively within 3 nautical miles and most likely on the lee side within 100 yards of land. This activity is primarily for personal consumption.

A second crustacean fishery undertaken in the 1990s, trapped deep-water shrimp with fishing occurring on flat areas near steep banks at depths greater than 350 meters, mostly on grounds around Saipan and Tinian (Ostazeski 1997). Two fishing companies began fishing for deep-water shrimp in May of 1994. While three species of pandalid shrimp are known to occur at varying depths in the waters around CNMI, (*Heterocarpus ensifer* (366–550 m), *Heterocarpus laevigatus* (550–915 m), and *Heterocarpus longirostris* (> 915 m) (Moffitt and Polovina 1987), the most commercially valuable and subsequently targeted is the largest species, *Heterocarpus laevigatus*. Between May of 1994 and February of 1996, 12,160 kilograms of deep-water shrimp were landed. Of these, more than 97 percent were *Heterocarpus laevigatus,* with the remainder being *Heterocarpus ensifer*. Bycatch included a few deepwater eels (*Synaphobranchus* spp.) and dogfish sharks. A large number of two species of Geryonid crabs were also caught. The crabs are a marketable incidental catch and could contribute to the success of any deep-water shrimp fishery. Strong currents, rough bottom topography, and the fishing depth all contribute to the potential for gear loss, which has been experienced by this fishery in the past.

One CNMI company stopped fishing in June of 1995 after fishing a total of 193 days. The second company began in December of 1995 and had fished 20 days by March of 1996 when non-Commercial Purchase Database (CPD) data collection ceased (Ostazeski 1997). The first company cited loss of gear as the reason for exiting the fishery. They were using oval plastic Fathom Plus traps which weighed 7 kg and experienced a trap loss of 3.5 percent per set with an average of 12.7 traps per string (range of 3 to 40 traps per string). The second company experienced no trap losses in 61 sets and 1561 traps deployed. Traps used by this company were lightweight with nylon netting. These traps weighed only 2.5 kg and if they became entangled on the bottom, they could tear away and still be recovered. Trap size was smaller and catch per trap was on average 76 percent of the plastic traps, but they were able to deploy many more traps per string without fear of gear loss. As the fishing grounds exploited are relatively close to Saipan and because neither vessel had freezer capabilities, shrimp were kept on ice for 12-48 hours before being brought to market.

Between May of 1994 and February of 1996, 12,160 kilograms of deepwater shrimp were landed. Of these, more than 97 percent were *Heterocarpus laevigatus,* with the remainder being *Heterocarpus ensifer*. Bycatch included a few deepwater eels (*Synaphobranchus* spp.) and dogfish sharks. A large number of two species of geryonid crabs were also caught. The crabs are a marketable incidental catch and could contribute to the success of any deepwater shrimp fishery. Strong currents, rough bottom topography, and fishing depth all contributed to gear loss, which has been experienced by this fishery in the past.

Throughout the Pacific, deep-water shrimp fisheries have been sporadic in nature (Hastie and Saunders 1992). The reasons for this are manifold. Gear loss has been a common problem and made many past ventures unprofitable. A second difficulty is the short shelf life and a history of inconsistent quality, leading to fluctuating market demand for the product. Lastly, these fisheries generally experience local depletion on known fishing grounds, which leads to much lower catch rates. While other banks might have abundant stocks, unfamiliarity with them could lead to even greater gear loss.

Shrimp trapping was conducted at 22 islands and banks during the Resource Assessment Investigation of the Mariana Archipelago (RAIOMA) cruises in the early 1980s. Depth and area distribution were observed for the three major species of pandalid shrimp. Average size, size at maturity, reproductive cycles, and sex ratios were analyzed and determined. Growth and mortality were also calculated. From analysis of catch per unit effort, determination of suitable habitat and the above parameters, total biomass, and sustainable yield were calculated. Moffitt and Polovina (1987) estimated 676.6 tons of *Heterocarpus laevigatus* biomass and an exploitable sustainable yield of 162 tons per year for the combined EEZ waters around Guam and CNMI.

The CNMI Division of Fish and Wildlife (DFW) conducted a data collection project specifically for the deepwater shrimp fishery between May of 1994 and June of 1995. Catch and effort data was gathered for both types of traps, as well as bycatch data. Depth ranges for the fishery as well as depth of greatest abundance were recorded. Sex ratios and reproductive cycles were determined from 1,533 *H. laevigatus* examined (Ostazeski 1997). Research has also been conducted to create a depletion model which would estimate catchability and would help determine the commercial viability of this fishery. It is likely that much shrimp went directly to an export market and was not caught by the CPD. The Northern Mariana Islands Division of Fish and Wildlife (DFW) monitors the commercial fishery by summarizing sales ticket receipts from commercial establishments. DFW staff routinely distributes and collects invoice books from 80 participating local fish purchasers on Saipan, including fish markets, stores, restaurants, government agencies and roadside vendors. There are no local permitting or reporting requirements in place for these fisheries.

4.3.1.2 Crustacean Fishery Statistics

CNMI's commercial lobster fishery is small, with 2,948 lbs of commercial landings in for 2004 worth an estimated $19,408 (NMFS 2004b). Because the number of participants in lobster fishery is unknown, the unreported commercial and noncommercial catch could double this figure.

4.3.1.3 Review of Bycatch

There is no bycatch in the CNMI lobster fishery as lobsters in CNMI do not readily enter traps and the fishery is primarily executed by hand harvest. As noted above, Ostazesk (1997) reported bycatch in the deep-water shrimp fishery included a few deepwater eels (*Synaphobranchus* spp.), dogfish sharks, and a large number of Geryonid crabs. Bycatch rates for this intermittent fishery are not available.

4.3.1.4 Status of CNMI Crustacean Fisheries

To date, CNMI's crustacean fisheries have not been determined to be overfished or subject to overfishing

4.3.1.5 CNMI Crustacean Fisheries MSY

There no available estimates of MSY values for the CNMI lobster or crab fishery available. The MSY for deepwater shrimp has been estimated for the Mariana Archipelago at 200 kg/nmi^2 (Moffitt and Polovina 1987)

4.3.1.6 CNMI Crustacean Fisheries Optimum Yield

To date the Council has not established an OY for crustacean fisheries operating around CNMI.

4.3.1.7 CNMI Crustacean Domestic Processing Capacity

Crustaceans harvested around CNMI 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

4.3.1.8 CNMI Crustacean TALFF

The OY for CNMI crustacean fisheries have yet to be established, however, it is likely that the domestic fleets of CNMI would have sufficient harvesting capacity to harvest the OY, however at this time the TALFF is undetermined.

4.3.1.9 Potential for Protected Species Interactions

Lobsters around the Mariana Archipelago are hand harvested, with virtually all harvests to date occurring in nearshore waters. There have been no observed or reported interactions with protected species and the potential for interactions in Federal waters around the Mariana Archipelago is believed to be very low due to the hand harvest methods used. 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 CNMI.

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

4.3.2 Guam Crustacean Fisheries

4.3.2.1 History and Patterns of Use

Little is known about Guam's crustacean fisheries. Fishing for these species around Guam mostly occurs in inshore territorial waters, usually in a subsistence or recreational context. In 2004, however, two Crustacean FMP permits were registered to vessels to fish in the EEZ around Guam. The activities of these vessels (if any) including catch levels, composition, bycatch or location are unknown (A. Katekaru, NMFS, personal communication, August 2004). It is estimated that a total of 2,225 pounds of spiny lobsters with a total ex-vessel value of $7,279 were harvested commercially from waters around Guam in 2003 (NMFS 2004b). In 2004, 1,996 pounds of spiny lobsters were harvested commercially (NMFS 2004b).

In the 1970's, one small scale, deepwater shrimp fishery was attempted in Guam, but no known operations have occurred since (Wilder 1979). The Division of Aquatic and Wildlife (DAWR) administers an offshore creel survey program that provides comprehensive estimates of island-wide catch and effort for all the major fishing methods used in commercial and recreational fishing. In 1982, the Western Pacific Fisheries Information Network (WPacFIN) began working with the Guam Fishermen's Cooperative Association to improve their invoicing system and obtain data on all fish purchases on a voluntary basis. Data are also collected from a major fish wholesaler and several retailers who make purchases directly from fishermen. These businesses voluntarily provide data to WPacFIN using invoices (trip tickets) provided by DAWR.
There are no local permitting or reporting requirements in place for these fisheries.

4.3.2.2 Review of Bycatch

No information is yet available on bycatch in the crustacean fisheries around Guam.

4.3.2.3 Status of Guam Crustacean Fisheries

To date, Guam's crustacean fisheries have not been determined to be overfished or subject to overfishing

4.3.2.4 Guam Crustacean Fisheries MSY

There are no available estimates of MSY values for Guam's lobster or crab fisheries. The MSY for deepwater shrimp has been estimated for the Mariana Archipelago at 200 kg/nmi^2 (Moffitt and Polovina 1987).

4.3.2.5 Guam Crustacean Fisheries Optimum Yield

To date the Council has not established an OY for crustacean fisheries operating around Guam.

4.3.2.6 Guam Crustacean Fisheries Domestic Processing Capacity

The OY for Guam's crustacean fisheries have yet to be established; however, it is likely that the domestic fleets of Guam have sufficient harvesting capacity to take the entire OY, when, and if that is established.

4.3.2.7 Guam Crustacean Fisheries TALFF

Available information indicates that U.S. vessels currently have the capacity to harvest the OY on an annual basis and therefore the TALFF would appear to be zero.

4.3.2.8 Potential for Protected Species Interactions

Lobsters around the Mariana Archipelago are hand harvested, with virtually all harvests around Guam occurring in Territorial waters. There have been no observed or reported interactions with protected species and the potential for interactions in Federal waters around the Mariana Archipelago is believed to be very low due to the hand harvest methods used. 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 Guam.

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

4.4 Coral Reef Ecosystem Fisheries of the Mariana Archipelago

4.4.1 CNMI Coral Reef Fisheries

4.4.1.1 History and Patterns of Use

Archaeological excavations indicate that marine turtle, shellfish, and invertebrates were collected by the prehistoric Chamorro. Shark and dolphin remains have been excavated as well (Hunter-Anderson et al. 1996; Moore et al. 2002). Under official Spanish colonization in1668, and their policy of *reducción*, key elements of the prehistoric cultural system were lost, including pelagic fishing as the Spanish destroyed the large canoes and canoe houses in punitive raids. During this period, inshore fishing for invertebrates and reef fish and reef gleaning were the main means of obtaining marine protein (Amesbury and Hunter-Anderson 2003).

Carolinians, who are Micronesians that settled on Saipan in the 1840s, are a small minority of the indigenous population, but they are known for their seafaring and fishing skill. Their fishing activity largely centered on the harvest of lagoon and reef species, but small paddling canoes were sometimes used to fish a short distance outside the reef (Amesbury and Hunter-Anderson 1989).

Under Japanese rule (1914–1944), the Northern Mariana Islands became a major fishing base, primarily for the harvest of skipjack tuna. However, the Chamorros or Carolinians of the Northern Mariana Islands had little or no involvement in these industrial-scale fish harvesting or processing operations. According to Joseph and Murray (1951), Japanese colonial policy prohibited commercial fishing—and most other remunerative enterprises—by Chamorros and Carolinians. Presumably, during this period the Chamorros and Carolinians relied heavily on subsistence use of inshore marine resources (Amesbury and Hunter-Anderson 1989).

The post–World War II years saw a gradual involvement of the Chamorros and Carolinians of the Northern Mariana Islands in commercial fishing. By 1980, several boats over 25 feet in length were actively engaged in commercial fishing, primarily for bottomfish and pelagic species (Orbach 1980).

It is difficult to assess the total harvest of present-day coral reef fisheries in the CNMI because of shortcomings in fisheries statistics. Coral reef fisheries in the CNMI are mostly limited to nearshore areas, especially off the islands of Saipan, Rota, and Tinian. Finfish and invertebrates are the primary targets, but small quantities of seaweed are also taken. All of the recent data are for commercial landings. Commercial landings of coral reef fish were approximately 136,000 pounds in 2003 (and include harvests of parrotfish, surgeonfish, goatfish, snappers, and emperors (NMFS 2004b). However, a significant amount offish landed are reported as miscellaneous (see Figure 13). Currently, moratoriums exist on invetebrate coral reef fisheries targeting sea cucumbers (*Actinopyga maruitiana*) and harvests of topshell (*Holothuria whitmaei*) are subject to closed seasons. Generally, coral reef fisheries in the CNMI are believed to be in good condition, but local depletion likely occurs in some areas of Saipan (Starmer et al. 2005).

Virtually no recent information is available for inshore subsistence and recreational catches of coral reef resources. This harvest is assumed to be substantial, especially in the more accessible areas like Saipan Lagoon. The CNMI is now reestablishing the inshore creel survey program at Saipan Lagoon to obtain this information. Also, little is known of the coral reef fisheries in the northern islands of CNMI, but the catch by domestic fishermen is believed to be minor. The exception was in 1995, when the nearshore reefs around six of the northern islands (especially Anatahan and Sarigan) were fished commercially for several months. During that time, these areas yielded a harvest of 15 metric tons of reef fish and 380 pieces of spiny lobster (Trianni 1998). Poaching by foreign fishing boats may occur in some places (Green 1997).

