ANNUAL STOCK ASSESSMENT AND FISHERY EVALUATION REPORT: MARIANA ARCHIPELAGO FISHERY ECOSYSTEM PLAN 2015

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The ANNUAL STOCK ASSESSMENT AND FISHERY EVALUATION (SAFE) REPORT for the MARIANA ARCHIPELAGO FISHERY ECOSYSTEM 2015 was drafted by the Fishery Ecosystem Plan Team. This is a collaborative effort primarily between the Western Pacific Regional Fishery Management Council, NMFS-Pacific Island Fisheries Science Center, Pacific Islands Regional Office, Division of Aquatic Resources (HI) Department of Marine and Wildlife Resources (AS), Division of Aquatic and Wildlife Resources (Guam), and Division of Fish and Wildlife (CNMI).

This report attempts to summarize annual fishery performance looking at trends in catch, effort and catch rates as well as provide a source document describing various projects and activities being undertaken on a local and federal level. The report also describes several ecosystem considerations including fish biomass estimates, biological indicators, protected species, habitat, climate change and human dimensions. Information like marine spatial planning and best scientific information available for each fishery are described. This report provides a summary of annual catches relative to the Annual Catch Limits established by the Council in collaboration with the local fishery management agencies.

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Executive Summary

As part of its 5 year fishery ecosystem plan (FEP) review, the Council identified the annual reports as a priority for improvement. The former annual reports have been revised to meet National Standard regulatory requirements for the Stock Assessment and Fishery Evaluation (SAFE) reports. The purpose of the report is twofold: monitor the performance of the fishery and ecosystem, and maintain the structure of the FEP living document. The reports are comprised of three chapters: fishery performance, ecosystem considerations, and data integration. The 2015 Mariana Archipelago annual SAFE report does not contain the data integration chapter. The Council will iteratively improve the annual SAFE report as resources allow.

The fishery performance section of this report first presents a general description of the local commercial fishery within Commonwealth of Northern Mariana Islands (CNMI) and Guam including both the bottomfish and coral reef management unit species (MUS). The fishery data collection system is then explained and time series of meta-data dashboard statistics are provided. The collection system encompasses shore-based and boat-based creel surveys, commercial receipt books, and boat inventories. The fishery statistics for each MUS are organized into a summary dashboard table showcasing the values for the most recent fishing year and a comparison to short-term (10 years) and long-term (20 years) averages. Time series for catch and effort statistics are also provided. For 2015 catch in CNMI, no MUS exceeded overfishing limit (OFL), allowable biological catch (ABC), or annual catch limit (ACL). For 2015 catch in Guam, all MUS were below OFL, ABC, and ACL except for jacks, which exceeded all three.

Ecosystem considerations were added to the annual SAFE report following the Council's review of its fishery ecosystem plans and revised management objectives. Fishery independent ecosystem survey data, human dimensions, protected species, climate and oceanographic, essential fish habitat, and marine planning information are included in the ecosystem considerations section.

Fishery independent ecosystem survey data was acquired through visual surveys conducted in CNMI, Pacific Remote Island Area, American Samoa, Guam, Main Hawaiian Islands, and Northwest Hawaiian Islands. This report illustrates the mean fish biomass for the reef areas within these locations. Additionally, the mean reef fish biomass and mean size of fishes (>10 cm) for CNMI and Guam are presented by sampling year and reef area. Finally, the reef fish population estimates for each study site within CNMI and Guam are provided for hardbottom habitat (0-30 m).

For CNMI, life history parameters including maximum age, asymptotic length, growth coefficient, hypothetical age at length zero, natural mortality, age at 50% maturity, age at sex switching, length at which 50% of a fish species are capable of spawning, and length of sex switching are provided for 10 species of reef fish and 11 species of bottomfish. The same nine life history parameters are provided for 12 species of reef fish and 11 species of bottomfish in Guam.

Summarized length derived parameters for coral reef fish and bottomfish in CNMI and Guam include: maximum fish length, mean length, sample size, sample size for L-W regression, and length-weight coefficients. Values for 25 coral reef fish species and 10 bottomfish species are presented for CNMI. Values for 22 coral reef fish species and three bottomfish species are presented for Guam.

Human dimensions data will be included in later versions of this report as resources allow.

The protected species section of this report summarizes information and monitors protected species interactions in fisheries managed under the Mariana Archipelago FEP. These fisheries generally have limited impacts to protected species, and do not have federal observer coverage. Consequently, this report tracks fishing effort and other characteristics to detect potential changes to the level of impacts to protected species. Fishery performance data contained in this report indicate that there have been no notable changes in the fisheries, and there is no other information to indicate that impacts to protected species have changed in recent years.

The 2015 Annual Report includes an inaugural section on indicators of current and changing climate and related oceanic conditions in the geographic areas for which the Western Pacific Regional Fishery Management Council has responsibility. In developing this section, the Council relied on a number of recent reports conducted in the context of the U.S. National Climate Assessment including, most notably, the 2012 Pacific Islands Regional Climate Assessment and the Ocean and Coasts chapter of the 2014 report on a Pilot Indicator System prepared by the National Climate Assessment and Development Advisory Committee. The primary goal for selecting the indicators used in this report is to provide fisheries-related communities, resource managers and businesses with climate-related situational awareness. In this context, indicators were selected to be fisheries relevant and informative, build intuition about current conditions in light of changing climate, provide historical context and recognize patterns and trends. The atmospheric concentration of carbon dioxide (CO_2) trend is increasing exponentially with the 2015 time series maximum at 400.83 ppm. The oceanic pH at Station Aloha, in Hawaii, is decreasing at a rate of 0.039 pH units per year, equivalent to 0.4% increase in acidity per year. A strong El Niño was present with sea surface temperature in waters throughout the Mariana Archipelago ranging between 29 - 30º C, reflecting a warm anomaly of approx. 0.5º C. At Apra Harbor, Guam, sea level showed a decline for most of 2015 reaching approximately 0.15 below average at its lowest point. The year also saw an abundance of tropical cyclones including 18 named storms and nine major hurricanes in the Eastern Pacific, 14 named storms and five major hurricanes in the Central Pacific, and 27 named storms in the Western Pacific. Wave forcing can have major implications for coastal ecosystems and pelagic fishing operations. Significant wave heights varied throughout the Mariana Archipelago from between 1.0 - 1.5 m for Guam and Saipan to between 2.0 - 2.5 m in Pagan and Maug.

The Mariana Archipelago FEP and National Standard 2 guidelines require that this report include a report on the review of essential fish habitat (EFH) information. The 2015 annual report includes a draft update of the precious corals species descriptions. The guidelines also require a report on the condition of the habitat. In the 2015 annual report, mapping progress and benthic cover are included as indicators, pending development of habitat condition indicators for the Mariana Archipelago not otherwise represented in other sections of this report. The annual report also addresses any Council directives toward its plan team. Toward this end, a report on the HAPC Process is included as an attachment to the report.

The marine planning section of this report tracks activities with multi-year planning horizons and begins to track the cumulative impact of established facilities. Development of the report in later years will focus on identifying appropriate data streams. Military activities in the Marianas continue to impact fisheries and access. With the Records of Decision on the Mariana Islands Testing and Training and Guam and CNMI Military Relocation SEIS, access to fishing grounds will be impacted at Ritidian Point on Guam and at Farallon de Medinilla in CNMI during live-fire exercises. Nearshore water quality will be impacted in Northern Guam until the Northern District Wastewater Treatment Plant is upgraded. A re-release of the draft CNMI Joint Military Training EIS is expected in March of 2017.

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ACRONYMS AND ABBREVIATIONS

ABC	Acceptable Biological Catch
ACE	Accumulated Cyclone Energy
ACL	Annual Catch Limits
ACT	Annual Catch Target
AM	Accountability Measures
AVHRR	Advanced Very High Resolution Radiometer
BAC-MSY	Biomass Augmented Catch MSY
B_{FLAG}	warning reference point for biomass
BiOp	Biological Opinion
BMUS	Bottomfish Management Unit Species
BOEM	Bureau of Ocean Energy Management
BSIA	Best Scientific Information Available
CFR	Code of Federal Regulations
CMLS	Commercial Marine License System
CMS	coastal and marine spatial
CMUS	Crustacean Management Unit Species
CNMI	Commonwealth of the Northern Mariana Islands
CPUE	Catch Per Unit Effort
CRED	Coral Reef Ecosystem Division
CREMUS	Coral Reef Ecosystem Management Unit Species
DAWR	Division of Aquatic and Wildlife Resources
DLNR-DAR	Department of Land and Natural Resources-Division of Aquatic Resources
DLNR-DFW	Department of Land and Natural Resources-Division of Fish and Wildlife
DPS	Distinct Population Segment
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EKE	Eddy kinetic energy
ENSO	El Niño Southern Oscillation
EO	Executive Order
ESA	Endangered Species Act
FEP	Fishery Ecosystem Plan
FMP	Fishery Management Plan
FRS	Fishing Report System
GAC	Global Area Coverage
GFS	global forecast system
HAPC	Habitat Area of Particular Concern
HDAR	Hawaii Division of Aquatic Resources
IBTrACS	International Best Track Archive for Climate Stewardship
LOF	List of Fisheries
LVPA	Large Vessel Prohibited Area
MFMT	Maximum Fishing Mortality Threshold
MHI	Main Hawaiian Island

MMA	marine managed area
MMPA	Marine Mammal Protection Act
MPA	marine protected area
MPCC	Marine Planning and Climate Change
MPCCC	Council's MPCC Committee
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
MSST	Minimum Stock Size Threshold
MSY	Maximum Sustainable Yield
MUS	management unit species
NCADAC	National Climate Assessment & Development Advisory Committee
NCDC	National Climatic Data Center
NEPA	National Environmental and Policy Act
NESDIS	National Environmental Satellite, Data, and Information Service
NMFS	National Marine Fisheries Service
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NWHI	Northwestern Hawaiian Islands
OFL	Overfishing Limits
OFR	Online Fishing Report
ONI	Ocean Niño Index
OR&R	Office of Response and Restoration
OY	Optimum Yield
PacIOOS	Pacific Integrated Ocean Observing System
PCMUS	Precious Coral Management Unit Species
Pelagic FEP	Fishery Ecosystem Plan for the Pacific Pelagic Fisheries
PI	Pacific Islands
PIBHMC	Pacific Island Benthic Habitat Mapping Center
PIFSC	Pacific Island Fisheries Science Center
PIRCA	Pacific Islands Regional Climate Assessment
PIRO	NOAA NMFS Pacific Islands Regional Office
PMUS	pelagic management unit species
POES	Polar Operational Environmental Satellite
PRIA	Pacific Remote Island Areas
RAMP	Reef Assessment and Monitoring Program
RPB	Regional Planning Body
SAFE	Stock Assessment and Fishery Evaluation
SBRM	Standardized Bycatch Reporting Methodologies
SDC	Status Determination Criteria
SEEM	Social, Economic, Ecological, Management uncertainties
SPC	Stationary Point Count
SST	Sea Surface Temperature
TAC	Total Allowable Catch
USACE	United States Army Corps of Engineers
WPacFIN	Western Pacific Fishery Information Network

WPRFMC	Western Pacific Regional Fishery Management Council
WPSAR	Western Pacific Stock Assessment Review
WW3	Wave Watch 3

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1 FISHERY PERFORMANCE

1.1 CNMI Fishery Descriptions

1.1.1.1 Background

The Commonwealth of the Northern Mariana Islands (CNMI) is a chain of islands in the Western Pacific Ocean. Along with the island of Guam, the chain is historically known as the Mariana Islands. The CNMI consists of 14 small islands situated in a north-south direction, stretching a distance of about 500km. The surrounding waters of the CNMI play an integral role in the everyday lives of its citizens. The ocean is a major source of food and leisure activities for residents and tourists alike. Archeological research has also revealed evidence of fishing activities in the CNMI dating back 3,000 years. Although the composition of fishing activities in the Marianas has changed significantly since then, a common view of its importance remains.

Fisheries during the German occupation

During the German occupational period (1899-1914) a majority of the economic focus in the Northern Marianas was on the copra industry. Few commercial fisheries were noted during this period of time, as the German administration focused efforts on crop production and feral cattle trade (Russell 1999). Chamorros and Carolinians utilized the protected lagoon and open waters with several fishing methods: talaya (cast net), chinchulu (surround net), gigao (fish weir), tokcha (spear), tupak (hook and line), with Carolinians additionally gleaning sea cucumbers for the Asian Markets. Most of these activities were for subsistence purposes, with the catch being distributed and bartered among relatives and acquaintances.

Fisheries during the Japanese occupation

Fisheries development prospered during the Japanese administration (1914-1945). The Japanese administration made fisheries the second largest industry. Small pelagic fishing operations were established and the Garapan port became the main area for drying fish. Large scale fishing activities occurred during the 1930’s where Saipan produced 11 percent of the total tuna haul within Micronesia (Bowers 2001). However, efforts to develop the tuna fishery shifted to Palau and FSM due to the availability of bait fish in the region. Subsistence fishing still persisted within the lagoon and fringing reefs, and were mainly conducted by the natives, although a large extraction of sea cucumbers did occur. The main fishing methods used during this period were cast net, spear, gillnet, surround net, hook and line, and gleaning. During this period the topshell (*Trochus niloticus*) was also introduced into the Marianas.

Fisheries during the U.S. military occupation

The fishing industry was destroyed during WWII, but quickly rebuilt after the war with support from the U.S. military. Okinawans who operated the fishery prior to the war were hired to operate and train locals to fish commercially, targeting pelagic species. A company called Saipan Fishing Company operated after the war, which contributed to the early re-development of commercial fisheries in the CNMI (Bowers 2001). Most of the fishing activities were for *Katsuwanus pelamis* (Bonito) and other tuna species. However, other resources such as Big-Eye Scad, reef fish, and lobster were also harvested during calm weather. The Chamorros and Carolinians continued subsistence fishing within the lagoon after the war. Although limited quantities of monofilament nets were available during this period, they were used to capture fish within the lagoon and along the reef lines. The use of modern fishing gear such as masks, rubber fins, and flash lights made it much easier to harvest coral reef resources during this time.

Fisheries activities within the past two decades
The CNMI has had numerous changes in fisheries within the past twenty years. In the mid 90's, commercial fisheries activities increased significantly. Commercial SCUBA fishing became a common method not only to support local demand for reef fish, but also exports to Guam. Large-scale commercial bottom fishing activity peaked from the mid 1990's through 2002, with landings being sold locally and exported to Japan. This fishery operated almost exclusively in the Northern Islands of the CNMI. Troll fishing continued to be the dominant fishing industry during this period. An exploratory, deep-water-shrimp fishery also evolved, but didn't last due to internal company issues, and gear losses. During this time a sea cucumber fishery evolved on Rota, then migrated to Saipan. Ultimately, this fishery was found to be unstable and was subsequently halted.

Several fishing companies entered the fisheries only to close down a few years later. The CNMI also reached its highest population during this period, most of whom were migrant workers from Asia. The tourism industry was also increasing at this time which contributed to high demand for fresh fish. Subsistence fishing within the nearshore waters of Saipan, Tinian, and Rota also increased.

In the 2000's, small scale troll, bottom and reef fish fisheries persisted, with landings sold locally. Federal and state support was provided multiple times to further develop fisheries in the CNMI, with intermittent success. An exploratory longline fishery was funded in the mid 2000's and operated in the CNMI for about two years, but eventually closed down due to low productivity for high-valued, pelagic fish and issues within the business. A few larger (40-80') bottom vessels were also operational during this period, with a majority of them fishing the northern islands and offshore banks. A few of these vessels were recipients of financial assistance to improve their fishing capacities. Fisheries in the CNMI tend to be relatively small and fluid, with 16' to 20' boats fishing within 20 miles from Saipan. Many of these small vessels conduct multiple fishing activities during a trip. For example, a company which is supported mainly by troll fishing will also conduct bottom and spearfishing to supplement income. Fishing businesses will enter and exit the fishery when it is economically beneficial. Fisheries in the CNMI are also highly sensitive to changes in the economy, development, population, and regulations. Subsistence fishing continues; however, fishing methods and target species have changed along with population demographics as well as fisheries restrictions. Nearshore hook and line, cast net, and spear fishing are common activities. However, fishing methods such as gillnet, surround net, drag nets, and SCUBA-spear have been restricted or outright banned in the CNMI since 2000.

1.1.1.2 Bottomfish Fishery
The bottomfish fishery has also changed minimally from previous years. Relatively small (<25ft) fishing vessels are still being used to access bottom fishing grounds around Saipan and Tinian, while the larger (>25ft) vessels are used to access bottomfish resources in the northern islands. Only a handful of these larger bottom fishing vessels are operating in the CNMI. Most of the small bottomfishing vessels are owned by the vendors; however, there are a few subsistence bottomfishers participating in the fishery intermittently.

Two distinct types of bottomfish fisheries are identified in the CNMI: shallow-water bottom fishing, which targets fish at depths down to 150 meters, and deep-water bottom fishing, which targets fish at depths greater than 150 meters. Species targeted within the shallow-water fishery consist of the Redgill Emperor (*Lethrinus rubrioperculatus*), Black Jack (*Caranx lugubris*), Matai (*Epinephelus fasciatus*), Sas (*Lutjanus kasmira*), Lunartail Grouper (*Variola louti*) and other fish in similar depth stratums. Species targeted within the deep-water bottom fishing depths (>150m) include; Onaga (*Etelis corsucans*), Ehu (*Etelis carbunculus*), Yelllowtail Kalekale (*Pristipomiodes auricilla*), Amberjack (*Seriola dumerili*), Blueline Gindai (*Pristipomiodes argyrogrammicus)*, Gindai (*Pristipomiodes zonatus*), Opakapaka (*Pristopomiodes filamentosus*), Eightbanded Grouper (*Hyporthordus octofasciatus*) and other fish found in similar depths.

Bottomfish Management Unit Species (BMUS) are not the only species being caught in the shallow-bottom fishery. Coral Reef Ecosystem Management Unit Species (CREMUS) are also caught in the shallow-bottom fishery because of the close proximity to the reef. These fish are caught with various hook and line gears such as: homemade hand lining gear, rod and reel, and electric reels. Deep-water bottomfishing requires more efficient fishing gears such as hydraulic and electric reels. Bottomfishing trips are generally during the day; however, fishing trips to the northern islands can take two to four days depending on vessel size and refrigeration capacity. These trips are most active during calm weather months. Successful fishermen targeting deep-water bottomfish tend to fish for one to four 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 four years). The slight difference between the shallow-water fishermen and the deep-water fishermen likely reflects the greater skill and investment required to participate in the deep-water, bottomfish fishery. In addition, these tend to be larger ventures that are more buffered from the impulses 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 challenging, if not impossible for CNMI bottom-fishermen to sustain more than a few years. A full list of BMUS species is provided in Appendix 3.

1.1.1.3 Coral Reef Fishery

Currently, coral reef fisheries have been consistent with previous years. Small scale nearshore fisheries in the CNMI continue to be an important part of subsistence, social, cultural, recreational, and financial resources. Most fishermen are subsistence fishers with a number of them selling a portion of their catch to roadside vendors. However, some vendors employ fishermen to maintain a constant supply of reef fish. Most of the fishing for coral reef species occurs within the Saipan lagoon and fringing reefs around the islands, with targets consisting of finfish and invertebrates. All reef fish catches are sold to the local markets or used for personal consumption with a minimal percentage exported for off-island residents. Shoreline access is the most common way to access coral reef resources. Vessels are generally used during calm weather to fish areas not as accessible other times of the year. Fishing trips to other islands are made when the weather is favorable. Fishing methods have not changed significantly when compared to previous years. Hook and line, cast netting, spear fishing, and gleaning are methods still being used today. Some of the common families found in the CNMI reef fish markets are; Acanthuridae (surgeonfish), Scarinae (parrotfish), Mullidae (goatfish), Serranidae (grouper), Labridae (wrasse), Holocentridae (soldier/squirrelfish), Carangidae (Jacks), Scombridae (scad), Haemulidae (sweetlips), Gerridae (mojarra), Kyphosidae (rudderfish), and Mugilidae (mullet), as well as other non-finfish families. A full list of CREMUS species is provided in Attachment 3.

1.1.2 Fishery Data Collection System

A majority of the information collected by the CNMI Division of Fish and Wildlife (DFW) are fishery-dependent data. Since the early 1980's attempts were made to establish a data collection program for the near shore fisheries, but failed due to intergovernmental issues. Over the past 10 years, significant time and effort has been made to further develop the fishery data section. This effort has resulted in the re-establishment of the Shore-based Creel Program. DFW in collaboration with other local and federal agencies have been working on expanding on these successes.

1.1.2.1 Creel Surveys

Currently the CNMI maintains a Boat- and Shore-based Creel Program for the island of Saipan, with plans to expand it to the neighboring populated islands. The programs were established in 2000 and 2005 respectively, in order to strengthen the Division's capacity in providing sufficient information to the public regarding fishery information. Other programs such as the invoicing system and importation monitoring provide supplemental information on harvest and demand for the fishery.

Effective management of Saipan's marine fishery resources requires the collection of fishing effort, methods used and harvest. The CNMI Boat- and Shore-based Creel Surveys are some of the major data collection systems used by DFW to estimate the total annual boat-based participation, effort and harvest and to survey the near-shore fishery resources. These surveys were formerly known as the "CNMI Offshore and Inshore Creel Survey." The term "offshore/inshore" were previously used when referring to these Creel Survey Programs. However, now the proper term that should be used is "boat- or shore-based" because it covers all the fishing done from a boat or from shore regardless of where the fishing occurred, e.g., inside or outside the reef or lagoon. This is an important distinction because where the fishing activity is initiated (shore vs. boat) determines how that type of activity will be accounted for in the survey systems. For instance, very small boats launched from non-standard launching areas, e.g., from the back of a pickup truck on a beach are not included in the Boat-based survey.

The objective of the Boat-based Creel Survey Program is to quantify fishing participation, effort and catch that are done on a vessel in CNMI's waters. DFW had an early creel survey data collection program from 1988 to 1996, however since the methods were not standardized, the data collected with that early program is not currently being used. The early program was terminated due to a lack of resources. On April 2, 2000, the DFW fishery staff reinitiated the boat-based creel survey program on the island's boat-based fishery following a three year hiatus. The fishery survey collects data on the island's boating activities - including commercial and noncommercial fishermen - and interviews returning fishermen at the three most active launching ramps/docks on the island: Smiling Cove; Sugar Dock; and Fishing Base. Essential fishery information is collected and processed from both commercial and noncommercial vessels and will be vital in the management process of one of the island's valuable natural resources. Saipan's Boat-based Creel Survey Program utilizes a random scheduling protocol to survey at the three most active launching ramps/docks on the island: Smiling Cove, Sugar Dock, and Fishing Base to collect catch and effort data and to analyze participation levels in Saipan's boat-based fishery. The two types of data collection programs utilized by Saipan's Boat-based Creel

Survey Program include: Boat-based Participation Count to collect participation data, and a Boat-based Access Point Survey to collect catch and effort data (through Survey Maps, Boat Logs and Interviews) at the three major boat ramp areas listed above. The data collected are then expanded at a stratum level (expansion period [quarterly or annually], charter or non-charter day type [weekday or weekend], and gear type) to create the estimated landings by gear type for CNMI's Boat-based fishery.

DFW had an early creel survey data collection program in 1984, and 1990 to 1994, however since the methods were not standardized, the data collected with that early program is not currently being used. The early program was terminated due to a lack of resources. In May 2005 the DFW fishery staff reinitiated the shore-based creel survey program on the island's shore-based fishery following an 11-year hiatus. With the assistance of the Western Pacific Fisheries Information Network (WPacFIN) program at the Pacific Islands Fisheries Science Center (PIFSC), data processing software and a database were developed to process these survey data. In addition, expansion software was also developed to create annual expanded (estimated) landings for this fishery.

The Shore-based survey currently covers the Western Lagoon of Saipan. Some pilot surveys are being conducted on Saipan's Eastern beaches such as; Laolao Bay, Obyan Beach, and Ladder Beach. Other accessible areas are not covered at this time due to existing limited resource availability and logistical constraints. The Western Lagoon starts from the northwest (Wing Beach) and extends to the southwest (Agingan Point) of Saipan. This encompasses over twenty accessible and highly active shoreline access points.

Saipan's Shore-based Creel Survey is a stratified randomized data collection program. This program collects two types of data to estimate catch and effort information of the shore-based fishery. The two types of data collection are: Participation Count (P) and Interview (I). The Participation Count involves counting the number of people fishing on randomly selected days and their method of fishing along the shoreline. The Interview involves interviewing fishermen to determine catch, method used, length and weights of fish, species composition, catch disposition and if any fish were not kept (by-catch). The data collected from this program are used to expand and create annual estimated landings for this fishery.

1.1.2.2 Vendor Invoice

DFW has been collecting fishery statistics on the commercial fishing fleet of Saipan since the mid-1970s. With the assistance of the National Marine Fisheries Service WPacFIN program, DFW also expanded its fisheries monitoring programs to include Rota and Tinian, the other two major inhabited islands in the CNMI. DFW's principal method of collecting domestic commercial fisheries data is a dealer invoicing system, sometimes referred to as a "trip ticket" system. The DFW provides numbered two-part invoices to all purchasers of fresh fishery products (including hotels, restaurants, stores, fish markets, and roadside vendors). Dealers then complete an invoice each time they purchase fish directly from fishers; one copy goes to DFW and one copy goes to their records. Some advantages of this data collection method are that it is relatively inexpensive to implement and maintain and is fairly easy to completely cover the commercial fisheries. DFW can also provide feedback to dealers and fishers to ensure data accuracy and continued cooperation.