4.4.1.2 Coral Reef Fisheries Catch Statistics

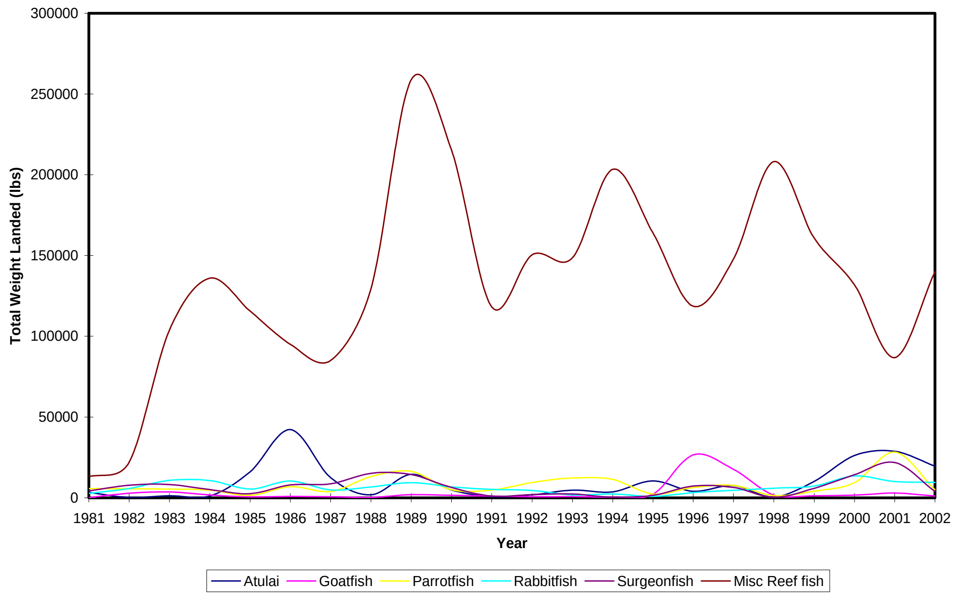


Figure 20. CNMI Commercial Reef Fish Landings by Species Group
Source: Western Pacific Fisheries Information Network

4.4.1.3 Review of Bycatch

No information is yet available on bycatch in the inshore coral reef fisheries of the CNMI as this data collection program has only recently (2005) been reinitiated. However, it can be presumed, that bycatch of CNMI boat-based bottomfish fishery (see Section 4.1.1), which also harvests shallow-water coral reef associated species, would account for much of the information available on coral reef species bycatch.

4.4.1.4 Status of CNMI Coral Reef Fisheries

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

4.4.1.5 CNMI Coral Reef Fisheries MSY

There are no available estimates of MSY values for coral reef ecosystem management unit species around CNMI.

4.4.1.6 CNMI Coral Reef Fisheries Optimum Yield

OY for coral reef ecosystem associated species is defined as 75 percent of their MSY. This definition is consistent with that contained in the Coral Reef Ecosystems FMP.

4.4.1.7 CNMI Coral Reef Fisheries Domestic Processing Capacity

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

4.4.1.8 CNMI 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 the TALFF would appear to be zero.

4.4.1.9 Potential for Protected Species Interactions

There have been no reported or observed interactions between protected species and coral reef fisheries in Federal waters around the Mariana Archipelago and the potential for interactions is believed to be low due to the gear types and fishing methods used. Following consultations under section 7 of the ESA, NMFS has determined that the coral reef ecosystem fisheries will not adversely affect any ESA-listed species or critical habitat in CNMI.

NMFS has also concluded that the CNMI coral reef ecosystem commercial fisheries will not affect marine mammals in any manner not considered or authorized under the Marine Mammal Protection Act.

4.4.2 Guam Coral Reef Fisheries

4.4.2.1 History and Patterns of Use

Coral reef resource utilization by prehistoric Chamorro on Guam mirrors that of the CNMI. Archaeological evidence reviewed by Amesbury et al. (1989) suggested "an apparent tendency throughout prehistory and historic times for Mariana Island native groups to have relied more on inshore fish species than offshore ones." And, like the Chamorros in the northern islands, Spanish colonizers also systematically destroyed large oceangoing canoes in Guam in order to concentrate the indigenous population in a few settlements, thereby facilitating colonial rule as well as religious conversion (Amesbury and Hunter-Anderson 1989).

By the mid-nineteenth century, there were only 24 outrigger canoes on Guam, all of which were used only for fishing inside the reef (Myers 1993). Another far-reaching effect of European colonization of Guam and other areas of the Mariana archipelago was a disastrous decline in the number of Chamorros, from an estimated 40,000 persons in the late seventeenth century to approximately 1,500 persons a hundred years later (Amesbury and Hunter-Anderson 1989).

After the U.S. acquired Guam in 1898, following the Spanish–American War, the U.S. colonial government held training programs to encourage local residents to participate in offshore commercial fishing (Amesbury and Hunter-Anderson 1989). However, because they lacked the capital necessary to purchase and maintain large enough boats, most couldn't participate. Amesbury et al. (1989) concluded that "in the decades prior to the Second World War, inshore but not offshore fishing was part of the subsistence base of the native people." One document they reviewed was a list of the "principal fishes of Guam" written by a scientifically trained naval officer. Nearly all the fishes listed were reef associated. The first year that a pelagic fish species was included in the catch reports of the postwar Guam civilian government was 1956. Until then, all catch reports were of reef-associated species (Amesbury et al. 1989).

Shortly after the end of World War II, the U.S. military assisted several villages in developing an inshore commercial fishery using nets and traps. Post–World War II wage work enabled some fishermen to acquire small boats with outboard engines and other equipment for offshore fishing (Amesbury and Hunter-Anderson 1989). However, even as late as the 1970s, relatively few people in Guam fished offshore because boats and deep-sea fishing equipment were too expensive for most people (Jennison-Nolan 1979).

In the late 1970s, a group of Vietnamese refugees living on Guam fished commercially on a large scale, verifying the market potential for locally-caught reef fish, bottomfish, tuna, and mackerel (AECOS 1983). The Guam Fishermen's Cooperative Association began operations during that time. Until the co-op established a small marketing facility at the Public Market in Agana, fishermen were forced to make their own individual marketing arrangements after returning from fishing trips (AECOS 1983). In 1980, the co-op acquired a chill box and ice machine, and emphasized wholesaling. Today, the co-op's membership includes over 160 full-time and part-time fishermen, and it processes and markets (retail and wholesale) an estimated 80 percent of the local commercial catch (M. Duenas, GFCA, personal communication).

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

Shore-based fishing accounts for most of the fish and invertebrate harvest from coral reefs around Guam. The coral reef fishery harvests more than 100 species of fish, including the families Acanthuridae, Carangidae, Gerreidae, Holocentridae, Kyphosidae, Labridae, Lethrinidae, Lutjanidae, Mugilidae, Mullidae, Scaridae, and Siganidae (Hensley and Sherwood 1993).

Myers (1997) noted that seven families (Acanthuridae, Mullidae, Siganidae, Carangidae, Mugilidae, Lethrinidae, and Scaridae) were consistently among the top ten species in any given year from fiscal year 1991 to fiscal year 1995 and accounted for 45 percent of the annual fish harvest. Approximately 40 taxa of invertebrates are harvested by the nearshore fishery, including 12 crustacean taxa, 24 mollusc taxa, and four echinoderm taxa (Hensley and Sherwood; Myers 1997). Species that became rare on shallow reefs due to heavy fishing include bumphead parrotfish (*Bolbometopon muricatum*), humphead wrasse (*Cheilinus undulatus*), stingrays, parrotfish, jacks, emperors, and groupers (Green 1997).

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

Virtually no information exists on the condition of the reefs on offshore banks. On the basis of anecdotal information, most of the offshore banks are in good condition because of their isolation. According to Myers (1997), less than 20 percent of the total coral reef resources harvested in Guam are taken from the EEZ, primarily because they are associated with less accessible offshore banks. Finfish make up most of the catch in the EEZ. Most offshore banks are deep, remote and subject to strong currents. Generally, these banks are only accessible during calm weather in the summer months (May to August/September). Galvez Bank is the closest and most accessible and, consequently, fished most often. In contrast, the other banks (White Tuna, Santa Rose, Rota) are remote and can only be fished during exceptionally good weather conditions (Green 1997). Local fishermen report that up to ten commercial boats, with two to three people per boat, and some recreational boats, use the banks when the weather is good (Green 1997).

At present, the banks are fished using two methods: bottomfishing by hook and line and jigging at night for bigeye scad (*Selar crumenophthalmus*; Myers 1997). In recent years, the estimated annual catch in these fisheries has ranged from 14 to 22 metric tons of shallow bottomfish and 3 to 11 metric tons of bigeye scad (Green 1997). The shallow-water component accounted for almost 68 percent (35,002 to 65,162 lbs.) of the aggregate bottomfish landings in fiscal year 1992–94 (Myers 1997). Catch composition of the shallow-bottomfish complex (or coral reef species) is dominated by lethrinids, with a single species (*Lethrinus rubrioperculatus*) alone accounting for 36 percent of the total catch. Other important components of the bottomfish catch include lutjanids, carangids, serranids, and sharks. Holocentrids, mullids, labrids, scombrids, and balistids are minor components. It should be noted that at least two of these species (*Aprion virescens* and *Caranx lugubris*) also range into deeper water and some of the catch of these species occurs in the deepwater fishery.

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

4.4.2.2 Coral Reef Fisheries Catch Statistics

Table 17. 2002 and 2003 Estimated Harvests of Top 10 Families for Inshore and Offshore Fisheries

Inshore*				Offshore**			
2002		2003		2002		2003	
Family	Catch (lbs)	Family	Catch (lbs)	Family	Catch (lbs)	Family	Catch (lbs)
Kyphosidae (Rudderfishes)	20,823	Acanthuridae (Surgeonfishes)	27,920	Lethrinidae (Emperors)	29,915	Lethrinidae (Emperors)	25,590
Siganidae (Rabbitfishes)	19,300	Carangidae (Jacks)	21,337	Acanthuridae (Surgeonfish)	20,523	Acanthuridae (Surgeonfish)	18,620
Acanthuridae (Surgeonfish)	17,129	Siganidae (Rabbitfishes)	12,408	Scaridae (Parrotfishes)	16,438	Scaridae (Parrotfishes)	18,141
Carangidae (Jacks)	14,938	Mullidae (Goatfishes)	11,818	Carangidae (Jacks)	12,192	Carangidae (Jacks)	21,117
Lethrinidae (Emperors)	9,856	Scaridae (Parrotfishes)	9,464	Serranidae (Groupers)	6,562	Serranidae (Groupers)	23,621
Mullidae (Goatfishes)	8,679	Lethrinidae (Emperors)	5,174	Lutjanidae (Snappers)	3,319	Lutjanidae (Snappers)	6,791
Lutjanidae (Snappers)	5,966	Diodontidae (Porcupinefish)	3,627	Sphyraenidae (Barracudas)	3,491	Sphyraenidae (Barracudas)	7,345
Serranidae (Groupers)	4,765	Scombridae (Mackerels)	2,875	Labridae (Wrasses)	3,060	Labridae (Wrasses)	5,229
Mugilidae (Mullets)	4,378	Serranidae (Groupers)	2,824	Mullidae (Goatfishes)	5,150	Scombridae (Mackerels)	7,548
Belonidae (Needlefishes)	4,329	Carcharhinidae (Requiem Sharks)	2,767	Siganidae (Rabbitfish)	3,055	Carcharhinidae (Requiem Sharks)	3,590

Sources: Gutierrez 2003; Flores 2003; DAWR unpublished data.
Note: Inshore data excludes seasonal runs of juvenile siganids and bigeye scads.
*Information gathered from creel surveys targeted at shore-based fishermen.
** Information gathered from creel surveys with boat-based fishermen at boat ramps and harbors.

Total coral reef fish landings for Guam in 2002 and 2003 were estimated at 273,799 pounds and 306,626 pounds, respectively (NOAA 2005b).

4.4.2.3 Review of Bycatch

Coral reef taxa are currently harvested primarily in Guam's territorial waters. No bycatch measures are necessary at this time. No permits for coral reef fisheries in Federal waters have yet been issued. At this time and under these circumstances, there is no reported bycatch associated with this fishery.

4.4.2.4 Status of Guam Coral Reef Fisheries

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

4.4.2.5 Guam Coral Reef Fisheries MSY

There are no available estimates of MSY values for coral reef ecosystem management unit species around Guam.

4.4.2.6 Guam Coral Reef Fisheries Optimum Yield

OY for coral reef ecosystem associated species is defined as 75% of their MSY. This definition is consistent with that contained in the Coral Reef Ecosystems FMP.

4.4.2.7 Guam Coral Reef Fisheries Domestic Processing Capacity

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

4.4.2.8 Guam 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 the TALFF would appear to be zero.

4.4.2.9 Potential for Protected Species Interactions

There have been no reported or observed interactions between protected species and coral reef fisheries in Federal waters around the Mariana Archipelago and the potential for interactions is believed to be low due to the gear types and fishing methods used. Following consultations under section 7 of the ESA, NMFS has determined that the coral reef ecosystem fisheries will not adversely affect any ESA-listed species or critical habitat in Guam.

NMFS has also concluded that the Guam coral reef commercial fisheries will not affect marine mammals in any manner not considered or authorized under the Marine Mammal Protection Act.

4.5 Precious Coral Fisheries of the Mariana Archipelago

4.5.1 CNMI Precious Coral Fisheries

4.5.1.1 History and Patterns of Use

Little is known about the presence of precious corals in the waters around the CNMI. The amount of habitat where precious corals can grow is limited throughout the archipelago because of the steep topography. Black coral grows in relatively shallow waters of 30–100 meters, while pink, gold, and bamboo coral grows in deeper waters of 300 to1,500 meters (Grigg, 1993). Thus, precious corals could theoretically exist in both the nearshore waters (0–3 nm) as well as in the offshore (3–200 nm) waters.

Reports of a fishery from pre–World War II suggest that large quantities of high-quality *Corallium* spp. were taken in waters north of Pagan Island (Takahashi 1942 as cited in Grigg and Eldredge 1975). Since then, no known precious coral harvests have occurred within EEZ waters around CNMI.

4.5.1.2 Status of CNMI Precious Corals Fishery

To date, CNMI's precious corals fishery has not been determined to be overfished or subject to overfishing.

4.5.1.3 CNMI Precious Corals Fishery MSY

There are no estimates available of MSY values for precious corals around CNMI.

4.5.1.4 CNMI Precious Corals Fishery Optimum Yield

Precious corals in the EEZ around CNMI comprise exploratory area XP-CNMI which has an OY of 1,000 kg per year for all species combined (except black corals). No OY has been determined for black corals around CNMI. This definition is consistent with that contained in the Precious Corals FMP.

4.5.1.5 CNMI Precious Corals Fishery 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.

4.5.1.6 CNMI Precious Coral Fishery TALFF

The TALFF for CNMI precious corals is defined as the 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 available for foreign fishing under a scientific research plan approved by NMFS in consultation with the Council and State agencies.

4.5.1.7 Potential for Protected Species Interactions

There have been no reported or observed interactions between marine mammals, sea turtles or seabirds and the precious corals fishery in the Hawaiian Archipelago (where there has been an active precious corals fishery). There could be some impact on marine mammals or sea turtles 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 would be expected to constitute a low-level risk to these species marine mammals if precious corals fishery were to develop in the Mariana Archipelago. 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 CNMI.

NMFS has also concluded that the CNMI precious corals commercial fisheries will not affect marine mammals in any manner not considered or authorized under the Marine Mammal Protection Act.

4.5.2 Guam Precious Coral Fisheries

4.5.2.1 History and Patterns of Use

During the 1970s, surveys for precious coral in the waters surrounding CNMI were performed (Grigg and Eldridge 1975). The study focused on the presence of pink and red corals (*Corallium* spp.) and black coral (*Antipathes* spp.). Very little precious coral resources were found in these surveys. There is no precious coral fishery currently operating around Guam, nor have there been any reported or observed landings of precious corals harvests from the EEZ around Guam.

4.5.2.2 Status of Guam Precious Corals Fishery

To date, Guam's precious corals fishery has not been determined to be overfished or subject to overfishing.

4.5.2.3 Guam Precious Corals Fishery MSY

There are no MSY estimates available for precious corals around Guam.

4.5.2.4 Guam Precious Corals Fishery Optimum Yield

Precious corals in the EEZ around Guam comprise exploratory area XP-GU which has an OY of 1,000 kg per year for all species combined (except black corals). No OY has been determined for black corals around Guam. This definition is consistent with that contained in the Precious Corals FMP.

4.5.2.3 Guam Precious Corals Fishery 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.

4.5.2.4 Guam Precious Coral Fishery TALFF

The TALFF for Guam precious corals is defined as the quota minus two times of the amount harvested by domestic vessels between July 1 and December 31 of the proceeding year. The TALFF will be available for foreign fishing under a scientific research plan approved by NMFS in consultation with the Council and State agencies.

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NMFS has also concluded that the Guam precious corals commercial fisheries will not affect marine mammals in any manner not considered or authorized under the Marine Mammal Protection Act.

4.6 Description of Mariana Archipelago Fishing Communities

The community setting of the fisheries of the Western Pacific Region 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 sub-island level with which to illustrate these points.

4.6.1 Identification of Fishing Communities

In Guam and CNMI, 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.

Given 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 Guam, and the Northern Mariana Islands—as separate fishing communities (64 FR 19067, April 19, 1999). 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 Economic and Social Importance of Fisheries in Guam and CNMI

Guam

Based on creel surveys of fishermen, only about one quarter to one third of Guam's inshore catch is sold. The remainder enters noncommercial channels (Knudson 1987). Reef and bottomfish continue to be important for social obligations, such as fiestas and food exchange with friends and families. One study found a preference for inshore fish species in noncommercial exchanges of food (Amesbury and Hunter-Anderson 1989). The social obligation to share one's fish catch extends to part-time and full-time commercial fishermen. Such gifts are often reef fish or shallow-water bottomfish (Amesbury and Hunter-Anderson 1989). Even when fish are purchased informally by friends, neighbors or relatives of the fisherman, the very personal marketing tends to restrain the price asked (WPRFMC 2003).

Domestic fishing on Guam supplements family subsistence, which is gained by a combination of small scale gardening, ranching and wage work (Amesbury and Hunter-Anderson 1989). The availability of economic activities such as part-time fishing is among the major reasons that Guam has not experienced more social problems during times of economic hardship and increasing unemployment. The subsistence component of the local economy has gained significance in recent years with the downturn in Guam's major industries and increasing unemployment.

Fishing in Guam continues to be important not only in terms of contributing to the subsistence needs of the Chamorro people but also in terms of preserving their history and identity. Fishing assists in perpetuating traditional knowledge of marine resources and maritime heritage of the Chamorro culture.

In-depth analyses of the historical and contemporary importance of fisheries to the indigenous peoples of Guam and the Northern Mariana Islands have been done by Amesbury and Hunter-Anderson (1989 and 2003), Amesbury et al. (1989), and Iversen et al. (1990). Over the centuries of acculturation, beginning with the Spanish conquest in the late seventeenth century, many elements of traditional Chamorro and Carolinian culture of Guam and the Northern Mariana Islands were lost but certain traditional values and attitudes were retained and have been melded with elements of Western culture that are now a part of local life and custom. Amesbury and Hunter-Anderson et al. (1989, p. 48) noted that the practice of sharing one's fish catch with relatives and friends during Christian holidays is rooted in traditional Chamorro culture:

> *A strongly enduring cultural dimension related to offshore fishing is the high value placed on sharing of the catch, and the importance of gifts of fish to relatives and friends.*

High value is placed on sharing one's fish catch with relatives and friends. Sometimes fish are sold in order to earn money to buy gifts for friends and relatives on important Catholic religious occasions such as novenas, births and christenings, and other holidays (Amesbury and Hunter-Anderson 1989).

Hensley and Sherwood (1993) note that the traditional practice of sharing the catch of *atulai* (*Selar crumenophthalmus*) from a surround net continues today, with equal portions given to the owner of the net, the village where the fish were caught, and the group that participated in the harvest.

The social obligation to share one's fish catch extends to part-time and full-time commercial fishermen. Such gifts are often reef fish or shallow-water bottomfish (Amesbury and Hunter-Anderson 1989). Even when fish are purchased informally by friends, neighbors or relatives of the fisherman, the very personal marketing tends to restrain the price asked (WPRFMC 2003).

Rubinstein (2001) asked respondents to indicate to whom they regularly give fish. Nearly all fishermen (96 percent) reported regularly giving fish to family (36 percent), friends (13 percent), or both (47 percent). Most fishermen (53 percent) said they do not give fish to people other than family and close friends; of those who did occasionally, the main recipients were church fiestas (32 percent) and other church events or organizations (20 percent). The author noted that the pattern of distribution reflected Guam's long and well-entrenched Catholic tradition.

CNMI

The Mariana Islands were first settled about 3,000 years ago, but their present social and demographic structure is largely the result of colonial experiences of the last 300 years. Fishing has occurred throughout the island's history. Archaeological evidence reviewed by Amesbury and Hunter-Anderson (1989) suggested "…an apparent tendency throughout prehistory and historic times for Mariana Island native groups to have relied more on inshore fish species than offshore ones ...." In the late 1880s, the Spanish governor of the Mariana Islands wrote of Guam that "inside the reef (indigenous people) catch different varieties (of fish) all year long." Whether the preference for reef fishing had anything to do with restrictions on the use of ocean-going canoes is not clear. The Governor also noted the importance of the seasonal arrival of rabbitfish (*manahak*) in inshore areas ("the populace then appears en masse to fish"), which is still an important event in Guam's reef fishery in modern times.

Prior to the arrival of Europeans in the Mariana Islands in the sixteenth century, the Chamorros, as the original inhabitants of those islands were called, possessed large sailing canoes that enabled them to fish on offshore banks and sea mounts (Amesbury and Hunter-Anderson 1989). The manufacture of these canoes was monopolized by the *matua* (noble caste) who were also the deep-sea fishermen and inter-island traders within Chamorro communities (Jennison-Nolan 1979). In the early seventeenth century a Spanish priest described the Chamorros as "…the most skilled deepwater fishing people yet to have been discovered" (Driver 1983:208). However, during the 1700s the large, oceangoing canoes of the Chamorros were systematically destroyed by the Spanish colonizers of the Mariana Islands in order to concentrate the indigenous population in a few settlements, thereby facilitating colonial rule as well as religious conversion (Amesbury and Hunter-Anderson 1989). After the enforced demise of the sailing canoes, fishing for offshore species was no longer possible. By the mid-nineteenth century, there were only 24 outrigger canoes on Guam, all of which were used only for fishing inside the reef (Myers 1993). Another far-reaching effect of European colonization of the Mariana Archipelago was a disastrous decline in the number of Chamorros, from an estimated 40,000 persons in the late seventeenth century to approximately 1,500 persons a hundred years later (Amesbury and Hunter-Anderson 1989).

Orbach (1980) noted that the fisheries in CNMI are inextricably involved with the lifestyles and plural-occupational patterns of fishery participants. Part-time fishing performed in conjunction with other activities has a prominent place in the socioeconomic adaptations of local residents. People fish for bottomfish and other species to supplement their family subsistence, which is gained by a combination of small scale gardening and wage work (Amesbury et al. 1989). Orbach suggests that the availability of economic activities such as part-time fishing is among the major reasons that CNMI has not experienced more of the problems of other island entities such as out-migration or high rates of crime and juvenile delinquency.

Fishing in the CNMI continues to be important not only in terms of contributing to the subsistence needs of the Chamorro people but also in terms of preserving their history and identity. Fishing has assisted in perpetuating the traditional knowledge of marine resources and maritime traditions of the Chamorro (and Carolinian) cultures and has helped them maintain their connection to the sea and its resources.

Community Dependence on Fishing and Seafood

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

In addition, the people of the Mariana Archipelago participate in many banquets throughout the year associated with neighborhood parties, wedding and baptismal parties, and especially the village fiestas that follow the religious celebrations of village patron saints. All of these occasions require large quantities of fish and other traditional foods (Rubinstein 2001).

Hensley and Sherwood (1993) note that the traditional practice of sharing the catch of *atulai* (*Selar crumenophthalmus*) from a surround net continues today, with equal portions given to the owner of the net, the village where the fish were caught, and the group that participated in the harvest.

Based on creel surveys of fishermen, only about one-quarter to one-third of Guam’s inshore catch is sold. The remainder enters non-commercial channels (Knudson 1987). Reef fish continues to be important for social obligations, such as fiestas and food exchange with friends and families. One study found a preference for inshore fish species in non-commercial exchanges of food (Amesbury and Hunter-Anderson 1989; Amesbury et al. 1989). The local harvest of reef fish is insufficient to meet commercial demand, and there are substantial imports from the FSM and the Philippines. Annual seafood consumption in Guam is about 56 lbs per capita (WPRFMC 2003).

The social obligation to share one's fish catch extends to part-time and full-time commercial fishermen. Such gifts are often reef fish or shallow-water bottomfish (Amesbury and Hunter-Anderson 1989). Even when fish are purchased informally by friends, neighbors or relatives of the fisherman, the very personal marketing tends to restrain the price asked (WPRFMC 2003).

Rubinstein (2001) asked respondents to indicate to whom they regularly give fish. Nearly all fishermen (96 percent) reported regularly giving fish to family (36 percent), friends (13 percent), or both (47 percent). Most fishermen (53 percent) said they do not give fish to people other than family and close friends; of those who did occasionally, the main recipients were church fiestas (32 percent) and other church events or organizations (20 percent). The author noted that the pattern of distribution reflected Guam's long and well-entrenched Catholic tradition.

4.6.3 Importance of Subsistence Fishing to Communities

Many tropical islands in the South Pacific Ocean are confronted by rapidly growing human populations, but have few economic resources that their residents can utilize. Fish resources, from traditional subsistence fishing in times past to today's more modem boat-based fisheries, have always been an important component of island economies (Doulman and Kearney, 1991). Fishing also continues to contribute to the cultural integrity and social cohesion of Pacific island communities.

The continuing importance of subsistence activities to today's Native Hawaiians has been recently described by Davianna McGregor (McGregor 2007) as follows below. Although McGregor wrote primarily about Native Hawaiians, her words are also considered relevant for many other indigenous groups and individuals in the Western Pacific Region.

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.

Resources obtained through subsistence are also used for a variety of special life cycle occasions that bond families and communities. Ohana [family] 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.

CHAPTER 5: MARIANA ARCHIPELAGO FEP MANAGEMENT PROGRAM

5.1 Introduction

This chapter describes Council's management program for bottomfish, crustaceans, precious corals and coral reef ecosystem fisheries of the Mariana Archipelago FEP as well as the criteria used to assess the status of managed species. All CNMI and Guam regulations and laws governing the use of marine resources continue to apply and are not superseded in any way by this FEP.

One of the principles of ecosystem-based management is the need to consider the precautionary approach, the burden of proof, and adaptive management. The Mariana Archipelago FEP will continue to give consideration to these principles and 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 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. The technical guidance for implementing National Standard 1 (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 21. 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 the Mariana's Archipelago'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.

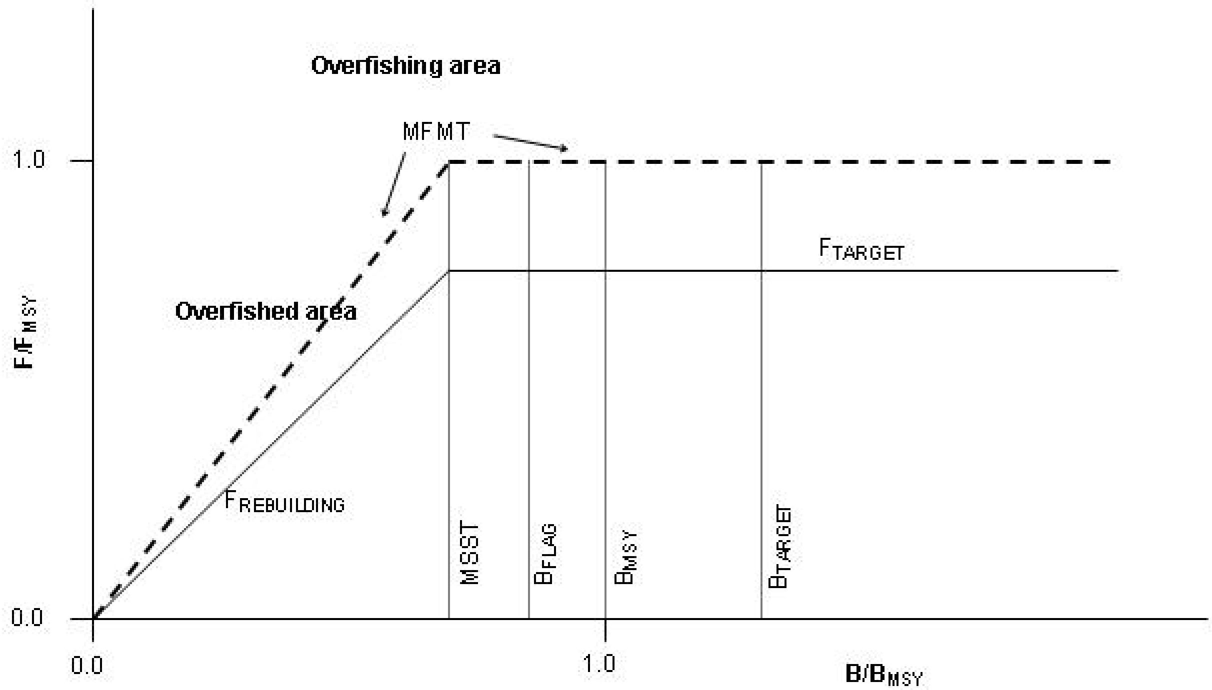

Figure 21. Example of MSY, Target and Rebuilding Control Rules
Source: Restrepo et al. 1998

In Figure 21 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 (FTARGET) and rebuilding (FREBUILDING) control rule.