There are some disadvantages to the trip ticket system: (1) dependency on non-DFW personnel to identify the catch and record the data; (2) restrictions on the types of data that can be collected; (3) required education and cooperation of all fish purchasers; and (4) limited recordings of fish actually sold to dealers. Therefore, a potentially important portion of the total landings is unrecorded. Since 1982, DFW has tried to minimize these disadvantages in several ways: (1) maintain a close working relationship with dealers; (2) add new dealers to their list and educate them; and (3) implement a creel survey to help estimate total catch, including recreational and subsistence catch. The current system collects data from dealers in Saipan, where DFW estimates more than 90% of all CNMI commercial landings are made. The DFW also estimates that the proportion of total commercial landings that have been recorded in the Saipan database since 1983 is about 90%. Previous volumes of FSWP reported only recorded landings, but in recent volumes the data have been adjusted to represent 100% coverage and are referenced as "Estimated Commercial Landings" in the tables and charts.

These data elements are collected for all purchases of fishery products; however, species identification is frequently identified only to a group level, especially for reef fish.

1.1.2.3 Biosampling

The bio-sampling data base contains general and specific bio-data obtained from individual commercial spearfish catches landed on Saipan from six different vendors during 2011. The following data was captured for each fishing trip sampled: date sampled; fishing gear type; time/hours fished; location fished; number/names of fishers; lengths/weights of individual fish; number/weight of octopus and squid; number/carapace size/weight of lobster; and whether boat- or shore-based fishing trip.

Although sampling effort was intended to be spread evenly among all participating vendors, smaller vendors were inherently much more difficult to sample within the time constraints allowed by the vendors. Therefore, a regular sampling schedule was implemented for the island's two largest vendors that included two weekdays and one weekend day each week since January/February 2011. Problems encountered in sampling the smaller vendors included: more days in any given month where no fish were purchased, the work area wasn't conducive for sampling, and communication problems. The bio-sampling data base focuses on night time spearfishing activities. Due to vendor-imposed limitations, the other gear types that typically land their catch during normal business hours were not sampled.

1.1.2.4 Exemption netting

In 2003 the use of gill nets was prohibited in the CNMI. In 2005 the Department/Division decided to allow gill netting under special circumstances. With approval from DFW, gill netting is allowed under the strict conditions provided by DFW. All gill netting activities are to be monitored and recorded by DFW personnel.

On 2010, a law was passed allowing for the use of a gill net on the island of Rota, for the purpose of subsistence. The following year, a regulation allowing for subsistence net fishing was passed for the island of Tinian.

For a majority of the permitted gillnet activities, length and weight measurements were taken at the fishing site. Fork lengths were taken in millimeters and weights were taken in grams. If time did not permit for individual measurements, then length measurements were taken for each fish and total weight was taken for each species. Length/weight ratios were used to estimate weights of sampled fish. Information is collected for activities conducted on the island of Saipan. No official collection of information is being conducted for the other two populated islands.

1.1.2.5 Life History

The CNMI Division of Fish and Wildlife life history program began in 1996 with the redgill emperors (*L. rubrioperculatus*). Since then, sampling has been conducted on other species such as; *A. lineatus*, Myriprestinae (*M. violacea, M. kuntee, M. pralinea, M. bernti, M. murdjan), L. harak, N. lituratus, C. sordidus*, and *C. undulatus*. Other life history programs have also developed over the past years. DFW personnel in collaboration with NOAA NMFS collect life history information on *S. rubroviolaceus, L. atkinsoni, P. barbarinus*, through funding provided by NOAA-NMFS. The life history survey captures biological information such as: reproductive cycle, age at length, and age at maturity. The DFW is continually working to improve the understanding of reef fish life history in the CNMI, through this program.

1.1.2.6 Monitoring of Imported Fish

The DFW Fisheries Data Sections collect fisheries-related importation invoices from the Department of Commerce at the end of every month. The data is then entered into the ticket receipt system and reviewed prior to being sent out for compilation by the Pacific Islands Fisheries Science Center (PIFSC). A majority of the information entered in the system can only be identified to the family taxa.

1.1.3 Meta-data Dashboard Statistics

The meta-data dashboard statistics describe the amount of information used or data available to calculate the fishery-dependent information. Creel surveys are sampling based system that requires random-stratified design applied to pre-scheduled surveys. The creel surveys are comprised of: 1) participation run that captures effort and participation estimates and; 2) catch interviews that capture catch, effort, CPUE information, catch composition, size-weight information. The number of sampling days, participation runs, and catch interviews would determine if there are sufficient samples to run the expansion algorithm. The trends of these parameters over time may infer survey performance. Monitoring the survey performance is critical for explaining the reliability of the expanded information.

Commercial receipt book information depends on the amount of invoices submitted and the number of vendors participating in the program. Fluctuations in these meta-data affect the commercial landing and revenue estimates.

1.1.3.1 Creel surveys meta-data statistics

Calculations: Shore-based data

Interview Days: This is the number of actual days that Creel Survey Data were collected. It's a count of the number of unique dates found in the interview sampling data (the actual sampling date data, include opportunistic interviews).

Participation Runs: Count of the number of unique occurrences of the combination of survey date and run number in the participation detail data.

Catch Interviews: Count of the number of unique occurrences of the combination of date and run number in the participation detail data/count of unique surveyor initials and date in PAR. This is divided into two categories, interviews conducted during a complete survey (Regular), and opportunistic interviews (Opp) which are completed on days when the whole survey is not conducted.

Calculation: Boat-based data

Sample days: Count of the total number of unique dates found in the boatlog data sampling date data.

Catch Interviews: Count of the total number of data records found in the interview header data (number of interview headers). This is divided into two categories, interviews conducted during a complete survey (Regular), and opportunistic interviews (Opp) which are completed on days when the whole survey is not conducted.

Table 1. Summary of creel survey meta-data describing survey performance parameters with potential influence on the creel survey expansion

Year	**Shore-based**			**Boat-based**	
	# interview days	**# participation run**	**# catch interviews**	**# sample days**	**# catch interviews**
2000				65	177
2001				67	285
2002				75	225
2003				90	339
2004				77	288
2005	68	157	300	78	446
2006	182	337	845	71	364
2007	220	413	637	63	315
2008	208	340	935	55	251
2009	193	324	894	64	266
2010	209	294	403	70	243
2011	224	327	402	73	249
2012	167	273	240	73	166
2013	190	277	299	71	191
2014	158	209	110	72	163
2015	148	115	55	62	8
10-year Avg	**179**	**279**	**465**	**68**	**242**
10-year SD	**44**	**87**	**314**	**7**	**115**

1.1.3.2 Commercial receipt book statistics

Calculations:

# of Vendors – Count of the number of unique buyer codes found in the commercial purchase header data.

Invoices – Count of the number of unique invoice numbers found in the commercial header data.

Table 2. Summary of commercial receipt book meta-data describing reporting performance parameters with potential influence on total commercial landing estimates (Note: Data will be reported only for years with ≥ 3 vendors reporting).

Year	Number of vendors	Number of invoices
2000	49	6,892
2001	42	5,820
2002	33	5,611
2003	27	4726
2004	25	3,720
2005	24	4,245
2006	21	4,541
2007	18	3688
2008	13	3242
2009	6	2649
2010	5	1708
2011	3	1061
2012	20	1630
2013	17	2270
2014	16	2,002
2015	14	510
10-year Avg	**14**	**2,504**
10-year SD	**7**	**1300**

1.1.4 Fishery Summary Dashboard Statistics

The Fishery Summary Dashboard Statics section consolidates all fishery dependent information comparing the most recent year with the short-term (recent 10 years) and long-term (recent 20 years). The summary dashboard shows the most current year value as the difference between the current year value with the 10 year average and the 20 year average (shown bolded in [brackets]). Trend analysis of the past 10 years will dictate the trends (increasing, decreasing, or no trend). The right-most symbol indicates whether the mean of the short-term and long-term years were greater than, less than, or within one standard deviation of the mean of the full time series.

Legend Key:

- *increasing trend in the time series*
- *decreasing trend in the time series*
- *no trend in the time series*
- *greater than 1 standard deviation*
- *less than 1 standard deviation*
- *within 1 standard deviation*

10,000 [**1,000**] – *point estimate of fishery statistic* [***difference from short/long term average***]

Table 3. Annual indicators for the coral reef and bottomfish fishery describing fishery performance comparing current estimates with the short-term (10 years) and the long-term (20 years) average.

Fishery	**Fishery statistics**	**Short-term (recent 10 years)**	**Long-term (20 years)**
Bottomfish	**Estimated catch (lbs)**		
All species caught in the BF gear	Boat and shore creel data estimated (expanded) total lbs (all BF trips)		
	Estimated total lbs (all species) commercial purchase data	8,133**[-23,215]**	8,133**[-34,064]**
Bottomfish management unit species only	Boat-based creel data Estimated (expanded) total lbs (all BF trips)		
	Estimated total lbs (all species) commercial purchase data	4,045**[-10,430]**	4,045**[-14,497]**
	Catch-per-unit effort (lbs/gear-hrs)		
	CPUE (creel data only)	0.16**[-0.2]**	NA
	Fishing effort *(only available for creel data)*		
	Estimated (expanded) total bottomfish # of trips	78**[-211]**	78**[-276]**
	Fishing participants		
	Estimated total # of boats that went bottomfishing		
	Bycatch		
	Total number of bycatch caught	191**[-5,273]**	NA
	# bycatch released	0**[-0.8]**	NA
	# bycatch kept	191**[-5,723]**	NA
	Federal permits		
	# federal permit holders (PIRO)		
Coral Reef	**Estimated catch (lbs all gears)**		
	Boat-based creel data (expanded estimate all gears, defined by a list of species?)	9,255**[-45,475]**	NA
	Shore-based creel (expanded estimate all gears, defined by a list of species?)	13,323**[-18,550]**	NA
	Commercial Purchase	No 2015 estimate	No 2015 estimate
	Catch-per-unit-effort (lbs/gear-hrs)		
	BB spear	2.56**[1.3]**	NA
	BB troll	0.06**[-0.2]**	NA
	BB atulai	1.3**[-2.1]**	NA
	BB castnets	No 2015 estimate	NA

Fishery	**Fishery statistics**	**Short-term (recent 10 years)**	**Long-term (20 years)**
	SB H&L	0.06**[0.01]**	NA
	SB spear	0.2**[-0.02]**	NA
	SB castnets	0.09**[-0.2]**	NA
	Fishing effort (# of gear-hours by gear type)		
	BB spear	610**[-1,083]**	NA
	BB troll	14,322**[-5,938]**	NA
	BB atulai	84**[-2,405]**	NA
	BB castnets	No 2015 estimate	NA
	SB H&L	17,844**[-41,051]**	NA
	SB spear	5,475**[-2,753]**	NA
	SB castnets	1,619**[-3,648]**	NA
	Fishing participants (# of gear)		
	BB spear	No 2015 estimate	NA
	BB troll	17**[-286]**	NA
	BB atulai	No 2015 estimate	NA
	BB castnets		
	SB H&L	72**[-555]**	NA
	SB spear	11**[-20]**	NA
	SB castnets	4**[-30]**	NA
	Bycatch		
	Total number of bycatch caught	347**[-2,582]**	NA
	# bycatch released	0**[-11]**	NA
	# bycatch kept	347**[-2,582]**	NA
	Federal permits		
	# federal permit holders (PIRO)		

1.1.5 Catch statistics

This section summarizes the catch statistics for the bottomfish and coral reef fishery in CNMI. Estimates of catch are summarized from the creel survey and commercial receipt book data collection programs. Catch statistics provide estimates of annual harvest from the different fisheries. Estimates of fishery removals can provide proxies for the level of fishing mortality and a reference level relative to established quotas. This section also provides detailed level of catch for fishing methods and the top species complex harvested in the coral reef and bottomfish fishery.

1.1.5.1 Catch by data stream

This describes the estimated total catch from the shore and boat-based creel survey program and the commercial landing from the commercial receipt book system. The difference between the creel total and the commercial landing is assumed to be the non-commercial component. However, there are cases where the commercial landing may be higher than the estimated creel total of the commercial receipt book program is able to capture the fishery better than the creel survey (e.g. night time spearfishing)

Calculations: Estimated landings are based on a pre-determined list of species (Appendix 3) identified as the BF Species Complex regardless of the gear used, for each data collection (shore-based creel, boat-based creel and the commercial purchase reports).

Table 4. Summary catch time series of the ALL SPECIES caught using the bottomfishing gear: estimated lbs (expanded) from the boat and shore-based creel surveys and estimated total lbs from the commercial purchase system

Note: The creel survey estimates were not available for this report but will be included in next year's report.

Year	Creel survey Estimates		Creel Total	Commercial landings
	Shore-based	Boat-based		
1983				28,529
1984				42,664
1985				40,975
1986				29,912
1987				49,715
1988				47,313
1989				24,438
1990				12,927
1991				7,093
1992				10,598
1993				18,461
1994				25,470
1995				36,102
1996				66,388
1997				64,144
1998				59,023
1999				55,991
2000				45,258
2001				71,256
2002				46,766
2003				41,904
2004				54,474
2005				70,398
2006				29,340
2007				39,477
2008				42,073
2009				41,176
2010				22,329
2011				24,834
2012				15,302
2013				22,510

Year	**Creel survey Estimates**		**Creel Total**	**Commercial landings**
	Shore-based	**Boat-based**		
2014				29,257
2015				8,133
10-year avg.				**31,348**
10-year SD				**16,761**
20-year avg.				**42,197**
20-year SD				**18,312**

Calculations: Estimated landings are based on a pre-determined list of species (Appendix 3) identified as the BMUS Complex regardless of the gear used, for each data collection (shore-based creel, boat-based creel and the commercial purchase reports).