5.2.1 MSY Control Rule and Stock Status Determination Criteria

A 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 are 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 the “objective and measurable criteria for identifying when the fishery to which the plan applies is overfished” that are required under the MSA. The guidelines for National Standard 1 (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.

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 stock 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[16] or existing remedial action to end previously identified overfishing or to rebuild an overfished stock has not resulted in adequate progress. The Secretary reports annually to the Congress and the Councils on the status of fisheries according to the above overfishing criteria.

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, and that it "must not exceed the fishing mortality rate or level associated with the relevant MSY control rule" Guidance in Restrepo et al. (1998) regarding specification of the MFMT is based on the premise that the MSY control rule constitutes the MFMT. In the example in Figure 21 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 stock size threshold [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 21 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 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 21. 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 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.

16 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).

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 21. 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. 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 14, 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 14 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 Measures for Bottomfish and Seamount Groundfish Fisheries

The following sections summarize current regulations for the Mariana Archipelago, which are intended to conserve and manage bottomfish MUS and protected species during bottomfish fishing operations.

5.3.1 Permit and Reporting Requirements

In order to identify participants and to collect adequate harvest and effort data, Federal permits and logbook reporting are required for all vessels greater than 50 ft or greater used to fish for, land, or transship bottomfish management unit species shoreward of the outer boundary of the Guam subarea of the bottomfish fishery management area. Mandatory permitting and reporting only applies to large bottomfish vessels (50 ft or greater) because the large vessels have been identified as having a greater capacity to deplete local populations of bottomfish. Federal permits and catch reports are also required for all commercial fishing for bottomfish management unit species in federal waters around CNMI and the operators of commercial vessels greater than 40 ft in length must also complete federal sales reports. Fishery participants have the option of using NMFS approved electronic logbooks in lieu of paper logbooks.

5.3.2 Gear Restrictions

To protect habitat and reduce bycatch, fishing for bottomfish by means of bottom trawls and bottom set gillnets is prohibited. Additionally, the possession or use of any poisons, explosives or intoxicating substances to harvest bottomfish or seamount groundfish is prohibited.

5.3.3 At-sea Observer Coverage

To gather additional information, 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 hours prior notice by NMFS of an observer requirement.

5.3.4 Area Restrictions

To maintain adequate opportunities for small-scale commercial, recreational, and subsistence bottomfish fishermen in the federal waters around Guam, bottomfish vessels 50 ft or greater are prohibited from fishing for bottomfish within 50 nm of Guam. For the same reason bottomfish vessels 40 ft or greater are prohibited from fishing within waters 0-50 miles around the Southern Islands of the Commonwealth of the Northern Mariana Islands (CNMI) and 0-10 miles around the Northern Island of Alamagan. These vessels must carry active VMS units that are owned, installed and maintained by NMFS.

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 2 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

Bycatch is reduced through implementation of prohibitions on the use of less or non-selective fishing methods including bottom trawls, bottom gillnets, explosive and poisons. A variety of operational and management measures are used to minimize bycatch and bycatch mortality in the bottomfish fishery around the Mariana Archipelago. In the bottomfish and troll and handline fisheries, the gear types and fishing strategies used tend to be relatively selective for desired species and sizes. Measures that serve to further reduce bycatch in the bottomfish fishery include prohibitions on the use of bottom trawls, bottom gillnets, explosives, and poisons. An additional measure in the process of being developed that would further reduce bycatch and protected species interactions is restrictions on the use of bottom-set longline gear. Bycatch reduction is also achieved through non-regulatory means, including outreach to fishermen and engagement of fishermen in research activities and the management process.

Five types of non-regulatory measures aimed at reducing bycatch and bycatch mortality, and improving bycatch reporting are 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.

5.3.7 Other Regulatory Measures

Due to concerns over habitat impacts, it is prohibited for any vessel larger than 50 feet to anchor on Guam's Southern Banks. However, in the event of an emergency caused by ocean conditions or vessel malfunctions, vessels are exempted from this prohibition (if able to adequately document the condition or malfunction).

5.3.8 Application of National Standard 1

MSY Control Rule

Biological and fishery data are poor for all bottomfish species in Guam and the CNMI. 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.

The overfishing criteria and control rules are specified and applied to individual species within the multi-species stock whenever possible. Where this is not possible, they will be based on an indicator species for the multi-species stock. It is important to recognize that individual species would be 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 result in excessive depletion of that species. For the seamount groundfish stocks, armorhead serves as the indicator species. No indicator species are being used for the two bottomfish multi-species stock complexes (Guam and CNMI). Instead, the control rules are applied to each stock complex as a whole.[17]

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 value of M used to determine the reference point values are 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. 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.

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[17] 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 specified at some 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 18.

Table 18. Overfishing Threshold Specifications for Bottomfish and Seamount Groundfish Stocks

MFMT	MSST	B_{FLAG}
$F(B) = \frac{F_{MSY} B}{c\, B_{MSY}}$ for $B \le c\, B_{MSY}$ $F(B) = F_{MSY}$ 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} would 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.

Since the MSY control rule specified here 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 excessive depletion. 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 applies 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 19. Again, E_{MSY} is used as a proxy for F_{MSY}.

Table 19. Recruitment Overfishing Control Rule Specifications for 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 Rules and Reference Points

While there is an established OY, it is not quantified or in the form of a control rule, therefore, no target control rules or reference points are currently specified for bottomfish stocks of the Mariana Archipelago.

Rebuilding Control Rule and Reference Points

No rebuilding control rule or reference points are currently specified for bottomfish stocks of the Mariana Archipelago.

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 the 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 such that 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 to 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, creel survey data, vessel observer data, and the findings of fishery-independent surveys when they are conducted. Spatial assessments will initially be done separately for EEZ waters around Guam and CNMI but may be integrated as stock bounds and ecosystem structure become better understood.

Measures to Address Overfishing and Overfished Stocks

To date no bottomfish stocks in either Guam or the CNMI have been determined to be overfished or subject to overfishing. 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. Measures that may be considered include 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 combination of control rules and reference points is illustrated in Figure 22. The primary control rules that will be 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 to provide for recovery from recruitment overfishing is shown in part (b).

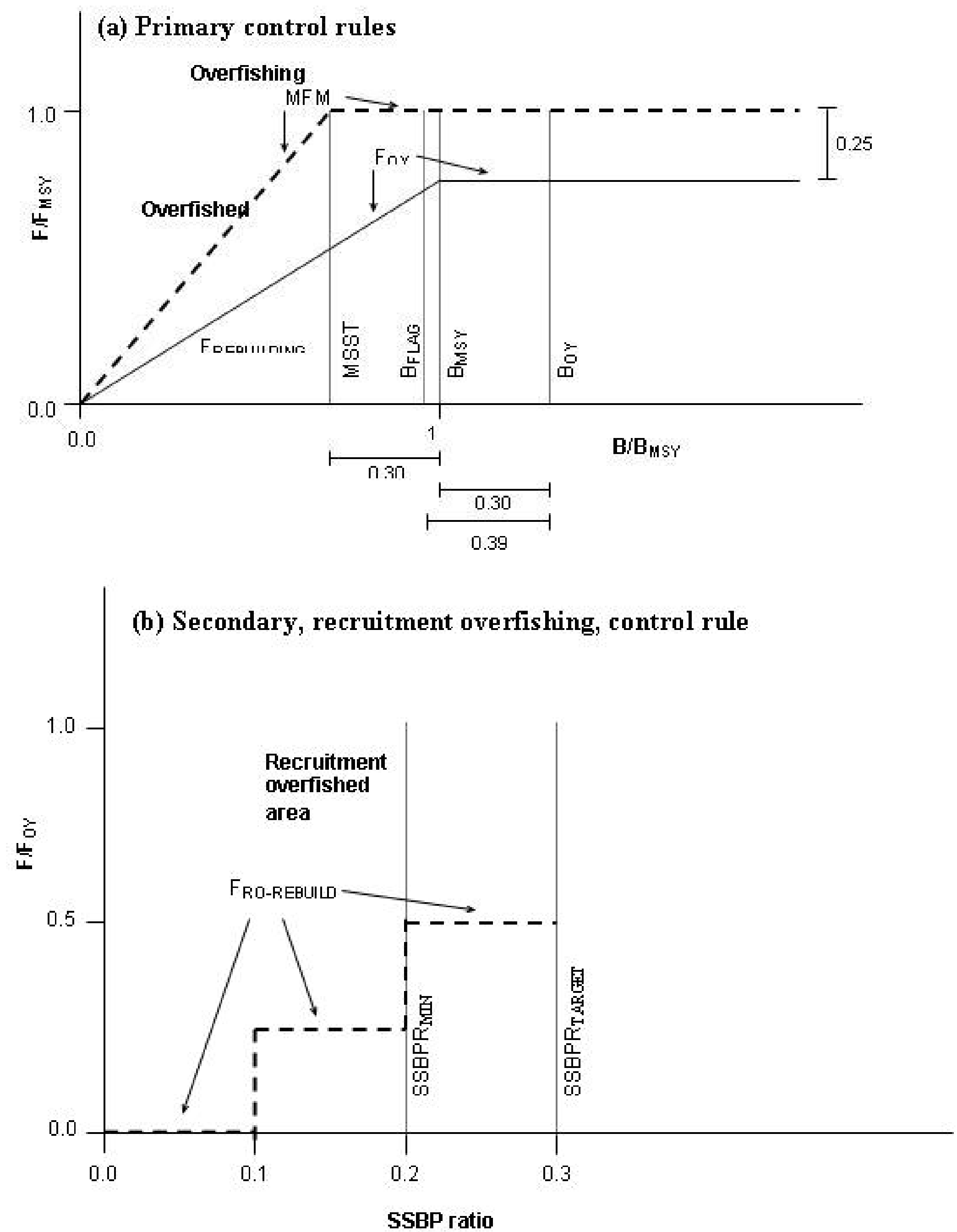

Figure 22. Combination of Control Rules and Reference Points for Bottomfish and Seamount Groundfish Stocks

5.4 Current Conservation and Management Measures for Precious Corals Fisheries

The following sections contain the current regulations, as they are written in the Code of Federal Regulations, which are intended to conserve and manage precious coral MUS and protected species during precious coral fishing operations.

Federal permits are required to harvest Precious Coral MUS in Federal waters around the CNMI or Guam and permit holders are required to maintain Federal logbooks of their catch and effort. This is an open access fishery and as of June 2007 no Federal permits had been issued. There are currently no defined known precious coral beds or active precious coral fisheries in either Federal or Territorial waters around the Mariana Archipelago. However, because the precious coral MUS are known to be present it is possible a future fishery may develop. If one were to develop it would be subject to the existing quotas for exploratory areas and would have an annual harvest quota 1,000 kg of all species combined (except black corals) kg for EEZ waters around CNMI and a second annual harvest quota of 1,000 kg of all species combined (except black corals) for EEZ waters around Guam.

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 to carry on board an observer when directed to do so by NMFS. This measure is intended to allow NMFS to learn more about sea turtle interactions with fishing operations, to evaluate existing measures to reduce sea turtle interactions, and to determine whether additional measures to reduce interactions may be necessary.

5.4.1 Permit and Reporting Requirements

In order to identify participants and to collect harvest and effort data, Federal permits and reporting are required for any vessel of the United States fishing for, taking or retaining precious corals in EEZ waters around Guam or CNMI. 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. Fishery participants have the option of using NMFS approved electronic logbooks in lieu of paper logbooks.

5.4.2 Seasons and Quotas

The fishing year for precious corals begins on July 1 and ends on June 30 the following year.

The quota limiting the amount of precious corals that may be taken in an exploratory area during the fishing year are 1,000 kg per area, all species combined (except black corals). Only live coral is counted toward the quota. Live coral means any precious coral that has live coral polyps or tissue.

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.

And, 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 may 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.

5.4.3 Closures

If the NMFS Regional Administrator determines that the harvest quota for any exploratory area will be reached prior to the end of the fishing year 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.

5.4.4 Restrictions

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).

Gear Restrictions --To protect habitat and reduce bycatch, 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.

Gold CoralHarvest Moratorium-- To prevent overfishing and stimulate research on gold corals, fishing for, taking, or retaining any gold coral (live and dead) in any precious coral permit area is prohibited through June 30, 2013. This includes all EEZ waters of the Western Pacific Region. Additional research results on gold coral age structures, growth rates, and correlations between length and age would be considered by the Council and NMFS prior to the expiration of the 5-year moratorium.

5.4.5 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 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 FEP, 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 Precious Corals 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 FEP, 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 Precious Corals 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.

5.4.6 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. However, only selective gear can be used to harvest precious corals, thereby reducing the potential for bycatch. 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.

5.4.7 Application of National Standard 1

Due to the paucity of information on the existence and distribution of precious corals and the absence of a precious coral fishery in the Mariana Archipelago, specification of MSY, OY and overfishing have not been individually determined for precious coral management unit species. However, OY values have been defined for precious corals in the exploratory areas around CNMI and Guam. Should a precious coral fishery develop in the Mariana Archipelago, the Council may develop specifications for specific coral species or beds depending on the information and stock assessment tools available. Spatial assessments will initially be done separately for EEZ waters around Guam and CNMI but may be integrated as stock bounds and ecosystem structure become better understood.

Measures to Address Overfishing and Overfished Stocks

At present no stocks of precious corals in the Mariana Archipelago have been determined to be overfished or experiencing overfishing. Provisions of the Precious Corals FMP, as amended, are sufficient to prevent overfishing and these measures have been carried over (i.e., maintained without change) into this FEP.

5.5 Current Conservation and Management Measures for Crustacean Fisheries

The following sections contain the current regulations, as they are written in the Code of Federal Regulations, which are intended to conserve and manage Crustacean MUS and protected species during crustacean fishing operations

A Federal permit is required to harvest Crustacean MUS in Federal waters around the Mariana Archipelago and permit holders are required to participate in local reporting systems.

5.5.1 Management Areas and Subareas

Permit Area 3 includes EEZ waters around Guam and American Samoa as well as EEZ waters outside of 3 nm around CNMI.

5.5.2 Permit and Reporting Requirements

In order to identify participants and to collect harvest and effort data, Federal permit and logbook reporting is required when fishing for Crustacean MUS in EEZ waters around Guam and CNMI. A permit application must obtained from the Regional Administrator and permits will be issued to the owner of the vessel that is used to fish for crustacean MUS. Fishery participants have the option of using NMFS approved electronic logbooks in lieu of paper logbooks.

5.5.3 Gear Restrictions

To protect habitat and reduce bycatch in Permit Area 3, it is unlawful for any person to fish for, take or retain lobsters with explosives, poisons, or electrical shocking devices.

5.5.4 Notifications

To support fishery monitoring, 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.

5.5.5 At-Sea Observer Coverage

To support fishery monitoring, all fishing vessels must carry an observer when requested to do so by the NMFS Regional Administrator.

5.5.6 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, 2 or 3. By June 30 of each year, the 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 FEP, 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 FEP, 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.

5.5.6 Bycatch Measures

No bycatch measures or actions are necessary at this time. Lobsters are taken by hand and harvest currently occurs primarily almost exclusively in territorial waters, 0-3 miles. There is no known bycatch associated with this fishery.

5.5.7 Application of National Standard 1

Specifications of OY and overfishing have not been determined for Crustacean MUS in the Mariana Archipelago as there is virtually no crustaceans fishery operating in the EEZ surrounding those areas at present. However, should a crustacean fishery develop, and the

Council determine a stock status determination is needed, the Council will rely on the specification of target and rebuilding control rules and reference points established for the NWHI lobster and deepwater shrimp fisheries until appropriate specifications are developed for crustacean fishery resources of the Mariana Archipelago. The specifications would be applied to multi-species stock complexes or to individual species, depending on the information and stock assessment tools available. Spatial assessments will initially be done separately for EEZ waters around Guam and CNMI but may be integrated as stock bounds and ecosystem structure become better understood.

5.6 Current Conservation and Management Measures for Coral Reef Ecosystem Fisheries

The following sections contain the current regulations, as they are written in the Code of Federal Regulations, which are intended to conserve and manage coral reef MUS and protected species during coral reef fishing operations.

5.6.1 Permit and Reporting Requirements

In order to identify participants, collect harvest and effort data, and control harvests, special permits are required for any directed fisheries on potentially harvested coral reef taxa (PHCRT) within the regulatory area or to fish for any CRE MUS in the coral reef regulatory area 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 who 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. 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. Fishery participants have the option of using NMFS approved electronic logbooks in lieu of paper logbooks.

5.6.2 Notification

To support fishery monitoring, any special permit holder must contact the appropriate NMFS enforcement agent in Guam 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

To protect habitat and reduce bycatch, allowable gear types comprise: (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.

5.6.5 Other Measures

Due to concerns over habitat impacts, it is prohibited for any vessel larger than 50 feet to anchor on Guam’s Southern Banks. However, in the event of an emergency caused by ocean conditions or vessel malfunctions, vessels would be exempted from this prohibition. They must be able to document the condition or malfunction after the fact. A proposed rule was published December 20, 2006 (71 FR 76265) which would require 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 to carry on board an observer when directed to do so by NMFS. NMFS is proposing this measure to learn more about sea turtle interactions with fishing operations, to evaluate existing measures to reduce sea turtle takes, and to determine whether additional measures to reduce takes may be necessary.

5.6.6 Bycatch Measures

Almost all coral reef fishes caught in the Mariana Archipelago are considered food fishes and are kept, regardless of size or species. There is no specific information available on bycatch from coral reef fisheries, particularly inshore fisheries. CRE MUS may not be taken by means of poisons, explosives, or intoxicating substances and further, possession and use of these materials is prohibited. 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.

5.6.7 Application of National Standard 1

MSY Control Rule and Stock Status Determination

Available biological and fishery data are poor for all coral reef ecosystem management unit species in the Mariana 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 will be used to evaluate the status of individual MUS stocks in order to prevent recruitment overfishing. When better data and the appropriate multi-species stock assessment methodologies become available, all stocks will be evaluated independently, without proxy. Spatial assessments will initially be done separately for EEZ waters around Guam and CNMI but may be integrated as stock bounds and ecosystem structure become better understood.

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 10.

Table 20. CPUE-based Overfishing Limits and Reference Points for Coral Reef Species

Value	Proxy	Explanation
MaxFMT (F_{MSY})	E_{MSY}	0.91 $CPUE_{MSY}$

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

*interim value of M=0.3 is applied

When reliable estimates of E_{MSY} and $CPUE_{MSY}$ are not available, they 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 ($CPUE_{REF}$).

Measures to Address Overfishing and Overfished Stocks

At present, no CRE stocks in the Mariana Archipelago have been determined to be overfished or subject to overfishing. 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.

While managing the multi-species stocks to provide maximum benefit, fishery managers must also ensure that the resulting fishing mortality rate does not reduce any individual species stock to a level requiring protection under the Endangered Species Act. Preventing recruitment overfishing on any component stock will satisfy this need in a precautionary manner. Best available data are used for each fishery to estimate these values. These reference points will be related primarily to recruitment overfishing and will be expressed in units such as spawning potential ratio or spawning stock biomass. However, no examples can be provided at present. Species for which managers have collected extensive survey data and know their life history parameters, such as growth rate and size at reproduction, 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.

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 highly valued by a species can be identified, allowing a more precise designation of EFH. Habitats of intermediate and low value 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 allowed Councils to provide comments and make recommendations to federal or state agencies that propose actions that may affect the 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.

None of the fisheries operating under the Mariana Archipelago FEP are expected to have adverse impacts on EFH or HAPC for species managed under the different fisheries. Continued and future operations of fisheries under the Mariana 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, Precious Corals and Pelagic MUS 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). For the purpose of this plan, Pelagics MUS are not part of the Mariana Archipelago FEP MUS.

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 can be found in the Council's Essential Fish Habitat Descriptions for Western Pacific Archipelagic and Remote Island Areas Fishery Ecosystem Management Unit Species. 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 preferred depth ranges of specific life stages 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 presented 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. 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 Mariana Archipelago.

For additional details on the life history and habitat utilization patterns of individual Mariana Archipelago 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 groupers. 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.

At present, there is not enough 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 (Table 25).

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. *P. penicillatus* is the most widely distributed, the other three species are absent from the waters of many island nations of the region. 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. *P. marginatus* is found seaward of the reefs and within the lagoons and atolls of the islands.

The reported depth distribution of *P. marginatus* is 3–200 meters. While this species is found down to depths of 200 meters, it usually inhabits shallower waters. *P. marginatus* 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*. Evidence (found in Hawaii) suggests that fine-scale oceanographic features, such as eddies and currents, serve to retain phyllosoma larvae (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 are 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 (Table 25).

In the Mariana Archipelago, shrimp trapping surveys conducted at 22 islands and banks between 1982 and 1984 reported the presence of all eight species of *Heterocarpus: Heterocarpus ensifer, H. laevigatus* and *H. longirostris* comprised 99 percent of the catch while *H. tricarinatus, H. gibbosus* and *H. sibogae* were rare (Moffitt and Polovina 1987). Maximum depths according to Moffitt and Polovina are *H. ensifer* 366 m, *H. laevigatus* 777 m, and *H. longirostris* 1052 m. Similar depth ranges were reported for *H. ensifer* and *H. laevigatus* in Guam (Wilder 1977).

To reduce the complexity and the number of EFH identifications required for each individual species and life stages of the genus *Heterocarpus* in the Western Pacific Region, and based upon the above information, the Council has recommended EFH for the complete assemblage of adult and juvenile *Heterocarpus* spp. as the outer reef slopes between 300 and 700 meters surrounding every island and submerged banks in the Western Pacific Region (Table 25).

The species complex designations includes all eight species of deepwater shrimp extant in the Western Pacific Region (*Heterocarpus ensifer, H. laevigatus, H. sibogae, H. gibbosus, H. Lepidus, H. dorsalis, H. tricarinatus and H. longirostris*). This designation is consistent with the Code of Federal Regulations (CFR) §600.815 (a)(1)(iv)(E).

At present, there are not enough data on the relative productivity of different habitats of *Heterocarpus* to develop EFH designations based on Level 3 (growth, reproduction and survival rates by habitat area) or Level 4 (production rates by habitat) data. In fact, there are little to no data available concerning growth rates, reproductive potentials and natural mortality rates at each life history stage.

The relationship between egg production, larval settlement and stock recruitment is also poorly understood and only available for a few specific sites (Wilder 1977; Clarke 1972; Moffitt and Polovina 1987). Mature shrimps may undergo a depth related seasonal migration in synchrony with reproduction and a shift into deeper waters from depths of about 550 meters to 700 meters. For these reasons the Council has designated EFH for *Heterocarpus* spp. eggs and larvae as the water column and outer reef slopes between 550 and 700 meters in the Western Pacific Region (Table 25).

6.2.3 Precious Corals

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* sp. and *Parazoanthus* sp.), and bamboo coral (*Lepidistis 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*.

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. 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.

The habitat sustaining precious corals is generally in pristine condition. There are no known areas in the Marinas Archipelago that have sustained damage due to resource exploitation.

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. 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 precious coral MUS to designate EFH, but rejected this alternative because of the rarity of the occurrence of suitable habitat conditions. Instead, the Council designated the six known beds of precious corals as EFH (Table 25). The Council believes that the narrow EFH designation will facilitate the consultation process.

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. These designations could also protect species managed under other Council FMPs to the degree that they share these habitats.

Except for several of the major coral reef associated species, very little is known about the life histories, habitat utilization patterns, food habits, or spawning behavior of most coral reef associated species. For this reason, the Council, 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.

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. Table 21 summarizes 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 throughout the Western Pacific Region are summarized in Table 22.

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 23 summarizes the habitat types used by PHCRT species. The designation of EFH for PHCRT throughout the Western Pacific Region is summarized in Table 24. As with CHCRT, the Council has designated EFH for species assemblages pursuant to the federal regulations cited above.

Table 21. Occurrence of Currently Harvested MUS
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*)	J	A, J, S	A, J, S	J	A, J, S	A, J, S	A, J, S		A, J	E, L
Yellowfin surgeonfish (*Acanthurus xanthopterus*)										
Convict tang (*Acanthurus triostegus*)										
Eye-striped surgeonfish (*Acanthurus dussumieri*)										
Blue-lined surgeon (*Acanthurus nigroris*)										
Whitebar surgeonfish (*Acanthurus leucopareius*)										
Blue-banded surgeonfish (*Acanthurus lineatus*)										
Blackstreak surgeonfish (*Acanthurus nigricauda*)										
Whitecheek surgeonfish (*Acanthurus nigricans*)										
White-spotted surgeonfish (*Acanthurus guttatus*)										
Ringtail surgeonfish (*Acanthurus blochii*)										
Brown surgeonfish (*Acanthurus nigrofuscus*)										
Mimic surgeonfish (*Acanthurus pyroferus*)										
Yellow-eyed surgeonfish (*Ctenochaetus strigousus*)										
Striped bristletooth (*Ctenochaetus striatus*)										
Twospot bristletooth (*Ctenochaetus binotatus*)										

Species	**Ma**	**La**	**Es**	**SB**	**Ss**	**Cr/Hs**	**Pr**	**Sz**	**DST**	**Pe**
Subfamily Nasinae (unicornfishes) Bluespine unicornfish (*Naso unicornus*) Orangespine unicornfish (*Naso lituratus*) Humpnose unicornfish (*Naso tuberosus*) Blacktounge unicornfish (*Naso hexacanthus*) Bignose unicornfish (*Naso vlamingii*) Whitemargin unicornfish (*Naso annulatus*) Spotted unicornfish (*Naso brevirostris*) Humpback unicornfish (*Naso brachycentron*) Gray unicornfish (*Naso caesius*)	J	A, J, S	J		A, S	A, J, S	A, J, S		A, S	All
Balistidae (trigger fish) Titan triggerfish (*Balistoides viridescens*) Clown triggerfish (*B. conspicillum*) Orangstriped trigger (*Balistapus undulatus*) Pinktail triggerfish (*Melichthys vidua*) Black triggerfish (*M. niger*) Blue Triggerfish (*Pseudobalistes fucus*) Picassofish (*Rhinecanthus aculeatus*) Wedged Picassofish (*Balistoides rectangulus*) Bridled triggerfish (*Sufflamen fraenatus*)	J	A, J, S	J	J		A, J, S	A, J, S	A	A, S	E, L

Species	**Ma**	**La**	**Es**	**SB**	**Ss**	**Cr/Hs**	**Pr**	**Sz**	**DST**	**Pe**
Carangidae (jacks) Bigeye scad (*Selar crumenophthalmus*) Mackerel scad (*Decapterus macarellus*)	A, J, S	A, J, S	A, J, S	J	A, J, S	A, J, S	A, J, S	A, J, S	All	
Carcharhinidae Grey reef shark (*Carcharhinus amblyrhynchos*) Silvertip shark (*Carcharhinus albimarginatus*) Galapagos shark (*Carcharhinus galapagenis*) Blacktip reef shark (*Carcharhinus melanopterus*) Whitetip reef shark (*Triaenodon obesus*)	A, J	A, J	A, J	J	A, J	A, J	A, J		A, J	A, J