Table 5. Summary of the available Bottomfish Management Unit Species (BMUS) catch time series: estimated lbs (expanded) from the boat and shore-based creel surveys and estimated total lbs from the commercial purchase system

Note: The creel survey estimates were not available for this report but will be included in next year's report.

Year	**Creel survey Estimates**		**Creel Total**	**Commercial landings**
	Shore-based	**Boat-based**		
1983				3,407
1984				3,463
1985				2,223
1986				3,822
1987				1,889
1988				2,413
1989				4,021
1990				1,273
1991				781
1992				607
1993				1,722
1994				5,476
1995				17,736
1996				32,446
1997				22,133
1998				27,593
1999				34,648
2000				14,968
2001				25,264
2002				24,518
2003				17,988
2004				12,872
2005				15,780
2006				10,491
2007				16,160
2008				16,965
2009				18,941
2010				13,237
2011				16,271
2012				11,072
2013				17,223
2014				19,037
2015				4,045
10-year avg.				**14,475**
10-year SD				**4,473**
20-year avg.				**18,542**
20-year SD				**7,268**

Calculations: Estimated landings are based on a pre-determined list of species (Appendix 3) identified as the CREMUS Complex regardless of the gear used, for each data collection (shore-based creel, boat-based creel and the commercial purchase reports). Need to finalize the CREMUS list to use for Creel and commercial landings and verify non-overlap between Bottomfish Complex and CREMUS. Also need to verify all shallow bottomfish are not included in CREMUS list.

Table 6. Summary of the predefined "coral reef fishery" (catch time series (for a discrete list of species – taken from CB lbs and CS lbs from the CREMUS module) from the boat and shore-based creel surveys and the commercial purchase system.

Year	**Creel surveys**		**Creel Total**	**Commercial landing**
	Shore-based	**Boat-based**		
1981				25,220
1982				42,650
1983				128,300
1984				154,620
1985				123,660
1986				118,190
1987				99,910
1988				163,900
1989				300,540
1990				232,430
1991				129,530
1992				166,600
1993				165,680
1994				216,630
1995				168,620
1996				161,890
1997				182,870
1998				216,440
1999				179,170
2000		85,393		170,040
2001		35,449		149,240
2002		37,398		158,770
2003		42,399		93,270
2004		50,138		60,650
2005	42,031	57,244	99,275	87,470
2006	56,619	57,982	114,603	126,900
2007	40,627	81,612	122,238	89,770
2008	43,483	73,178	116,662	84,170
2009	63,051	78,910	141,960	72,210
2010	24,251	59,346	83,594	59,900
2011	11,771	55,240	67,011	55,110
2012	12,229	74,434	86,662	30,320
2013	36,580	38,170	74,749	13,190
2014	6,633	16,659	23,291	22,970
2015	13,323	9,255	22,579	
10-year avg.	**31,873**	**54,730**	**86,602**	**64,201**
10-year SD	**19,366**	**24,220**	**38,501**	**35,183**
20-year avg.	**N.A.**	**N.A.**	**N.A.**	**109,149**
20-year SD	**N.A.**	**N.A.**	**N.A.**	**60,651**

1.1.5.2 Expanded catch estimates by fishing methods

Catch information is provided for the top shore-based and boat-based fishing methods that contributes 99% and 84% of the annual catch, respectively.

Calculations: The creel survey time series of catch will be the sum of the estimated weight by selected gear in all strata for all species except for trolling which would exclude PMUS and any pelagic species complex.

Table 7. Expanded catch time series estimates using boat and shore-based creel survey data sets by gear type.

Year	Shore-based methods			Boat-based methods				
	H&L	Spear	Castnet	Bottom	Spear	Troll	Atulai	Castnet
2000				40,540	20,770	4,608	1,048	
2001				16,199	11,323	2,762	3,411	
2002				14,977	9,804	5,475	478	
2003				9,357	5,413	9,457	13,285	2,314
2004				31,062	7,339	10,723	1,013	
2005	13,224	23,973	4,833	32,378	8,034	15,328		558
2006	17,251	28,395	10,974	36,380	8,558	7,520	5,248	278
2007	11,589	20,397	8,642	59,079	11,838	3,564	7,131	
2008	24,317	14,022	5,121	40,821	12,933	3,789	13,863	1,021
2009	42,974	10,457	9,618	46,036	18,715	858	11,707	1,593
2010	8,253	5,828	10,168	35,687	4,897	11,263	6,209	1,289
2011	7,270	3,818	685	30,110	7,099	9,017	7,847	1,165
2012	4,915	1,855	5,460	45,888	8,488	5,244	14,438	
2013	13,369	19,057	4,138	32,188	2,932	1,812	1,240	
2014	3,971	309	2,353	8,893	2,257	4,441	330	736
2015	2,700	9,229	1,393	3,449	4,905	792	109	
10-year avg.	**13,621**	**12,485**	**5,762**	**33,719**	**8,241**	**5,784**	**6,812**	**949**
10-year SD	**11,623**	**9,427**	**3,609**	**15,982**	**4,822**	**4,588**	**5,310**	**453**
20-year avg.	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**
20-year SD	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**

1.1.5.3 Top species in the catch for the boat and shore-based fisheries

The time series for catch is an indicator of fishery performance. Fluctuations in the catch can be attributed to various factors and there is no single explanatory variable for the trends. The 10 species group in the boat and shore-based catch for the coral reef fishery make up 91% of the total annual catches.

Calculations: Catch by species complex can be summed directly from current boat-based expanded species composition data over all by gear or by gear and species, for all strata. (geographic, temporal).

The averages for the table this year were calculated from catch estimates from the entire time series for each of the CREMUS groupings. The average catch for each grouping is ranked from the highest to lowest catch. The dominant groups that make up more than 50% of the catch are reported.

Table 8. Catch time series of the 12 managed species complexes (rank ordered by management importance and average catch of recent 10 years) from the boat based creel data. The CREMUS complex comprise > 92% of the total boat based landing. (ALL BF and BMUS were deemed commercial).

	All BF	**BMUS**	**Emperor**	**Jack**	**Atulai**	**Grouper**	**Snapper**	**Surgeon**	**Parrot**	**Mullet**	**Squirrel**	**Rudder**
1983	28,529	3,407										
1984	42,664	3,463										
1985	40,975	2,223										
1986	29,912	3,822										
1987	49,715	1,889										
1988	47,313	2,413										
1989	24,438	4,021										
1990	12,927	1,273										
1991	7,093	781										
1992	10,598	607										
1993	18,461	1,722										
1994	25,470	5,476										
1995	36,102	17,736										
1996	66,388	32,446										
1997	64,144	22,133										
1998	59,023	27,593										
1999	55,991	34,648										
2000	45,258	14,968	41,399	21,344	892	6,494	4,210	2,745	1,050	130	85	
2001	71,256	25,264	11,757	3,859	3,497	4,196	1,876	5,817	1,788		361	243
2002	46,766	24,518	13,108	7,253	584	1,171	2,149	3,524	2,026	1,967	972	
2003	41,904	17,988	4,275	9,529	13,285	3,494	1,982	4,185	917		2,097	260
2004	54,474	12,872	24,939	11,320	993	4,220	1,836	2,107	1,279		497	586
2005	70,398	15,780	22,735	17,736		4,863	3,804	1,714	747		188	852
2006	29,340	10,491	21,319	11,098	4,916	6,230	2,219	4,263	1,795		348	235
2007	39,477	16,160	34,229	6,324	7,148	7,432	10,005	3,947	2,778		4,391	985
2008	42,073	16,965	26,677	6,816	13,632	3,020	4,279	4,775	4,049		1,069	496
2009	41,176	18,941	31,907	4,810	12,259	4,376	5,829	7,390	3,897		649	3,076
2010	22,329	13,237	22,936	14,356	6,209	3,509	4,250	3,451	1,248		692	
2011	24,834	16,271	19,736	11,566	7,847	1,273	5,309	4,018	205		542	3,716
2012	15,302	11,072	43,563	1,676	14,438	4,119	803	975	1,148		1,150	88
2013	22,510	17,223	26,308	2,540	1,237	1,757	3,680	1,170	69		3	219
2014	29,257	19,037	6,362	5,161	330	497	372	2,063	695		236	
2015	8,133	4,045	1,471	1,672	109	29	687	4,476	132		350	135
10-year avg.	**31,348**	**14,475**	**23,386**	**7,614**	**6,813**	**3,373**	**3,749**	**3,477**	**1,524**	**N.A.**	**874**	**1,089**
10-year SD	**16,761**	**4,473**	**11,853**	**5,368**	**5,349**	**2,346**	**2,797**	**1,893**	**1,448**	**N.A.**	**1,219**	**1,354**
20-year avg.	**42,197**	**18,542**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**
20-year SD	**42,197**	**18,542**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**

Calculations: Catch by species complex can be summed directly from current shore-based expanded species composition data over all by gear or by gear and species, for all strata (geographic, temporal).

The averages were for the table below was calculated from catch estimates from the entire time series for each of the CREMUS grouping. The average catch is ranked from the highest to lowest catch. The dominant groups that make up more than 60% of the catch are reported.

Table 9. Catch time series of the 11 managed species complexes (rank ordered by management importance and average catch of recent 10 years) from the shore-based creel data The CREMUS complex comprise > 91% of the total boat based landing

	Shorebased methods										
	Jack	**Emperor**	**Rabbit**	**Surgeon**	**Goatfish**	**Atulai**	**Parrot**	**Mollusk**	**Mullet**	**Wrasse**	**Rudder**
2005	4,418	4,949	4,251	5,877	5,189	236	2,854	4,057	2,424	2,736	50
2006	7,782	9,924	2,677	7,140	9,046	4,508	3,509	1,450	3,602	846	350
2007	4,716	6,886	2,123	2,122	2,806	2,773	1,682	7,881	4,019	545	153
2008	17,701	4,720	989	4,044	2,645	1,766	6,969	41	1,463	143	17
2009	17,555	7,446	19,643	2,750	3,121	749	2,020	761	3,578	430	1,566
2010	3,113	3,563	228	4,945	943	8,835	239	57	751	89	
2011	5,045	1,954	159	1,226	420	130	170		458	118	59
2012	3,303	1,604	2,577	325	876	152	242	1,509	720	80	
2013	4,655	3,053	1,985	4,917	7,457	7,160	3,468		592	540	400
2014	3,404	1,176	21	130	35	45			307	18	549
2015	1,254	2,412	2,415	2,207	1,488	93	1,552		281	83	341
10-year avg.	**6,631**	**4,335**	**3,370**	**3,244**	**3,093**	**2,404**	**2,271**	**2,251**	**1,654**	**512**	**387**
10-year SD	**5,665**	**2,775**	**5,551**	**2,309**	**2,963**	**3,123**	**2,081**	**2,830**	**1,472**	**784**	**479**
20-year avg.	**N.A.**	**N.A.**	**N.A.**	**N.A.**		**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**
20-year SD	**N.A.**	**N.A.**	**N.A.**	**N.A.**		**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**

1.1.6 Catch Per Unit Effort (CPUE) Statistics

This section summarizes the estimates for catch-per-unit effort in the boat and shore-based fisheries. The boat-based fisheries include the bottomfishing (handline gear), spearfishing (snorkel), troll, atulai nets, and castnets that comprise 84% of the total catch. Trolling method are primarily a pelagic fishing method but also catches coral reef fishes like jacks and gray jobfish. The shore-based fisheries include the hook-and-line, spearfishing and cast nets comprise 99% of the total coral reef fish catch. CPUE is reported as pounds per gear-hours for the shore-based methods whereas in the boat-based methods its pound per trip.

Calculations: The previous CREPT report generated CPUE estimates for the top CREMUS groups by fishing method. The top 3-4 CREMUS groups that dominate the catch by fishing method were used to represent the CPUE by method. The proportion of the dominant CREMUS groups relative to the total catch is described in the method header. The representative CPUE by method was calculated from the average CPUE for these CREMUS groups.

Table 10. Catch per unit effort time series by dominant fishing methods from the shore-based fisheries. CPUE estimates was derived from the top 3 - 5 dominant taxonomic groups that make up more than 50% of the catch. The percentage of catch is shown in parenthesis beside the method.