Species	**Ma**	**La**	**Es**	**SB**	**Ss**	**Cr/Hs**	**Pr**	**Sz**	**DST**	**Pe**
Holocentridae (soldierfish/squirrelfish) Bigscale soldierfish (*Myripristis berndti*) Bronze soldierfish (*Myripristis adusta*) Blotcheye soldierfish (*Myripristis murdjan*) Bricksoldierfish (*Myripristis amaena*) Scarlet soldierfish (*Myripristis pralinia*) Violet soldierfish (*Myripristis violacea*) Whitetip soldierfish (*Myripristis vittata*) Yellowfin soldierfish (*Myripristis chryseres*) Pearly soldierfish (*Myripristis kuntee*) (*Myripristis hexagona*) Tailspot squirrelfish (*Sargocentron caudimaculatum*) File-lined squirrelfish (*Sargocentron microstoma*) Crown squirrelfish (*Sargocentron diadema*) Blue-lined squirrelfish (*Sargocentron tiere*) Ala‘ihi (*Sargocentron xantherythrum*) Saber or long jaw 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) Barred flag-tail (*Kuhlia mugil*)	A, J	A, J	A, J	A, J				A		E, L

Species	**Ma**	**La**	**Es**	**SB**	**Ss**	**Cr/Hs**	**Pr**	**Sz**	**DST**	**Pe**
Kyphosidae (rudderfishes) Rudderfish (*Kyphosus bigibbus*) (*K. cinerascens*) (*K. vaigiensis*)	J	A, J, S	A, J, S		A, J	A, J, S	A, J, S	A, J		All
Labridae (wrasses) Saddleback hogfish (*Bodianus bilunulatus*) Razor wrasse (*Xyricthys pavo*) Whitepatch wrasse (*Xyrichtes aneitensis*)		J	J	J	A, J, S	A, J, S	A, J, S		A, J, S	E, L
Triple-tail wrasse (*Cheilinus trilobatus*) Floral wrasse (*Cheilinus chlorourus*) Harlequin tuskfish (*Cheilinus fasciatus*)		A, J	J		A, J, S	A, J, S	A, J, S		A, J, S	E, L
Ring-tailed wrasse (*Oxycheilinus unifasciatus*) Bandcheek wrasse (*Oxycheilinus diagrammus*)		A, J			A, J, S	A, J, S	A, J, S		A, J, S	E, L
Blackeye thicklip (*Hemigymnus melapterus*) Barred thicklip (*Hemigymnus fasciatus*) Cigar wrass (*Cheilio inermis*		A, J		J	A, J, S	J	J, S		A, J, S	E, L

Species	**Ma**	**La**	**Es**	**SB**	**Ss**	**Cr/Hs**	**Pr**	**Sz**	**DST**	**Pe**
Threespot wrasse (*Halichoeres trimaculatus*)										
Checkerboard wrasse (*Halichoeres hortulanus*)		A, J	J		A, J, S	A, J, S		A, J		E, L
Weedy surge wrasse (*Halichoeres margaritacous*)		A, J		J	A, J, S	A, J, S	A, J, S			E, L
Surge wrasse (*Thalassoma purpureum*)										
Redribbon wrasse (*Thalassoma quinquevittatum*)										
Sunset wrasse (*Thalassoma lutescens*)		A, J			A, J, S	A, J, S				
Longface wrasse (*Hologynmosus doliatus*)								A, J		
Rockmover wrasse (*Novaculichthys taeniourus*)										
Napoleon wrasse (*Cheilinus undulatus*)	J	J		J		A, J, S	A, J, S		A, S	E, L

Species	**Ma**	**La**	**Es**	**SB**	**Ss**	**Cr/Hs**	**Pr**	**Sz**	**DST**	**Pe**
Mullidae (goatfish) Yellow goatfish (*Mulloidichthys* spp.) (*Mulloidichthys vanicolensis*) (*Mulloidichthys flavolineatus*) Banded goatfish (*Parupeneus spp*.) (*Parupeneus barberinus*) (*Parupeneus bifasciatus*) (*Parupeneus heptacanthus*) (*Parupeneus ciliatus*) (*Parupeneus ciliatus*) (*Parupeneus cyclostomas*) (*Parupeneus pleurostigma*) (*Parupeneus indicus*) (*Parupeneus multifaciatus*) Bandtail goatfish (*Upeneus arge*)		A, J	A	A, J	A, J	A, J	A, J			E, L
Octopodidae (octopuses) *(Octopus cyanea)* *(Octupus ornatus)*	A, J, S	All	A, J, S	All	All	All	All		All	L
Mugilidae (mullets) Stripped mullet (*Mugil cephalus)* Engel's mullet (*Moolgarda engeli*) False mullet (*Neomyxus leuciscus*) Fringelip mullet (*Crenimugil crenilabis*)	J	A, J, S	A, J, S	J		A, J		A		E, L

Species	**Ma**	**La**	**Es**	**SB**	**Ss**	**Cr/Hs**	**Pr**	**Sz**	**DST**	**Pe**
Muraenidae (moray eels) Yellowmargin moray (*Gymnothorax flavimarginatus*) Giant moray (*Gymnothorax javanicus*) Undulated moray (*Gymnothorax undulatus*)	A, J, S	A, J, S	A, J, S	A, J	A, J, S	A, J, S	A, J, S	A, J, S	E, L	
Polynemidae (threadfins) Threadfin (*Polydactylus sexfilis*) -Moi	A, J	A, J, S	A, J, S		A, J, S			A, J		E, L
Priacanthidae (bigeyes) Glasseye (*Heteropriacanthus cruentatus*) Bigeye (*Priacanthus hamrur*)						A, J	A, J		A, J	E, L
Siganidae (rabbitfish) Forktail rabbitfish (*Siganus aregentus*) Golden rabbitfish (*Siganus guttatus*) Gold-spot rabbitfish (*Siganus punctatissimus*) Randall's rabbitfish (*Siganus randalli*) Scribbled rabbitfish (*Siganus spinus*) Vermiculate rabbitfish (*Signaus vermiculatus*)	A, J, S	A, J, S	A, J, S	J		A, J, S	A, J, S		E, L	

Species	**Ma**	**La**	**Es**	**SB**	**Ss**	**Cr/Hs**	**Pr**	**Sz**	**DST**	**Pe**
Scaridae (parrotfishes) Parrotfishes (*Scarus* spp.) Pacific longnose parrotfish (*Hipposcarus longiceps*) Stareye parrotfish (*Catolomus carolinus*)	J	A, J, S		A, J		A, J, S	A, J, S			E, L
Bumphead parrotfish (*Bolbometopon muricatum*)	J	J		J		A, J, S	A, J, S		A, J	E, L
Scombridae (tuna/mackerel) Dogtooth tuna (*Gymnosarda unicolor*)		A, J, S			A, J	A, J, S	A, J,		A, J	E, L
Sphyraenidae (barracudas) Heller's barracuda (*Sphyraena helleri*) Great Barracuda (*Sphyraena barracuda*)	A, J	A, J, S	A, J, S	J		A, J, S	A, J, S		A, S	All
Turbinidae (turban shells) Turbo spp.		A, J, S				A, J, S	A, J, S		A	E, L

Table 22. Summary of EFH Designations for Currently Harvested Coral Reef Taxa

Species Assemblage/Complex	EFH (Egg and Larvae)	EFH (Adult and Juvenile)
Acanthuridae	The water column from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All bottom habitat and the adjacent water column from 0 to 50 fm.
Balistidae	The water column from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All bottom habitat and the adjacent water column from 0 to 50 fm.
Carangidae	The water column from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All bottom habitat and the adjacent water column from 0 to 50 fm.
Carcharhinidae	N/A	All bottom habitat and the adjacent water column from 0 to 50 fm to the outer extent of the EEZ.
Holocentridae	The water column from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All rocky and coral areas and the adjacent water column from 0 to 50 fm.
Kuhliidae	The water column from the shoreline to the outer limits of the EEZ to a depth of 50 fm.	All bottom habitat and the adjacent water column from 0 to 25 fm.
Kyphosidae	Egg, larvae, and juvenile: the water column from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All rocky and coral bottom habitat and the adjacent water column from 0 to 15 fm.
Labridae	The water column and all bottom habitat extending from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	
Mullidae	The water column extending from the shoreline to the outer boundary of the EEZ to a depth of 50 fm.	All rocky/coral and sand-bottom habitat and adjacent water column from 0 to 50 fm.

Species Assemblage/Complex	EFH (Egg and Larvae)	EFH (Adult and Juvenile)
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.
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.

Table 23. 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 spp. (wrasses)	J	A, J, E	J	J	A, J	A, J, S	A, J, S	A, J	E, L
Kuhliidae	A, J	A, J	All	A, J		A, S	A, S		E, L
Carcharhinidae, Sphyrnidae, (sharks)	A, J	A, J	A, J		A, J	A, J	A, J	A, J	A, J
Dasyatididae, Myliobatidae, Mobulidae (rays)	A, J	A, J	A, J		A, J	A, J	A, J	A, J	A, J
Serranidae spp. (groupers)	J	A, J		J	A, J, S	A, J, S	A J, S	A, S	E, L
Carangidae (jacks/trevallies)	A, J, S	A, J, S	A, J, S	J	A, J, S	A, J, S	A, J, S	A, J, S	All
Holocentridae spp. (soldierfish/squirrelfish)		A, J, S	A, J, S	J		A, J, S	A, J, S	A, S	E, L
Scaridae spp. (parrotfishes)	J	A, J, S		A, J		A, J, S	A, J, S		E, L
Mullidae spp. (goatfish)	A, J, S	A, J, S	A, J, S	A, J	A, J, S	A, J, S	A, J, S	A, J	E, L
Acanthuridae spp. (surgeonfish/unicornfish)	J	A, J, S	A, J, S	J	A, J, S	A, J, S	A, J, S	A, J	E, L
Lethrinidae spp. (emperors)	J	A, J, S	J	J	A, J, S	A, J, S	A, J, S	A, S	E, L
Chlopsidae, Congridae, Moringuidae, Ophichthidae, Muraenidae (eels)	A, J, S	A, J, S	A, J, S	A, J	A, J, S	A, J, S	A, J, S	A, J, S	E, L
Apogonidae (cardinalfish)	A, J, S	A, J, S	A, J, S	A, J, S		A, J, S	A, J, S	A, J, S	E, L
Zanclidae spp. (Moorish idols)		A, J				A, J	A, J		E, L

MUS/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	DST	Pe
Chaetodontidae spp. (butterflyfish)	J	A, J, S	J	J		A, J, S	A, J, S	A, S	E, L
Pomacanthidae spp. (angelfish)	J	A, J, S	J	J		A, J, S	A, J, S	A, S	E, L
Pomacentridae spp. (damselfish)	J	A, J, S	J	J		A, J, S	A, J, S	A, S	E, L
Scorpaenidae (scorpionfish)	J	A, J, S	A, J, S	J		A, J, S	A, J, S		E, L
Blenniidae (blennies)		A, J, S	A, J, S		A, J, S	A, J, S	A, J, S	A, J, S	E, L
Ephippidae (batfish)	J	A, J, S	J		A, S	A, J, S	A, J, S	A, S	All
Monodactylidae (mono)	A, J, S	A, J, S	A, J, S			A, J, S	A, J, S		E, L
Haemulidae (sweetlips)	J	A, J, S	A, J, S	J		A, J, S	A, J, S		E, L
Echineididae (remoras)						A, J, S	A, J, S	A, J, S	E, L
Malacanthidae (tilefish)		A, J, S			A, J, S	A, J, S	A, J, S		E, L
Acanthoclinidae (spiny basslets)						A, J		A, J	E, L
Pseudochromidae (dottybacks)	J	J		J		A, J, S	A, J, S		E, L
Plesiopidae (prettyfins)	J	A, J, S				A, J, S	A, J, S		E, L
Tetrarogidae (waspfish)	J	A, J, S				A, J, S	A, J, S		E, L
Caracanthidae (coral crouchers)						A, J, S	A, J, S		E, L
Grammistidae (soapfish)						A, J, S	A, J, S		E, L
Aulostomus chinensis (trumpetfish)	J	A, J, S		A, J	A	A, J, S	A, J, S		E, L
Fistularia commersoni (coronetfish)	J	A, J, S		A, J		A, J, S	A, J, S		E, L
Anomalopidae (flashlightfish)						J	J	A, J, S	E, L

MUS/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	DST	Pe
Clupeidae (herrings)	A, J, S	A, J, S	A, J, S			A, J, S	A, J, S	A, S	All
Engraulidae (anchovies)	A, J, S	A, J, S	A, J, S			A, J, S	A, J, S	A, S	All
Gobiidae (gobies)	All	All	All	All	All	All	All	All	All
Lutjanids (snappers)	A, J, S	A, J, S	A, J, S	J		A, J, S	A, J, S	A, S	E, L
Ballistidae/Monocanthidae spp.	J	A, J, S	J	J		A, J, S	A, J, S	A, S	L
Siganidae spp. (rabbitfishes)	A, J, S	A, J, S	A, J, S	J		A, J, S	A, J, S		E, L
Kyphosidae	J	A, J, S	A, J, S			A, J, S	A, J, S		All
Caesionidae	J	A, J, S			A, S	A, J, S	A, J, S	A, S	All
Cirrhitidae		A, J, S				A, J, S	A, J, S	A, J, S	All
Antennariidae (frogfishes)		All		All		All	All		L
Syngnathidae (pipefishes/seahorses)	All	All		All		All	All		L
Sphyraenidae spp. (barracudas)	A, J	A, J, S	A, J, S	J		A, J, S	A, J, S	A, S	All
Priacanthidae	J	A, J, S	J			A, J, S	A, J, S	A, S	E, L
Stony corals		A, J, S	A, J, S			A, J, S	A, J, S	A, J, S	E, L
Heliopora (blue)		A, J, S	A, J, S			A, J, S	A, J, S	A, J, S	E, L
Tubipora (organpipe)						A J	A, J		
Azooxanthellates (non–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

MUS/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	DST	Pe
Small/Large polyped corals (endemic spp.)		A, J				A, J	A, J	A, J	
Millepora (firecorals)		A, J, S				A, J, S	A, J, S	A, J, S	E, L
Soft corals and gorgonians		A, J, S			A, J, S	A, J, S	A, J, S	A, J, S	E, L
Anemones (non-epifaunal)	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	E, L
Zooanthids	A, J, S	A, J, S	A, J, S		A, J, S	A, J, S	A, J, S	A, J, S	E, L
Sponges	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	E, L
Hydrozoans	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	E, L
Stylasteridae (lace corals)	A, J, S	A, J, S	A, J, S			A, J, S	A, J, S	A, J, S	E, L
Solanderidae (hydroid fans)	A, J, S	A, J, S	A, J, S			A, J, S	A, J, S	A, J, S	E, L
Bryozoans	A, J, S	A, J, S	A, J, S	A, J		A, J, S	A, J, S	A, J, S	E, L
Tunicates (solitary/colonial)	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	E, L
Feather duster worms (Sabellidae)	A, J, S	A, J, S	A, J, S		A, J, S	A, J, S	A, J, S	A, J, S	E, L
Echinoderms (e.g., sea cucumbers, sea urchins)	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	E, L
Mollusca	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	E, L
Sea Snails (gastropods)	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	A, J, S	E, L
Trochus spp.		A, J, S				A, J, S	A, J, S		E, L
Opistobranchs (sea slugs)	A, J	A, J, S		A, J, S	A, J, S	A, J, S	A, J, S	A, J	E, L

MUS/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	DST	Pe
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 24. 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 (c) 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.