Year	Shore-based methods (annual est. total lbs/est. gear-hr)				
	Lbs/Gear-hr Complex A				
	H&L (72%)	Spear (63%)	Castnet (72%)		
2005	0.028	0.263	0.279		
2006	0.041	0.254	0.290		
2007	0.033	0.254	0.263		
2008	0.063	0.297	0.240		
2009	0.074	0.224	0.445		
2010	0.041	0.181	0.790		
2011	0.042	0.133	0.032		
2012	0.038	0.075	0.194		
2013	0.091	0.712	0.243		
2014	0.036	0.001	0.324		
2015	0.062	0.221	0.090		
10-year avg.	**0.050**	**0.238**	**0.290**		
10-year SD	**0.020**	**0.181**	**0.199**		
20-year avg.	**N.A.**	**N.A.**	**N.A.**		
20-year SD	**N.A.**	**N.A.**	**N.A.**		

Table 11. Catch per unit effort time series by dominant fishing methods from the boat-based fisheries. CPUE estimates was derived from the top 3 - 5 dominant taxonomic groups that make up more than 50% of the catch. The percentage of catch is shown in parenthesis beside the method.

	Boat-based methods (annual est. total lbs/est. trips)					
	Lbs/trip	Lbs/hr	Lbs/hour			
Year	Bottom	Bottom (82%)	Spear (58%)	Troll (74%)	Atulai (93%)	Castnet (74%)
1983	43					
1984	70					
1985	117					
1986	104					
1987	169					
1988	181					
1989	73					
1990	81					
1991	47					
1992	59					
1993	84					
1994	74					
1995	93					
1996	119					
1997	137					
1998	148					
1999	156					
2000	56	0.541	1.60	0.121	5.17	
2001	68	0.200	1.83	0.065	4.47	
2002	101	0.264	1.36	0.290	6.07	

2003	89	0.226	0.81	0.354	3.99	5.79
2004	104	0.423	0.81	0.426	0.97	
2005	76	0.364	1.05	0.707		5.43
2006	48	0.237	0.71	0.335	2.98	5.64
2007	60	0.403	0.71	0.168	5.42	
2008	59	0.232	1.54	0.133	2.17	0.98
2009	60	0.289	1.27	0.041	1.66	5.79
2010	60	0.204	0.73	0.460	2.17	7.49
2011	55	0.362	1.31	0.496	3.50	1.19
2012	41	0.554	2.19	0.033	4.40	
2013	57	0.494	0.75	0.099	4.58	
2014	122	0.219	1.40	0.214	6.07	11.58
2015	37	0.156	2.56	0.055	1.30	
10-year Ave	**61.36**	**0.319**	**1.293**	**0.249**	**3.425**	**5.443**
10-year SD	**22.69**	**0.127**	**0.619**	**0.222**	**1.641**	**3.652**
20-year Ave	**83.14**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**
20-year SD	**36.00**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**

NOTE: consider “castnets” deleting because there is insufficient data available

1.1.7 Effort Statistics

This section summarizes the effort trends in the coral reef and bottomfish fishery. Fishing effort trends provide insights on the level of fishing pressure through time. Effort information is provided for the top shore-based and boat-based fishing methods that contributes 99% and 84% of the annual catch.

Calculations: The values were derived from the shore and boat-based CPUE estimates and catch estimates extracted from the previous CREPT reports. For the bottomfish effort, values were derived from the old bottomfish fishery modules.

Effort estimates for the coral reef shore-based fisheries and boat-based non-bottomfish fisheries (expressed in gear-hours) were derived from the CPUE and catch of the dominant CREMUS groups per method. The catch (expressed in pounds) of the top 3-4 CREMUS groups per method was divided by its corresponding CPUE (expressed in pounds per gear-hours) from Table 10 and 11 to derive effort (expressed in gear-hours). For the bottomfish fishery, the sum of the total number of recorded trips constitutes the fishing effort.

Table 12. Time series of effort estimates from the coral reef and bottomfish fisheries. Shore-based fisheries are expressed in gear-hours (expanded total number of hours fishing by total number of gears used). The boat-based fisheries are expressed in number of trips for bottomfish and number of gear hours for spear, troll, atulai, and castnest). Cells marked with * indicates data is confidential due to less than 3 entities surveyed or reported

	Estimated Effort by Gear or Fishing Method	
	# of SB gear-hours (estimated annual expanded)	**# of BB trips (estimated annual expanded)**

	H&L	Spear	Castnet	Bottom	Spear	Troll	Atulai	Castnet
1983				536				
1984				489				
1985				279				
1986				229				
1987				236				
1988				209				
1989				267				
1990				128				
1991				122				
1992				143				
1993				176				
1994				276				
1995				310				
1996				448				
1997				375				
1998				318				
1999				288				
2000				647	2,984	28,423	173	
2001				833	1,837	26,150	764	
2002				370	2,080	18,873	79	
2003				378	1,442	25,264	3,328	200
2004				288	2,199	23,621	1,027	
2005	74,364	13,728	6,228	508	1,506	21,618		48
2006	100,049	16,142	10,111	321	2,867	20,299	1,651	24
2007	76,847	12,242	6,472	431	3,461	21,240	1,312	
2008	109,446	9,440	8,280	461	1,859	26,644	6,261	297
2009	86,123	7,659	5,215	376	3,056	21,029	6,882	138
2010	37,911	6,347	4,118	167	1,669	24,474	2,862	111
2011	43,909	3,574	4,931	182	1,028	18,063	2,240	488
2012	31,750	5,474	3,651	244	1,059	17,652	3,278	
2013	45,439	6,211	4,453	257	1,004	17,883	270	
2014	24,166	4,211	2,858	155	509	19,631	54	64
2015	17,844	5,475	1,619	78	610	14,322	84	
10-year Avg.	**58,895**	**8,228**	**5,267**	**289**	**1,693**	**20,259**	**2,489**	**167**
10-year SD	**31,664**	**4,139**	**2,424**	**141**	**1,016**	**3,389**	**2,428**	**168**
20-year Avg.	**N.A.**	**N.A.**	**N.A.**	**354**	**N.A.**	**N.A.**	**N.A.**	**N.A.**
20-year SD	**N.A.**	**N.A.**	**N.A.**	**171**	**N.A.**	**N.A.**	**N.A.**	**N.A.**

NOTE: Table below shows fishing effort in gear-hours divided by the number of gear per year.

	Estimated Effort by Gear or Fishing Method							
	# of SB gear-hours (estimated annual expanded)			**# of BB trips (estimated annual expanded)**				
	H&L	**Spear**	**Castnet**	**Bottom**	**Spear**	**Troll**	**Atulai**	**Castnet**
1983				536				
1984				489				
1985				279				
1986				229				

1987				236				
1988				209				
1989				267				
1990				128				
1991				122				
1992				143				
1993				176				
1994				276				
1995				310				
1996				448				
1997				375				
1998				318				
1999				288				
2000				647	77	108		*
2001				833	46	55		*
2002				370	65	50		*
2003				378	80	39	88	*
2004				288	40	52	57	*
2005	227	312	160	508	23	33		*
2006	95	269	123	321	44	41		*
2007	94	490	122	431	35		82	*
2008	91	262	99	461	48	90	139	*
2009	75	207	137	376	46	85	405	*
2010	69	254	196	167	152			*
2011	82	155	290	182	103	87		*
2012	52	274	203	244	35			*
2013	106	230	371	257	72		19	*
2014	164		572	155	57	75		*
2015	248	498	405	78				*
10-year Avg.	**118**	**295**	**243**	**289**	**61**	**68**	**161**	
10-year SD	**65**	**113**	**150**	**141**	**39**	**25**	**170**	
20-year Avg.	**N.A.**	**N.A.**	**N.A.**	**354**	**61**	**68**	**161**	
20-year SD	**N.A.**	**N.A.**	**N.A.**	**171**	**N.A.**	**N.A.**	**N.A.**	

1.1.8 Participants

This section summarizes the estimated number of participants in each fishery type. The information presented here can be used in the impact analysis of potential amendments in the FEPs associated with the bottomfish and coral reef fisheries. The trend in the number of participants over time can also be used as an indicator for fishing pressure.

Calculations:

For Boat-based – estimated number of participants is calculated by using and average number of boats out fishing (check to see if we can use number of fishers instead?) per day multiplied by the numbers of dates in the calendar year by gear type. The total is a combination of weekend and weekday stratum estimates.

For Shore-based – estimated number of participants is calculated by using and average number of fishers out fishing per day multiplied by the numbers of dates in the calendar year by gear type. The total is a combination of weekend, weekday, day and night stratum estimates.

Table 13. Number of fishermen participating in the bottomfish fishery and number of gear in the boat and shore-based coral reef fishery. Cells marked with * indicates data is confidential due to less than 3 entities surveyed or reported.

Year	Bottomfish	Coral Reef BB				Coral Reef SB Fishery		
	Bottomfish	Spear	Troll	Atulai	Castnet	H&L	Spear	Castnet
1983	90							
1984	101							
1985	62							
1986	55							
1987	46							
1988	28							
1989	31							
1990	33							
1991	19							
1992	36							
1993	20							
1994	32							
1995	34							
1996	71							
1997	68							
1998	50							
1999	53							
2000	72	39	264	*	*			
2001	74	40	472	*	*			
2002	53	32	377	*	*			
2003	59	18	650	38	*			
2004	43	55	457	18	*			
2005	65	66	663	*	*	328	44	39
2006	46	65	494	27	*	1049	60	82
2007	41	98	389	16	*	815	25	53
2008	48	39	296	45	*	1202	36	84
2009	43	67	248	17	*	1155	37	38
2010	28	11	207	*	*	549	25	21
2011	32	10	207	*	*	536	23	17
2012	21	30	267	*	*	614	20	18
2013	17	14	282	14	*	429	27	12
2014	11	9	263	*	*	147		5
2015	4	*	17	*	*	72	11	4
10-year Avg.	**32**	**41**	**303**	**24**	**N.A.**	**627**	**31**	**34**
10-year SD	**18**	**31**	**167**	**13**	**N.A.**	**388**	**14**	**29**

Year	Bottomfish	Coral Reef BB				Coral Reef SB Fishery		
	Bottomfish	Spear	Troll	Atulai	Castnet	H&L	Spear	Castnet
20-year Avg.	44	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
20-year SD	20	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

1.1.9 Bycatch estimates

This section focuses on MSA § 303(a)(11), which requires that all FMPs establish a standardized reporting methodology to assess the amount and type of bycatch occurring in the fishery, and include conservation and management measures that, to the extent practicable, minimize bycatch and bycatch mortality. The MSA § 303(a)(11) standardized reporting methodology is commonly referred to as a ''Standardized Bycatch Reporting Methodology'' (SBRM) and was added to the MSA by the Sustainable Fisheries Act of 1996 (SFA). The Council implemented omnibus amendments to FMPs in 2003 to address MSA bycatch provisions and established SBRMs at that time.

Calculations:

Numbers caught = Sum of the total number of fish or invertebrates found in the raw interview (catch) data.

Numbers kept = Sum of values in the number of fish or invertebrates field from data records that are not marked as bycatch.

Numbers released = caught - kept

Coral reef fishery bycatch = Sum of the number of fish or invertebrates from data records that are marked as bycatch (unknown, alive or dead), for which the fishing methods is not trolling or bottomfishing (or for American Samoa also Troll-bottom Mix).

% bycatch should be % of numbers caught for the included gears. Need to discuss with FEPT. If coral reef is defined based on species, as opposed to by gear, the calculations may need to be adjusted.

"Total Bycatch": Sum of the number of pieces field from all data records found in the interview database (all fishing methods are counted)

Table 14. Time series of bycatch estimates in the boat-based fisheries. Percent bycatch is calculated from the numbers caught and identified as bycatch versus all caught in the fishery.

Year	Numbers caught	Kept	# ID's as bycatch	Released	% bycatch	% release
2000	3,907	3,883	24	24	0.61	0.61
2001	6,663	6,661	2	2	0.03	0.03
2002	5,789	5,775	14	14	0.24	0.24
2003	9,662	9,626	36	36	0.37	0.37
2004	7,096	7,076	20	20	0.28	0.28
2005	9,997	9,993	4	4	0.04	0.04

Year	Numbers caught	Kept	# ID's as bycatch	Released	% bycatch	% release
2006	8,606	8,601	5	5	0.06	0.06
2007	8,793	8,793	0	0	0.00	0.00
2008	5,621	5,621	0	0	0.00	0.00
2009	5,571	5,571	0	0	0.00	0.00
2010	4,936	4,936	0	0	0.00	0.00
2011	4,249	4,249	0	0	0.00	0.00
2012	4,745	4,745	0	0	0.00	0.00
2013	4,589	4,589	0	0	0.00	0.00
2014	2,808	2,808	0	0	0.00	0.00
2015	191	191	0	0	0.00	0.00
10-year Ave.	**5,464**	**5,463**	**0.82**	**0.82**	**0.01**	**0.01**
10-year SD	**2,818**	**2,817**	**1.83**	**1.83**	**0.02**	**0.02**
20-year Ave.	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**
20-year SD	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**

Table 15. Time series of bycatch estimates in the bottomfish fishery. Percent bycatch is calculated from the numbers caught and identified as bycatch versus all caught in the fishery.

Year	Numbers caught	Kept	# ID's as bycatch	Released	% bycatch	% release
2005	3,170	3,104	66	66	2.08	2.08
2006	6,015	5,987	28	28	0.47	0.47
2007	2,670	2,660	10	10	0.37	0.37
2008	7,142	7,135	7	7	0.10	0.10
2009	4,412	4,411	1	1	0.02	0.02
2010	1,839	1,839	0	0	0.00	0.00
2011	2,601	2,601	0	0	0.00	0.00
2012	1,466	1,465	1	1	0.07	0.07
2013	2,007	2,001	6	6	0.30	0.30
2014	548	548	0	0	0.00	0.00
2015	347	347	0	0	0.00	0.00
10-year Ave.	**2,929**	**2,918**	**11**	**11**	**0.31**	**0.31**
10-year SD	**2,150**	**2,144**	**20**	**20**	**0.61**	**0.61**

Year	Numbers caught	Kept	# ID's as bycatch	Released	% bycatch	% release
20-year Ave.	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**
20-yearSD	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**N.A.**

1.1.10 Number of federal permit holders

In CNMI, the following Federal permits are required for fishing in the EEZ:

1.1.10.1 Northern Mariana Island Bottomfish Permit

This permit is required for any vessel commercially fishing for, landing, or transshipping bottomfish management unit species in the EEZ around the Commonwealth of the Northern Mariana Islands (CNMI). The permit expires one year after the date of issuance.
CNMI bottomfish fishing vessels 40 feet or longer in overall length are required to carry and operate a NOAA Fisheries owned and installed vessel monitoring system (VMS) unit. Vessel operators must submit a logbook to NOAA Fisheries within 72 hours after landing. Vessel owners must mark their vessels according to CNMI or Federal regulations. Medium vessels (40 feet or longer and less than 50 feet in overall length) and large vessels (50 feet or longer in overall length) are prohibited from bottomfishing in the CNMI medium and large vessel bottomfish prohibited areas. Commercial fishing is also prohibited within the boundaries of the Islands Unit of the Marianas Trench Marine National Monument.

1.1.10.2 Special Coral Reef Ecosystem Permit

The coral reef ecosystem special permit is required for anyone fishing for coral reef ecosystem management unit species in a low-use MPA, fishing for species on the list of Potentially Harvested Coral Reef Taxa, or using fishing gear not specifically allowed in the regulations. The permit expires one year after the date of issuance. Permit holder must submit a logbook to NOAA Fisheries within 30 days of each landing of coral reef harvest.

A transshipment permit is required for any receiving vessel used to land or transship potentially harvested coral reef taxa, or any coral reef ecosystem management unit species caught in a low-use MPA. Exceptions to this permit requirement are made for anyone issued a permit to fish under the other western Pacific fishery management plans (pelagic, bottomfish and seamount groundfish, crustacean, or precious corals) who catch coral reef management unit species incidentally while fishing for the management unit species covered by the permit they possess. Permit holders must submit a logbook to NOAA Fisheries within 7 days following the date the vessel arrived in port to land transshipped fish. Regulations governing this fishery can be found in the Code of Federal Regulations, Title 50, Part 665.

Note: The estimates were not available for this report but will be included in next year's report.

Table 16. Number of federal permits holders over time

Year	**Coral reef**	**Bottomfish**
Start year		

Year	**Coral reef**	**Bottomfish**
2014		
10-year Avg.?		
20-year Avg.?		

1.1.11 Status Determination Criteria

1.1.11.1 Bottomfish Fishery

Overfishing criteria and control rules are specified and applied to individual species within the multi-species stock whenever possible. When this is not possible, they are based on an indicator species for the multi-species stock. It is important to recognize that individual species would be affected differently based on this type of control rule, and it is important that for any given species fishing, mortality does not currently exceed a level that would result in excessive depletion of that species. No indicator species are being used for the bottomfish multi-species stock complexes and the coral reef species complex. Instead, the control rules are applied to each stock complex as a whole.

The MSY control rule is used as the maximum fishing mortality threshold (MFMT). The MFMT and minimum stock size threshold (MSST) are specified based on recommendations in 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.

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 17.

Table 17. Overfishing threshold specifications for the bottomfish management unit species in CNMI

MFMT	**MSST**	$\mathbf{B_{FLAG}}$
$F(B) = \frac{F_{MSY} B}{c\, B_{MSY}}$ for $B \le c\, B_{MSY}$ $F(B) = F_{MSY}$ for $B > c\, B_{MSY}$	$c\, B_{MSY}$	B_{MSY}
where c = max (1-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 (SSB_{Pt}) to a given reference level (SSB_{PREF}) 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 SSB_{Pt}/SSB_{PREF}, 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 SSB_{PRMIN}. 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 18. Again, E_{MSY} is used as a proxy for F_{MSY}.

Table 18. Rebuilding control rules for the bottomfish management unit species in CNMI

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

1.1.11.2 Coral Reef Fishery

Available biological and fishery data are poor for all coral reef ecosystem management unit species in the Mariana Islands. 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 can 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.

Individual species that are 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 depletion.

For the coral reef fishery, 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 are used to evaluate the status of individual MUS stocks in order to prevent recruitment overfishing. When better data and the appropriate multi-species stock assessment methodologies become available, all stocks will be evaluated independently, without proxy.

Establishing Reference Point Values

Standardized values of catch per unit effort (CPUE) and effort (E) are used to establish limit and reference point values, which act as proxies for relative biomass and fishing mortality, respectively. Limits and reference points are calculated in terms of $CPUE_{MSY}$ and E_{MSY} included in Table 19.

Table 19. Status determination criteria for the coral reef management unit species using CPUE based proxies

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

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

1.1.11.3 Current Stock Status

1.1.11.3.1 Bottomfish

Biological and other fishery data are poor for all bottomfish species in the Mariana Archipelago. 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 most recent stock assessment update (Yau et al. 2015) for the CNMI bottomfish management unit species complex (comprised of 17 species of shallow and deep species of snapper, grouper, jacks, and emperors) was based on estimate of total catch, an abundance index derived from the nominal CPUE generated from the creel surveys, and a fishery independent point estimate of MSY from the Our Living Oceans Report (Humphreys and Moffitt 1999, Moffitt & Humphreys 2009). The assessment utilized a state-space surplus production model with explicit process and observation error terms (Meyer and Millar 1999). Determinations of overfishing and overfished status can then be made by comparing current biomass and harvest rates to MSY level reference points. To date, the CNMI BMUS is not subject to overfishing and is not overfished (Table 20).

Table 20. Stock assessment parameters for the CNMI BMUS complex (Yau et al 2015)

Parameter	Value	Notes	Status
MSY	173.1 ± 32.19	Expressed in 1000 lbs (± std error)	

Parameter	Value	Notes	Status
H_{2013}	0.022	Expressed in percentage	
H_{MSY}	0.261 ± 0.063	Expressed in percentage (± std error)	
H/H_{MSY}	0.088		No overfishing occurring
B_{2013}	1,262	Expressed in thousand pounds	
B_{MSY}	683.5 ± 126.7	Expressed in 1000 lbs (± std error)	
B/B_{MSY}	1.85		Not overfished

1.1.11.3.2 Coral reef

The application of the SDCs for the management unit species in the coral reef fisheries is limited due to various challenges. First, the thousands of species included in the coral reef MUS makes the SDC and status determination impractical. Second, the CPUE derived from the creel survey is based on the fishing method and there is no species-specific CPUE information available. In order to allocate the fishing method level CPUE to individual species, the catch data (the value of catch is derived from CPUE hence there is collinearity) will have to be identified to species level and CPUE will be parsed out by species composition. The third challenge is that there is very little species level identification applied to the creel surveys. There has been no attempt to estimate MSY for the coral reef MUS until the 2007 re-authorization of MSA that requires the Council to specify ACLs for species in the FEPs.

For ACL specification purposes, MSYs in the coral reef fisheries are determined by using the Biomass-Augmented Catch-MSY approach (Sabater and Kleiber 2014). This method estimates MSY using plausible combination rates of population increase (denoted by r) and carrying capacity (denoted by k) assumed from the catch time series, resilience characteristics (from FishBase), and biomass from existing underwater census surveys done by the Pacific Island Fisheries Science Center. This method was applied to species complexes grouped by taxonomic families. The most recent MSY estimates are found in Table 21. The SSC utilized the MSYs for the coral reef MUS complexes as the OFLs.

Table 21. Best available MSY estimates for the coral reef MUS in CNMI

Coral Reef MUS Complex	MSY (lbs)
Selar crumenophthalmus – atulai or bigeye scad	122,500
Acanthuridae – surgeonfish	361,200
Carangidae – jacks	55,300
Crustaceans – crabs	9,100
Holocentridae – squirrelfish	78,500
Kyphosidae – chubs/rudderfish	29,500
Labridae – wrasses[1]	73,500
Lethrinidae – emperors	69,700
Lutjanidae – snappers	225,800
Mollusks – turbo snail; octopus; giant clams	16,700
Mugilidae – mullets	7,700
Mullidae – goatfish	31,000
Scaridae – parrotfish[2]	189,900
Serranidae – groupers	110,300
Siganidae – rabbitfish	12,000

Coral Reef MUS Complex	**MSY (lbs)**
All Other CREMUS Combined - Other CRE-finfish - Other invertebrates - Misc. bottomfish - Misc. reef fish - Misc. shallow bottomfish	14,500
Cheilinus undulatus – humphead (Napoleon) wrasse	N.A.
Bolbometopon muricatum – bumphead parrotfish	N.A.
Carcharhinidae – reef sharks	N.A.

1.1.12 Overfishing Limit, Acceptable Biological Catch, and Annual Catch Limits

1.1.12.1 Brief description of the ACL process

The Council developed a Tiered system of control rules to guide the specification of ACLs and Accountability Measures (AMs) (WPRFMC 2011). The process starts with the use of the best scientific information available (BSIA) in the form of, but not limited to, stock assessments, published paper, reports, or available data. These information are classified to the different Tiers in the control rule ranging from Tier 1 (most information available typically an assessment) to Tier 5 (catch-only information). The control rules are applied to the BSIA. Tiers 1 to 3 would involve conducting a Risk of Overfishing Analysis (denoted by P*) to quantify the scientific uncertainties around the assessment to specify the Acceptable Biological Catch (ABC). This would lower the ABC from the OFL (MSY-based). A Social, Ecological, Economic, and Management (SEEM) Uncertainty Analysis is performed to quantify the uncertainties from the SEEM factors. The buffer is used to lower the ACL from the ABC. For Tier 4 which are stocks with MSY estimates but no active fisheries, the control rule is 91% of MSY. For Tier 5 which has catch only information, the control rule is a third reduction in the median catch depending on the qualitative evaluation on what the stock status is based on expert opinion. ACL specification can choose from a variety of method including the above mentioned SEEM analysis or a percentage buffer (% reduction from ABC based on expert opinion) or the use of an Annual Catch Target. Specifications are done on an annual basis but the Council normally specifies a multi-year specification.

The Accountability Measure for the coral reef and bottomfish fisheries in CNMI is an overage adjustment. The ACL is downward adjusted with the amount of overage from the ACL based on a three year running average.

1.1.12.2 Current OFL, ABC, ACL, and recent catch

The most recent multiyear specification of OFL, ABC, and ACL for the coral reef fishery was completed in the 160th Council meeting on June 25 to 27, 2014. The specification covers fishing year 2015, 2016, 2017, and 2018 for the coral reef MUS complexes. A P* and SEEM analysis was performed for this multiyear specification (NMFS 2015). For the bottomfish, it was a roll over from the previous specification since an assessment update was not available for fishing year 2015.

Table 22. Mariana Archipelago – CNMI ACL table with 2015 catch (values are in pounds)

Fishery	**MUS**	**OFL**	**ABC**	**ACL**	**Catch**
Bottomfish	Bottomfish multi-species complex	293,000	228,000	228,000	13,149

Crustacean	Deepwater shrimp	N.A.	275,570	275,570	NAF
	Spiny lobster	9,600	7,800	7,410	473
	Slipper lobster	N.A.	60	60	0
	Kona crab	N.A.	6,300	6,300	NAF
Precious coral	Black coral	8,250	2,100	2,100	NAF
	Precious coral in CNMI expl. area	N.A.	2,205	2,205	NAF
Coral Reef	*Selar crumenophthalmus*	122,500	89,400	77,400	2,999
	Acanthuridae-surgeonfish	361,200	324,600	302,600	5,079
	Carangidae-jacks	55,300	47,400	44,900	6,243
	Crustaceans-crabs	9,100	5,300	4,400	0
	Holocentridae-squirrelfish	78,500	69,300	66,100	367
	Kyphosidae-rudderfish	29,500	24,600	22,700	1,226
	Labridae-wrasse	73,500	59,900	55,100	357
	Lethrinidae-emperors	69,700	58,200	53,700	13,718
	Lutjanidae-snappers	225,800	202,700	190,400	1,683
	Mollusk-turbo snails; octopus; clams	16,700	11,600	9,800	72
	Mugilidae-mullets	7,700	5,300	4,500	402
	Mullidae-goatfish	31,000	29,200	28,400	2,547
	Scaridae-parrotfish	189,900	157,300	144,000	1,650
	Serranidae-groupers	110,300	92,800	86,900	1,034
	Siganidae-rabbitfish	12,000	10,400	10,200	1,166
	All other CREMUS combined	14,500	8,500	7,300	1,236
	Cheilinus undulatus	N.A.	2,009	2,009	24
	Bolbometopon muricatum	N.A.	797	797*	0
	Carcharhinidae-reef sharks	N.A.	5,600	5,600	0

NOTE: *The ACL for *B. muricatum* is shared with Guam (1 ACL for the whole archipelago)

The catch shown in Table 22 takes the average of the recent three years as recommended by the Council at its 160th meeting to avoid large fluctuations in catch due to data quality and outliers. NAF indicates no active fisheries as of date.