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 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.
The recent discovery of concentrations of juvenile snappers in relatively shallow water and featureless bottom habitat in Hawaii indicates the need for more research to help identify, map, and study nursery habitat for juvenile snapper in the Mariana Archipelago.

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 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 believes 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. Panulirid 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

There are no HAPC identified for precious corals in the Mariana Archipelago.

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 because such areas have been singled out for their ecological values during their designation as a protected area, and therefore would likely meet the HAPC criteria as well. The Coral Reef Ecosystem MUS HAPCs identified in Table 25 have met at least one of the four criteria listed above, or the fifth criterion just identified (i.e., protected areas). 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. One coral reef ecosystem HAPC has been designated in the CNMI and five in Guam (see Table 26).

Table 25: EFH and HAPC Designations for all Western Pacific Archipelagic FEP MUS (including the Mariana Archipelago)

	Species Complex	EFH	HAPC
Bottomfish and Seamount Groundfish	**Shallow-water species (0–50 fm):** uku (*Aprion virescens*), thicklip trevally (*Pseudocaranx dentex*), lunartail grouper (*Variola louti*), blacktip grouper (*Epinephelus fasciatus*), ambon emperor (*Lethrinus amboinensis*), redgill emperor (*Lethrinus rubrioperculatus*), giant trevally (*Caranx ignoblis*), black trevally (*Caranx lugubris*), amberjack (*Seriola dumerili*), taape (*Lutjanus kasmira*)	**Eggs and larvae:** the water column extending from the shoreline to the outer limit of the EEZ down to a depth of 400 m (200 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*), yelloweye opakapaka (*P. flavipinnis*), 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 lattitude 29°–35° **Juvenile/adults:** all EEZ waters and bottom habitat bounded by latitude 29°–35° N and longitude 171° E–179° W between 200 and 600 m (100 and 300 fm)	No HAPC designated for seamount groundfish
Crustaceans	**Spiny and slipper lobster complex:** Hawaiian spiny lobster (*Panulirus marginatus*), spiny lobster (*P. penicillatus, P.* sp.), ridgeback slipper lobster (*Scyllarides haanii*), Chinese slipper lobster (*Parribacus antarticus*) **Kona crab:** Kona crab (*Ranina ranina*)	**Eggs and larvae:** the water column from the shoreline to the outer limit of the EEZ down to a depth of 150 m (75 fm) **Juvenile/adults:** all of the bottom habitat from the shoreline to a depth of 100 m (50 fm)	All banks 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* sp.), gold coral (*Callogorgia gilberti*), gold coral (*Narella* spp.), gold coral (*Calyptrophora* spp.), bamboo coral (*Lepidisis olapa*), bamboo coral (*Acanella* spp.) **Shallow-water precious corals (10-50 fm):** black coral (*Antipathes dichotoma*), black coral (*Antipathis grandis*), black coral (*Antipathes ulex*)	EFH for Precious Corals is confined to six known precious coral beds located off Keahole Point, Makapuu, Kaena Point, Wespac bed, Brooks Bank, and 180 Fathom Bank EFH has also been designated for three beds known for black corals in the Main Hawaiian Islands between Milolii and South Point on the Big Island, the Auau Channel, and the southern border of Kauai	Includes the Makapuu bed, Wespac bed, Brooks Banks bed For Black Corals, the Auau Channel has been identified as a HAPC
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 26: Coral Reef Ecosystem HAPC in the Mariana Archipelago

HAPC	Rarity of Habitat	Ecological Function	Susceptibility to Human Impact	Likelihood of Developmental Impacts	Existing Protective Status
Guam					
Cocos Lagoon	x	x	x		
Orote Point Ecological Reserve Area	x	x	x	x	x
Haputo Point Ecological Reserve Area	x	x			x
Ritidian Point	x	x			x
Jade Shoals	x	x	X		
CMNI					
Saipan (Saipan Lagoon)	x	x	X	x	x (Managaha Marine Conservation Area)

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. 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. Although lobster traps have a potential impact on the benthic habitat, the tropical lobster *Panulirus penicillatus* does not enter lobster traps. In the limited areas where harvesting does occur in the Mariana Archipelago, lobsters are caught by hand. This technique causes limited damage or no fishing-related impacts to the benthic habitat, and its continued use is likely.

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 the first phase of a submersible-supported research project conducted in Hawaii in 2001 preliminarily determined that bottomfish gear exhibited minimal to no impact on the coral reef habitat (C. Kelley, personal communication). A November 2001 cruise in the Main Hawaiian Islands determined that precious corals harvesting has “negligible” impact on the habitat (R. Grigg, personal communication). 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 land 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 (1997a), Grigg 2002, and Clark and Gulko (1999). (These findings are summarized in Table 27.) More recently, the U.S. Coral Reef Task Force identified six key threats to coral reefs: (1) landbased sources of pollutions, (2) overfishing, (3) recreational overuse, (4) lack of awarness, (5) climate change, and (6) coral bleaching and disease. In general, reefs closest to human population centers are more heavily used and are in worse condition than those in remote locations (Green 1997). Nonetheless, it is difficult to generalize about the present condition of coral reefs in the U.S. Pacific Islands because of their broad geographic distribution and the lack of long-term monitoring to document environmental and biological baselines. Coral reef conditions and use patterns vary throughout the U.S. Pacific Islands.

A useful distinction is between coral reefs near inhabited islands of American Samoa, CNMI, Guam, and the main Hawaiian islands and coral reefs in the remote NWHI, PRIAs, and northern islands of the CNMI. Reefs near the inhabited islands are heavily used for small-scale artisanal, recreational, and subsistence fisheries, and those in Hawaii, CNMI and Guam are also the focus for extensive non-consumptive marine recreation. Rather than a relatively few large-scale mechanized operations, many fishermen each deploy more limited gear. The more accessible banks in the main Hawaiian Islands (Penguin Bank, Kaula Rock), Guam (southern banks), and the CNMI (Esmeralda Bank, 300 Reef, Marpi Reef, Dump Coke and Malakis Reef are the most heavily fished offshore reefs in the Western Pacific Region management area.

The vast majority of the reefs in the Western Pacific Region are remote and, in some areas, they have protected status. Most of these are believed to be in good condition.

Existing fisheries are limited. The major exception is in the NWHI, where there are commercial fisheries for spiny lobster and deep-slope bottomfish (Green 1997). Poaching by foreign fishing fleets is suspected at Guam's southern banks, in the PRIA, and possibly in other areas. Poachers usually target high-value and often rare or overfished coral reef resources. These activities are already illegal but difficult to detect.

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 (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 27: Threats to Coral Reefs in the Mariana Archipelago

Activity	Guam	CNMI
Coastal construction	X	X
Destructive fishing		
Flooding	X	
Industrial pollution		X
Overuse/over harvesting	X	X
Nutrient loading (sewage/eutrophication)	X	X
Poaching/depletion of rare species		X

Activity	Guam	CNMI
Soil erosion/sedimentation	X	X
Vessel groundings/oil spills	X	X
Military activity	X	X
Hazardous waste	X	X
Tourist impacts	X	X
Urbanization	X	X

Sources: Birkeland 1997a; Clark and Gulko 1999; Grigg 2002; Jokiel 1999; Maragos et al. 1996

6.5.1 Habitat Conservation and Enhancement Recommendations

According to NMFS guidelines, Councils should 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

- Changes in abundance of 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 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

- Changes in abundance of 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

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 (PRIAs, NWHI, and northern islands of the CNMI).

3. Exotic species should not be introduced for aquaculture purposes unless a thorough scientific evaluation and risk assessment are performed (see section on aquaculture).

4. Effluent from public aquaria display laboratories and educational institutes using exotic species should be treated prior to discharge.

6.6 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 available 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) and are summarized below.

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
- Data to obtain a better SPR estimate for American Samoa's bottomfish complex
- Baseline (virgin stock) parameters (CPUE, percent immature) for the Guam/NMI deep- and shallow-water bottomfish complexes
- 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)
- Establish baseline parameters (CPUE) for the Guam/Northern Marinas crustacean populations
- Research to determine habitat related densities for all CMUS life history stages in American Samoa, Guam, Hawaii, and NMI
- 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 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 MARIANA 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 23.

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 28). 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 28: FEP Advisory Panel and Sub-panel Structure

Representative	**American Samoa FEP**	**Hawaii FEP**	**Mariana FEP**	**Pelagic FEP**
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 panels 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 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 FEP 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 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 (REACs) 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 committee 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, 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, 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. The resultant cultural hegemony is manifested in the poverty, unemployment, social disruption, poor education, poor housing, loss of traditional, 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 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
There are two programs 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 Coumunity Development Program (CDP) establishes a process to increase participation of the indigenous community in fisheries managed by the Council through FEP 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 management plans.

The Council has one CDP project in the Mariana Archipelago. The Guam Volunteer Fishery Data Collection Project uses community participation to enhance and complement creel survey and market data in Guam.

7.3.2 Western Pacific Community Demonstration Project Program (CDPP)

The Community Demonstration Project Program is a grant program. The Council develops the funding priorities. 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.

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. The Council also participates in broad international education initiatives such as the International Pacific Marine Educators Conference (1/15-17, 2007; Honolulu) as well as international marine debris conferences and fisheries forums. The Council will work with the U.S. Department of State and in coordination with NOAA International Affairs to appropriately broach issues of an international nature especially if they involve matters of policy, or law.

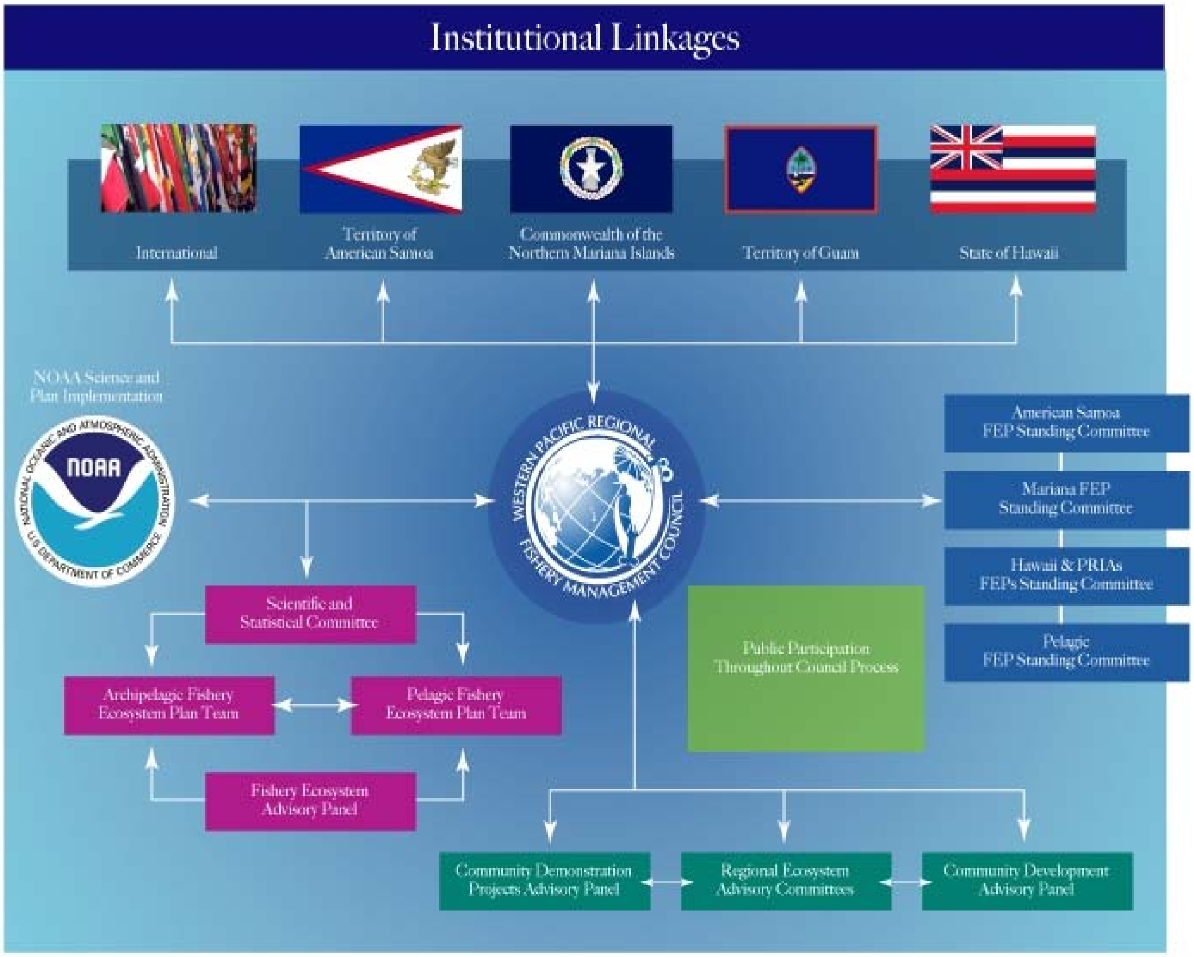

Figure 23. Illustration of Institutional Linkages in the Council Process

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.