1.1.13 Best scientific information available

1.1.13.1 Bottomfish fishery

1.1.13.1.1 Stock assessment benchmark

The benchmark stock assessment for the Territory Bottomfish Management Unit Species complex was developed and finalized in October 2007 (Moffitt et al. 2007). This benchmark utilized a Bayesian statistical framework to estimate parameters of a Schaefer model fit to a time series of annual CPUE statistics. The surplus production model included process error in biomass production dynamics and observation error in the CPUE data. This was an improvement to the previous approach of using index-based proxies for B_{MSY} and F_{MSY}. Best available information for the bottomfish stock assessment is as follows:

Input data: The CPUE and catch data used were from the Guam off-shore creel survey. The catch and CPUE were expanded on annual level. CPUE was expressed in line-hours. The data was screened for trips that landed more than 50% BMUS species using the handline gear.

Model: state-space model with explicit process and observation error terms (see Meyer and Millar, 1999).

Fishery independent source for biomass: point estimate of MSY from the Our Living Oceans Report (Humphreys and Moffitt 1999, Moffitt & Humphreys 2009)

1.1.13.1.2 Stock assessment updates

Updates to the 2007 benchmark done in 2012 (Brodziak et al. 2012) and 2015 (Yau et al. 2015). These included a 2-year stock projection table used for selecting the level of risk the fishery will be managed under ACLs. Yau et al. (2015) is considered the best scientific information available for the Territory bottomfish MUS complex after undergoing a WPSAR Tier 3 panel review (Franklin et al. 2015). This was the basis for the P* analysis and SEEM analysis the determined the risk levels to specify ABCs and ACLs.

1.1.13.1.3 Other information available

Approximately every five years PIFSC administers a socioeconomic survey to small boat fishermen in CNMI. This survey consists of about 60 questions regarding a variety of topics, including fishing experiences, market participation, vessels and gear, demographics and household income, and fishermen perspectives. The survey requests participants to identify which MUS they primarily targeted during the previous 12 months, by percentage of trips. Full reports of these surveys can be found at the PIFSC Socioeconomics webpage (Hospital and Beavers 2011)

1.1.13.2 Coral reef fishery

1.1.13.2.1 Stock assessment benchmark

No stock assessment has been generated for the coral reef fisheries. The SDCs using index-based proxies were tested for its applicability in the different MUS in the coral reef fisheries (Hawhee 2007). This analysis was done on a gear level. It paints a dire situation for the shore-based fishery with 43% of the gear/species combination fell below B_{flag} and 33% below MSST with most catch and CPUE trends showing a decline over time. The off-shore fisheries were shown to be less dire with 50% of the gear/species combination fell below B_{flag} and 38% below MSST but the catch and CPUE trends were increasing over time. The inconsistency in the CPUE and catch trends with the SDC results makes this type of assessment to be unreliable.

The first attempt to use a model based approach in assessing the coral reef MUS complexes was done in 2014 using a biomass-based population dynamics model (Sabater and Kleiber 2014). This model was based on the original Martell and Froese (2012) model but was augmented with biomass information to relax the assumption behind carrying capacity. It estimates MSY based on a range of rate of population growth (*r*) and carrying capacity (K) values. The best available information for the coral reef stock assessment is as follows:

Input data: The catch data was derived from the inshore and off-shore creel surveys. Commercial receipt book information was also used in combination of the creel data. A downward adjustment was done to address for potential overlap due to double reporting.

Model: Biomass Augmented Catch MSY approach based on the original catch-MSY model (Martell and Froese 2012; Sabater and Kleiber 2014).

Fishery independent source for biomass: biomass density from the Rapid Assessment and Monitoring Program of NMFS-CRED was expanded to the hard bottom habitat from 0-30 m (Williams 2010).

This model had undergone a CIE review in 2014 (Cook 2014; Haddon 2014; Jones 2014). This was the basis for the P* analysis that determined the risk levels to specify ABCs

1.1.13.2.2 Stock assessment updates

No updates available for the coral reef MUS complex. However, NMFS-PIFSC is finalizing a length-based model for estimating sustainable yield levels and various biological reference points (Nadon et al. 2015). This can be used on a species level. The Council is also working with a contractor to enhance the BAC-MSY model to incorporate catch, biomass, CPUE, effort, length-based information in an integrated framework (Martell 2015)

1.1.13.2.3 Other information available

Approximately every five years PIFSC administers a socioeconomic survey to small boat fishermen in CNMI. This survey consists of about 60 questions regarding a variety of topics, including fishing experiences, market participation, vessels and gear, demographics and household income, and fishermen perspectives. The survey requests participants to identify which MUS they primarily targeted during the previous 12 months, by percentage of trips. Full reports of these surveys can be found at the PIFSC Socioeconomics webpage (Hospital and Beavers 2011).

PIFSC and the Council conducted a workshop with various stakeholders in CNMI to identify factors and quantify uncertainties associated with the social, economic, ecological, and management of the coral reef fisheries (Sievanen and McCaskey 2014). This was the basis for the SEEM analysis that determined the risk levels to specify ACLs.

1.1.14 Harvest capacity and extent

The MSA defines the term “optimum,” with respect to the yield from a fishery, as the amount of fish which:

- 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.
- is prescribed on the basis of the MSY from the fishery, as reduced by any relevant social, economic, or ecological factor.
- in the case of an overfished fishery, provides for rebuilding to a level consistent with producing the MSY in such fishery [50 CFR §600.310(f)(1)(i)].

Optimum yield in the coral reef and bottomfish fisheries is prescribed based on the MSY from the stock assessment and the best available scientific information. In the process of specifying ACLs, social, economic, and ecological factors were considered and the uncertainties around those factors defined the management uncertainty buffer between the ABC and ACL. OY for the bottomfish and coral reef fish MUS complexes is defined to be the level of harvest equal to the ACL consistent with the goals and objectives of the Fishery Ecosystem Plans and used by the Council to manage the stock.

The Council recognizes that MSY and OY are long term values whereas the ACLs are yearly snapshots based on the level of fishing mortality at F_{MSY}. There are situations when the long-term means around MSY are going to be lower than ACLs especially if the stock is known to be productive or relatively pristine or lightly fished. One can have catch levels and catch rates exceeding that of MSY over short-term enough to lower the biomass to a level around the estimated MSY and still not jeopardize the stock. In this situation is true for the territory bottomfish multi-species complex.

The harvest extent, in this case, is defined as the level of catch harvested in a fishing year relative to the ACL or OY. The harvest capacity is the level of catch remaining in the annual catch limit that can potentially be used for the total allowable level of foreign fishing (TALFF). Table 23 summarizes the harvest extent and harvest capacity information for CNMI in 2015

Table 23. Mariana Archipelago – CNMI proportion of harvest extent (values are in percentage), defined as the proportion of fishing year landing relative to the ACL or OY, and the harvest capacity, defined as the remaining portion of the ACL or OY that can potentially be harvested in a given fishing year.

Fishery	MUS	ACL	Catch	Harvest extent (%)	Harvest capacity (%)
Bottomfish	Bottomfish multi-species complex	228,000	13,149	5.8	94.2
Crustacean	Deepwater shrimp	275,570	NAF		
	Spiny lobster	7,410	473	6.4	93.6
	Slipper lobster	60	0	0.0	100.0
	Kona crab	6,300	NAF		
Precious coral	Black coral	2,100	NAF		
	Precious coral in CNMI expl. area	2,205	NAF		
Coral Reef	*Selar crumenophthalmus*	77,400	2,999	3.9	96.1
	Acanthuridae-surgeonfish	302,600	5,079	1.7	98.3
	Carangidae-jacks	44,900	6,243	13.9	86.1
	Crustaceans-crabs	4,400	0	0.0	100.0
	Holocentridae-squirrelfish	66,100	367	0.6	99.4
	Kyphosidae-rudderfish	22,700	1,226	5.4	94.6
	Labridae-wrasse	55,100	357	0.6	99.4
	Lethrinidae-emperors	53,700	13,718	25.5	74.5
	Lutjanidae-snappers	190,400	1,683	0.9	99.1
	Mollusk-turbo snails; octopus; clams	9,800	72	0.7	99.3
	Mugilidae-mullets	4,500	402	8.9	91.1
	Mullidae-goatfish	28,400	2,547	9.0	91.0
	Scaridae-parrotfish	144,000	1,650	1.1	98.9
	Serranidae-groupers	86,900	1,034	1.2	98.8
	Siganidae-rabbitfish	10,200	1,166	11.4	88.6
	All other CREMUS combined	7,300	1,236	16.9	83.1
	Cheilinus undulatus	2,009	24	1.2	98.8
	Bolbometopon muricatum	797	0	0.0	100.0
	Carcharhinidae-reef sharks	5,600	0	0.0	100.0

1.1.15 Administrative and Regulatory Actions

This summary describes management actions PIRO has taken since the April 2015 Joint FEP Plan Team meeting, as reported to the 163rd to 165th Western Pacific Fishery Management Council meetings held June 2015, October 2015, and March 2016.

On August 31, 2015, NMFS published a final rule to implement annual catch limits for 2015 Pacific Island bottomfish, crustacean, precious coral, and coral reef ecosystem fisheries, and accountability measures to correct or mitigate any overages of catch limits (80 FR 52415). The catch limits and accountability measures.

On October 9, 2015, NMFS specified a limit of 2,000 mt of longline-caught bigeye tuna for the Commonwealth of the Northern Mariana Islands (CNMI), and allowed the CNMI to allocate up to 1,000 mt to U.S. longline fishing vessels in a specified fishing agreement (80 FR 61767, October 14, 2015). The Governor of the CNMI immediately transmitted a specified fishing agreement that NMFS determined met the criteria set forth at 50 CFR 665.819. NMFS began attributing bigeye tuna caught by those vessels to the CNMI starting on October 9, 2015. Between October 9, 2015 and November 24, 2015, vessels identified in the CNMI agreement harvested the full 1,000-mt allocation.

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1.2 Guam Fishery Descriptions

1.2.1.1 Bottomfish Fishery

Bottomfishing on Guam is a combination of recreational, subsistence, and small-scale commercial fishing. It can be separated into two distinct fisheries separated by depth and species composition. The shallow water complex (<500 feet) makes up the largest portion of the total bottomfish effort and harvest and is comprised primarily of reef-dwelling snappers of the genera *Lutjanus*, *Aphareus*, and *Aprion*, groupers of the genera *Epinephelus*, *Variola*, and *Cephalopholis*, jacks of the genera *Caranx* and *Carangoides*, *Holocentrids* (*Myripristis* spp. and *Sargocentron* spp.), emperors of the genera *Lethrinus*, and *Gymnocranius*, and Dogtooth Tuna (*Gymnosarda unicolor*). The deep water complex (>500 feet) consists primarily of groupers of the genera *Hyporthodus* and *Cephalopholis*, jacks of the genera *Caranx* and *Seriola*, and snappers of the genera *Pristipomoides*, *Etelis*, and *Aphareus*. In recent years, deep water species have made up a significant portion of the expanded bottomfishing catch.

The majority of people in this fishery are either subsistence or part-time commercial, operate boats less than 25 feet in length, target primarily the shallow water bottomfish complex It is not uncommon to intercept fishermen combining bottomfishing with other methods such as trolling, spearing, and jigging to maximize their catch. The high demand for reef fish and bottomfish has made it profitable to sell locally caught bottomfish, although overhead costs such as fuel and gear may be significant factors for in determining a fisherman's selection of fishing method. The demand for local bottomfish, when combined with environmental pressures, however, may be stressing local bottomfish stocks.

The majority of bottom fishing around Guam takes place on offshore banks. 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 are generally fished only 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.

Species commonly taken in the shallow bottom fishery of Guam:

Aphareus furca
Aprion virescens
Lutjanus kasmira, L. fulvus
Carangoides orthogrammus
Caranx lugubris, C. melampygus, C. ignobilis
Selar crumenophthalmus
Cephalopholis argus, C. spiloparaea, C. urodeta
Epinephelus fasciatus
Gymnocranius spp.
Lethrinus atkinsoni, L. erythracanthus, L. olivaceus, L. rubrioperculatus,
L. xanthochilus
Gymnosarda unicolor
Sargocentron spp.
Myripristis spp.
Variola albimarginata, V. louti

Species taken in the deep bottom fishery of Guam:
Aphareus rutilans
Aprion virescens
Caranx lugubris
Seriola dumerilii
Cephalopholis igarashiensis, C. sonnerati
Hyporthodus octofasciatus
Etelis carbunculus, E. coruscans
Pristipimoides spp.