8.2 MSA Requirements

8.2.1 Fishery Description

Chapter 4 describes the bottomfish, coral reef, crustacean, and precious coral fisheries that have operated or are currently operating in Guam and CNMI. Chapter 5 describes the management regimes in place for these fisheries. For additional information, see the Council's annual reports which are available at www.wpcouncil.org or by mail.[18]

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 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.

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 fisheries operating within federal waters of the Mariana Archipelago.

8.2.5 Description of EFH

See Chapter 6 for a description and identification of EFH within the Mariana Archipelago.

[18] Western Pacific Regional Fishery Management Council. 1164 Bishop St. Ste. 1400, Honolulu, HI. 96813.

8.2.6 Scientific Data Requirements

Although not necessarily needed to implement the FEP, the following is a list of scientific research areas that would further the ecosystem approach to fisheries for the Mariana Archipelago.

- Socio-economic and cultural study of the fishing communities with respect to potential resource allocation.
- Various projects addressing the multiple land-based threats to the near-shore coral reef ecosystem.
- Mapping.
- Rapid ecological assessments, biomass surveys, long-term remote and direct monitoring.
- Education.
- Marine debris.
- Effectiveness of MPAs as management tools.
- Archaeo-ichthyological studies.
- Relationship between habitat and stock abundance.
- Determination of indicator species for rapid assessment of ecosystem health.
- Relation of natural and anthropogenic stressors.
- Food web and trophic interactions for ecosystem modeling.
- Standardization of data collection systems to facilitate use in management.

8.2.6 Fishery Impact Statement

The institutional structure for ecosystem approaches to management under this FEP does not introduce any new regulatory changes to fishery operations, thereby no short-term impacts are anticipated for fishery participants or communities in the Mariana 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 Mariana 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 Mariana Archipelago FEP see the Council's Programmatic EIS on the Fishery Ecosystem Plans.

8.2.7 Bycatch Reporting

Bycatch by bottomfishing vessels over 50 ft in length fishing in EEZ waters around Guam is collected via federal logbooks. Bycatch information on other demersal fisheries in the Mariana Archipelago is collected via creel surveys as described in Chapter 5.

In response to the 1998 Sustainable Fisheries Act MSA Amendments regarding bycatch reporting, the creel survey instruments were modified in 1999 in order to include collection of bycatch data, which is recorded by species, number and/or weight, and condition (live, dead/injured). Where possible, fishery-wide bycatch estimates are derived from the sample data and expressed in SAFE report in absolute terms (by number or weight), and as a percent of the total catch, by species and condition. Bycatch data sources for the region's bottomfish fisheries are listed in Table 29 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.

Table 29: Bycatch Reporting Methodology for Mariana Archipelago Demersal Fisheries

	Observer Programs[19]	NMFS Federal Logbook Programs (EEZ waters)	Creel Surveys (all waters)
Guam Bottomfish	None	Federal logbook required for catch and effort from vessels > 50 ft.	DAWR: Guam Offshore Creel Census, Inshore Creel Survey
CNMI Bottomfish	None	Federal logbook required for all catch and effort from commercial vessels	DFW: CNMI Offshore Creel Survey
Coral Reef Ecosystem species	None	Federal logbook required for all catch and effort 3-200 miles from shore	DAWR: Guam Offshore Creel Census, Inshore Creel Survey DFW: CNMI Offshore Creel Survey, Inshore Creel Census
Precious Corals	None	Federal logbook required for all catch and effort	DAWR: Guam Offshore Creel Census, Inshore Creel Survey DFW: CNMI Offshore Creel Survey, Inshore Creel Census

[19] 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).

Crustaceans	None	Federal logbook required for all lobster and deepwater shrimp catch and effort	DAWR: Guam Offshore Creel Census, Inshore Creel Survey DFW: CNMI Offshore Creel Survey, Inshore Creel Census

For specific information on standardized bycatch reporting methodologies see Amendment 6 (Supplement) to the Bottomfish FMP, Amendment 10 (Supplement) to the Crustaceans FMP, Amendment 4 (Supplement) to the Precious Corals FMP (WPRFMC 2002) and the Coral Reef Ecosystems FMP (WPRFMC 2001).

8.2.8 Recreational Catch and Release

Chapter 4 of this document describes the recreational demersal fisheries in the Mariana Archipelago. Additional information may be found in the Council's annual reports on the bottomfish fishery. There are no MSA recognized catch and release fishery management programs in the Mariana Archipelago.

8.2.9 Description of Fishery Sectors

Chapter 4 of this document describes the different fishery sectors in the Mariana Archipelago. Additional information including landings data and trends may be found in the Council's annual reports.

8.3 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 Mariana Archipelago Fishery Ecosystem Plan. As described in Chapter 5, the reference points and control rules for species or species assemblages within those four FMPs are maintained in this FEP without change. There are currently no overfished stocks or stocks experiencing overfishing in the Mariana Archipelago.

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 Mariana 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 do they allocate fishing privileges among fishery participants.

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 Mariana 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 further management measures in the Mariana 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 affect 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.

8.4 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 PRIA (Table 30). Implementation of the FEPs is not expected to significantly affect the fishing operations or catches of any fisheries, rather it would simply replace and reorganize the FMPs into several geographically defined ecosystem plans. 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 30: EFH and HAPC for Management Unit Species 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
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 **Deepwater shrimp** The outer reef slopes at depths between 300-700 m	Water column down to 150 m Water column and associated outer reef slopes between 550 and 700 m	All banks with summits less than 30 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 FEP, all PRIAs, many specific areas of coral reef habitat (see Chapter 6)

8.5 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 policies of an affected state's coastal zone management program. Copies of this document will be provided to the appropriate local government agencies in Guam and CNMI for their review and concurrence that the recommended measures are consistent, to the maximum extent practicable, with their coastal zone management programs.

8.6 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*) occurs around Hawaii and some of the PRIA.

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 Hawaiian lobster 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

Bottomfish
In a Biological Opinion issued in March 2002 (NMFS 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.

Informal consultations completed by NMFS in June 2008 concluded that Mariana Archipelago bottomfish fisheries are not likely to jeopardize the species or adversely affect any other ESA-listed species or critical habitat.

The management and conservation measures contained in this FEP for targeting bottomfish or seamount groundfish species are being carried forth (i.e., maintained without change) 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.

Crustaceans

A Biological Opinion issued by NMFS in May 1996 (NMFS 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.

Informal consultations completed by NMFS in September 2008 concluded that Mariana 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 (i.e., maintained without change) 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.

Precious Corals

In a Biological Opinion issued in October 1978 (NMFS 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.

Informal consultations completed by NMFS in February 2008 concluded that Mariana 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 (i.e., maintained without change) from the Precious Corals FMP and no additional measures are proposed at this time. Therefore, the Council believes that the precious coral 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.

Coral Reef Ecosystem
An informal consultation was concluded March 7, 2002. As a result of the informal consultation, the NMFS Regional Administrator determined 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. 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 (i.e., maintained without change) 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 conducted 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 any critical habitat.

A Biological Opinion was issued December 29, 1998 (NMFS 1998) concerning the potential impacts to hawksbill and green sea turtles and humpback whales from U.S. Navy, U.S. Air Force and the U.S. Marine Corp live-fire activities consistent with aerial bombardment and ship to shore gunnery training conducted at Farallon de Medinilla (FDM), CNMI. The available information cited in this BiOp indicates that incidental taking of listed sea turtle may occur as a result of training conducted by the above named federal agencies at FDM. The Incidental Take Statement (ITS) anticipates that no more than 100 individuals per year will be taken by harassment and no more than two serous injuries or mortalities of a listed sea turtle is anticipated per year. This ITS is still current. Pre and post aerial surveys for listed species are required prior to and after live-fire activities. If listed species are sighted within 1,000 m of FDM, delivery of explosive ordnance must be delayed until the animals have left the immediate area. Since 1998, there has not been any observed incidental interactions with listed species reported.

Informal consultations completed by NMFS in June 2008 concluded that Mariana Archipelago coral reef fisheries are not likely to adversely affect any ESA-listed species or critical habitat.

8.7 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, 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 fisheries conducted pursuant to this FEP in waters of the Mariana 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 of the Mariana 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 Mariana 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.

8.8 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).

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, staff from NMFS' Pacific Islands Regional Office, NMFS' General Counsel 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.

8.9 Paperwork Reduction Act

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 new paperwork requirements and all existing requirements were lawfully approved and have been issued the appropriate OMB control numbers.

8.10 Regulatory Flexibility Act

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.

8.11 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; and (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.

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.

8.12 Information Quality Act

The information contained in this document 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 FEP 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.

8.13 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.

8.14 Executive Order 13089

In June 1998 the President signed an Executive Order for Coral Reef Protection, which established the Coral Reef Task Force (CRTF) and directed all federal agencies with coral reef-related responsibilities to develop a strategy for coral reef protection. Federal agencies were directed to work cooperatively with state, territorial, commonwealth, and local agencies; non-governmental organizations; the scientific community; and commercial interests to develop the plan. The Task Force was directed to develop and implement a comprehensive program of research and mapping to inventory, monitor, and address the major causes and consequences of degradation of coral reef ecosystems. The Order directs federal agencies to use their authorities to protect coral reef ecosystems and, to the extent permitted by law, prohibits them from authorizing, funding, or carrying out any actions that will degrade these ecosystems.

Of particular interest to the Council is the implementation of measures to address: (1) fishing activities that may degrade coral reef ecosystems, such as overfishing, which could affect ecosystem processes (e.g., the removal of herbivorous fishes leading to the overgrowth of corals by algae) and destroy the availability of coral reef resources (e.g., extraction of spawning aggregations of groupers); (2) destructive fishing techniques, which can degrade EFH and are thereby counter to the Magnuson-Stevens Act; (3) removal of reef substrata; and (4) discarded and/or derelict fishing gear, which can degrade EFH and cause “ghost fishing.”

To meet the requirements of Executive Order 13089, the Coral Reef Task Force issued the National Action Plan to Conserve Coral Reefs in March 2000. In response to the recommendations outlined in the Action Plan, the President announced Executive Order 13158, which is designed to strengthen and expand Marine Protected Areas.

CHAPTER 9: STATE, LOCAL AND OTHER FEDERAL AGENCIES

9.1 Introduction

The Mariana Archipelago consists of the 14 islands of the Commonwealth of the Northern Mariana Islands, the Territory of Guam and a number of offshore banks and seamounts.

The CNMI was part of the United Nations Trust Territory of the Pacific Islands (administered by the U.S.) until 1978 when its citizens chose to be become a U.S. commonwealth by plebiscite, and this was agreed to by Congress. Although title of the emergent land was conveyed to the Commonwealth, the U.S. government withheld title to the submerged lands.[20] The ownership of submerged lands and underlying resources adjacent to CNMI remain owned by the federal government and subject to its management authority (Beuttler 1995). Recent attempts by the CNMI to gain ownership of submerged lands out to 12 nautical miles from the archipelagic baseline through U.S. federal courts have been unsuccessful and the EEZ includes all waters surrounding CNMI from shore out to 200 nautical miles. However, the Council, for the purposes of fisheries management, defers management in waters 0-3 nautical miles to the CNMI while actively managing fishery resources 3-200 nautical miles. For this reason, all CNMI regulations and laws governing the use of marine resources continue to apply and are not superseded in any way by this FEP.

Pursuant to the Territorial Submerged Lands Act of 1960, the Territory of Guam owns and has management responsibility over the marine resources out to three "geographic" miles. In general, the authority of the MSA begins at three nautical miles from the shoreline at Guam. There are, however, exceptions to the management authority in the Territories. For example, the federal government administers waters off Ritidian Point as a National Wildlife Refuges and the U.S. Air Force and Navy control entry to certain marine waters surrounding Anderson Air Force Base and Naval Base Guam, Apra Harbor.

9.2 CNMI, Department of Land and Natural Resources, Division of Fish and Wildlife

Pending legal resolution to the ownership of submerged lands surrounding the CNMI, the Department of Land and Natural Resources, Division of Fish and Wildlife provides for the conservation of fish and game. They accomplish this through research and regulations governing hunting, fishing and conservation areas (i.e., fish reserves, marine conservation areas and marine sanctuaries) in the CNMI. The goal is to manage and conserve

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

resources so that future generations can enjoy them. Regulations governing fishing activities and harvest of marine resources in the CNMI can be found in the Commonwealth Register Volumes 22, 23 and 25.

9.3 Department of Agriculture, Department of Aquatic and Wildlife Resources

The management responsibility of marine resources in the Territory of Guam is vested to the Department of Agriculture through the Division of Aquatic and Wildlife Resource (DAWR). The mission of the Fisheries Section of the DAWR is to restore, conserve, manage, and enhance the aquatic resources in and about Guam and to provide for the public use of and benefits from these resources. The DAWR manages the fisheries through education and conservation initiatives to foster health of the reefs on which the fish depend, including placing shallow water moorings to prevent reef damage and setting aside marine protected areas to help restock the fishing areas. Regulations governing fishing activities and harvest of marine resources in Guam can be found in the (a) Organic Act of Guam, (b) Guam Code, Title 5, Division 6, Chapter 63 and (c) Guam Administrative Rules Title 16, Chapter 2

9.4 U.S. Fish and Wildlife Refuges and Units

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

9.5 Marianas Trench Marine National Monument

On January 6, 2009, then President George W. Bush established the Marianas Trench Marine National Monument, through Presidential Proclamation 8335. The Secretaries of Commerce, through the National Oceanic and Atmospheric Administration, and the Interior, will manage the monument pursuant to applicable legal authorities and in consultation with the Secretary of Defense. The Secretary of Commerce has primary management responsibility, in consultation with the Secretary of the Interior, with respect to fishery related activities. Proclamation 8335 directs the Secretary of Commerce to prohibit commercial fishing within the Islands Unit of the monument (i.e., within 50 nm of the islands of Maug, Farallon de Pajaros and Asuncion) but allow sustenance fishing, recreational and traditional indigenous fishing after consultation with the Government of CNMI. The Secretary of the Interior may permit scientific exploration and research within the monument. It also directs the Secretaries to establish the Mariana Monument Advisory Council to provide advice and recommendations on the development of management plans and management of the monument.

CHAPTER 10: PROPOSED REGULATIONS

In preparation.

CHAPTER 11: REFERENCES

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