1.2.1.2 Coral Reef Fishery

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 members of the families Acanthuridae, Carangidae, Gerreidae, Holocentridae, Kyphosidae, Labridae, Lethrinidae, Lutjanidae, Mugilidae, Mullidae, Scaridae, and Siganidae (Hensley and Sherwood 1993). There are several pulse fisheries for juvenile fish that can be major components of the coral reef fishery, but totals in these can vary year to year . These include juvenile rabbitfish (manahak and lesso'), juvenile jacks (i'e), and juvenile goatfish (ti'ao).
Common species in the coral reef fishery include:

Naso unicornis, N. lituratus
Acanthurus xanthopterus, A. lineatus, A. triostegus
Caranx melampygus, C. papuensis, i'e
Selar crumenophthalmus

Gerres acinaces
Myripristis spp.
Sargocentron spp.
Neoniphon spp.
Kyphosus cinerascens, K. vaigiensis
Cheilinus undulatus, *Cheilinus* spp., *Halichoeres* spp.
Lethrinus harak, L. obseletus, L. atkinsoni, Gnathodentex aurolineatus
Lutjanus fulvus, L. monostigma, L. bohar, L. argentimaculatus
Mulloidichthys flavolineatus, M. vanicolensis, ti'ao
Parupeneus multifasciatus, P. barberinus, P. cyclostomus
Ellechelon vaigiensis, Moolgarda engeli, M. seheli
Chlorurus spilurus, C. frontalis,
Scarus psittacus, S. altipinnis, S. rubrioviolaceus, S. ghobban, S. schlegeli
Siganus spinus, S. argenteus, manahak, lesso

Hook and line is the most common method of fishing for coral reef fish on Guam, accounting for around 70% of fishers and gear. Throw net (talaya) is the second most common method, accounting for about 15% of fishers and gear. Other methods include gill net, snorkel spearfishing, SCUBA spearfishing, surround net, drag net, hooks and gaffs, and gleaning.

1.2.2 Fishery Data Collection System

Guam currently has four fishery dependent collection programs which can be described as long-term data collection programs with different approaches for collecting important information on fishery collection methods performed by fishermen. The four programs are the offshore data program, the inshore data program, the commercial fishery program, and the volunteer program. Sportfish Restoration Grant from the US Fish and Wildlife Service provides the significant portion of the funding for these programs. Training of the fishery staff to collect information is rigorous, and year end totals are calculated by an expansion process done with in collaboration with NOAA's Pacific Islands Fishery Science Center (PIFSC). Identification of fish to the species level is the goal of Guam's fishery staff.

The offshore and inshore programs, boat and shore-based creel survey respectively, are long term programs that collect participation, effort, and catch data from fishermen. Collaboration with PIFSC has resulted in a reproducible computer database program that can analyze the data to produce various types of trends that describe status of the various fisheries, both charter and non-charter, in federal and local waters. The volunteer data collection program's goal was to obtain volunteer data from fishermen; however, information for this program was minimal. The commercial receipt book program is an important source of information for fish that enter the commercial market; however, obtaining information from dealers has been sporadic, with less than three (3) dealers throughout the time series providing data. In order to improve this situation, the Council, DAWR and PIFSC partnered to increase vendor participation in the data collection program through the Territory Science Initiative. Extensive training, follow-ups, education, and outreach efforts were conducted to vendors and fishermen to increase participation in data collection.

Oram et al (in press) describes the fishery data collection process for the offshore and inshore programs. In general, DAWR staff collects fishery information through a series of random-stratified surveys for participation (accounts for fishing effort) and catch interviews (accounts for catch composition, size frequency, and catch-per-unit effort). These data are transcribed into the WPacFIN database and the annual catch estimates are expanded from the effort and CPUE information. Monthly commercial vendor reports are tallied at the end of the year and adjusted based on the coverage estimates provided by the vendor themselves or the data collection program staff.

1.2.3 Meta-data Dashboard Statistics

The meta-data dashboard statistics describe the amount of information used or data available to calculate the fishery-dependent information. Creel surveys are sampling based system that requires random-stratified design applied to pre-scheduled surveys. The creel surveys are comprised of: 1) participation run that captures effort and participation estimates and; 2) catch interviews that capture catch, effort, CPUE information, catch composition, size-weight information. The number of sampling days, participation runs, and catch interviews would determine if there are sufficient samples to run the expansion algorithm. The trends of these parameters over time that may infer survey performance. Monitoring the survey performance is critical for explaining the reliability of the expanded information.

Commercial receipt book information depends on the amount of invoices submitted and the number of vendors participating in the program. Fluctuations in these meta-data affect the commercial landing and revenue estimates.

1.2.3.1 Creel surveys meta-data statistics

Calculations: Shore-based data

Interview Days: This is the number of actual days that Creel Survey Data were collected. It’s a count of the number of unique dates found in the interview sampling data (the actual sampling date data, include opportunistic interviews).

Participation Runs: Count of the number of unique occurrences of the combination of survey date and run number in the participation detail data.

Catch Interviews: Count of the number of unique occurrences of the combination of date and run number in the participation detail data/ count of unique surveyor initials and date in PAR. This is divided into two categories, interviews conducted during a complete survey (Regular), and opportunistic interviews (Opp) which are completed on days when the whole survey is not conducted.

Calculation: Boat-based data

Sample days: Count of the total number of unique dates found in the boatlog data sampling date data.

Catch Interviews: Count of the total number of data records found in the interview header data (number of interview headers). This is divided into two categories, interviews conducted during a complete survey (Regular), and opportunistic interviews (Opp) which are completed on days when the whole survey is not conducted.

Table 24. Summary of creel survey meta-data describing survey performance parameters with potential influence on the creel survey expansion.

Year	Shore-based			Boat-based	
	# sample days	# participation runs	# catch interviews	# sample days	# catch interviews
1980			2		
1981			23		
1982			1	46	23
1983			56	47	1
1984	12	23	367	54	56
1985	48	78	291	66	367
1986	48	74	245	49	291
1987	47	62	280	48	245
1988	48	62	297	51	280
1989	47	63	485	60	297
1990	48	62	497	60	485
1991	48	54	611	60	497
1992	46	55	598	60	611
1993	48	48	702	61	598
1994	48	48	764	69	702
1995	48	49	679	96	764
1996	48	53	915	96	679
1997	48	67	880	96	915
1998	48	73	940	96	880
1999	48	68	791	96	940
2000	48	84	753	96	791
2001	48	96	443	96	753
2002	50	94	528	84	443
2003	55	96	372	79	528
2004	48	93	374	96	372
2005	48	96	300	97	374
2006	48	96	361	96	300
2007	48	96	282	96	361
2008	48	96	322	96	282
2009	48	94	299	96	322
2010	48	94	250	96	299
2011	48	96	272	96	250
2012	46	92	257	96	272
2013	48	94	227	96	257
2014	96	92	325	90	227
2015	81	96	2	95	325
10-year Ave.	**55**	**95**	**263**	**95**	**297**
10-year SD	**17**	**2**	**95**	**2**	**46**
20-year Ave.	**52**	**86**	**456**	**94**	**492**
20-year SD	**12**	**15**	**264**	**5**	**250**

1.2.3.2 Commercial receipt book statistics

Calculations:

# of Vendors – Count of the number of unique buyer codes found in the commercial purchase header data.

Invoices – Count of the number of unique invoice numbers found in the commercial header

data.

Table 25. Summary of commercial receipt book meta-data describing reporting performance parameters with potential influence on total commercial landing estimates (Note: Data will be reported only for years with ≥ 3 vendors reporting).

Year	Number of vendors	Number of invoices
2000	3	3,868
2001	3	4,155
2002	3	3,498
2003	2	*
2004	3	3,107
2005	3	2,649
2006	4	2,589
2007	2	*
2008	1	*
2009	1	*
2010	2	*
2011	2	*
2012	1	*
2013	1	*
2014	8	1,355
2015	8	1,268
10-year Ave.	**3**	**1,965**
10-year SD	**3**	**756**
20-year Ave.	**N.A.**	**N.A.**
20-year SD	**N.A.**	**N.A.**

1.2.4 Fishery Summary Dashboard Statistics

The Fishery Summary Dashboard Statics section consolidates all fishery dependent information comparing the most recent year with the short-term (recent 10 years) and long-term (recent 20 years). The summary dashboard shows the most current year value the difference between the current year value with the 10-year average and the 20-year average (shown bolded in [brackets]). Trend analysis of the past 10 or 20 years will dictate the trends (increasing, decreasing, or no trend). The right most symbol indicates whether the mean of the short-term and long-term years were greater than, less than, or within the standard deviation of the mean of the full time series.

Legend Key:

- *increasing trend in the time series*
- *greater than standard deviation*
- *decreasing trend in the time series*
- *less than standard deviation*
- *no trend in the time series*
- *within standard deviation*

10,000 [**1,000**] – *point estimate of fishery statistic* [***difference from short/long term average***]

Table 26. Annual indicators for the coral reef and bottomfish fishery describing fishery performance comparing current estimates with the short-term (10 years) and the long-term (20 years) average.

Fishery	Fishery statistics	Short-term (recent 10 years)	Long-term (20 years)
Bottomfish	**Estimated catch (lbs)**		
All species caught in the BF gear	Boat and shore creel data estimated (expanded) total lbs (all BF trips)	50,792**[-21,995]**	50,792**[-47,209]**
	Estimated total lbs (all species) commercial purchase data	4,353**[-8,322]**	4,353**[-10,887]**
Bottomfish management unit species only	Total creel data Estimated (expanded) total lbs (all BF trips)	13,664**[-18,280]**	13,664**[-23,752]**
	Estimated total lbs (all species) commercial purchase data	1,171**[-4,667]**	1,171**[-4,878]**
	Catch-per-unit effort (lbs/gear-hrs)		
	CPUE (creel data only)	3.3**[-1.9]**	3.3**[1.3]**
	Fishing effort *(only available for creel data)*		
	Estimated (expanded) total bottomfish # of trips	2,130**[-809]**	2,130**[-2,768]**
	Fishing participants		
	Estimated total # of boats that went bottomfishing	224**[-59]**	224**[102]**
	Bycatch		
	Total number of bycatch caught	1,420**[-1,380]**	NA
	# bycatch released	70**[-16]**	NA
	# bycatch kept	1,350**[-1,365]**	NA
	Federal permits		
	# federal permit holders (PIRO)		
Coral Reef	**Estimated catch (lbs all gears)**		

	Boat-based creel data (expanded estimate all gears, defined by a list of species?)	127,283**[47,639]**	127,283**[14,945]**
	Shore-based creel (expanded estimate all gears, defined by a list of species?)	104,198**[-22,788]**	104,198**[-95,396]**
	Commercial Purchase	33,155**[-173,475]**	33,155**[-278,777]**
	Catch-per-unit-effort (lbs/gear-hrs)		
	BB spear	1.6**[-0.9]**	1.6**[-0.8]**
	BB SCUBA	1.4**[-5.8]**	1.4**[6.7]**
	BB Gillnet	No 2015 estimate	No 2015 estimate
	BB Troll	0.13**[-0.01]**	0.13**[-0.04]**
	SB H&L	0.05**[-0.01]**	0.05**[0.00]**
	SB Throw/cast	0.11**[0.01]**	0.11**[0.01]**
	SB Gillnet	0.14**[-0.11]**	0.14**[-0.07]**
	SB Spear	0.96**[0.79]**	0.96**[0.69]**
	SB H&G	0.7**[0.01]**	0.7**[0.03]**
	Fishing effort (# of gear-hours by gear type)		
	BB spear	3,095**[572]**	3,095**[-552]**
	BB SCUBA	1,330**[349]**	3,095**[-42]**
	BB Gillnet	No 2015 estimate	No 2015 estimate
	BB Troll	62,751**[22,004]**	62,751**[16,672]**
	SB H&L	58,879**[-68,489]**	58,879**[-103,949]**
	SB Throw/cast	14,385**[-14,491]**	14,385**[-17,772]**
	SB Gillnet	7,536**[-3,169]**	7,536**[-6,171]**
	SB Spear	10,582**[-1,669]**	10,582**[-4,945]**
	SB H&G	2,516**[-2,525]**	2,516**[-3,019]**
	Fishing participants (# of gear)		
	BB spear	85**[30]**	85**[5]**
	BB SCUBA	Confidential	Confidential
	SB H&L	20**[-400]**	20**[-610]**
	SB Throw/cast	58**[-10]**	58**[-30]**

	SB Gillnet	46**[19]**	46**[-25]**
	SB Spear	45**[24]**	45**[-4]**
	SB H&G	12**[4]**	12**[-1]**
	Bycatch		
	Total number of bycatch caught		
	# bycatch released		
	# bycatch kept		
	Federal permits		
	# federal permit holders (PIRO)		

1.2.5 Catch statistics

This section summarizes the catch statistics for the bottomfish and coral reef fishery in Guam. Estimates of catch are summarized from the creel survey and commercial receipt book data collection programs. Catch statistics provide estimates of annual harvest from the different fisheries. Estimates of fishery removals can provide proxies for the level of fishing mortality and a reference level relative to established quotas. This section also provides detailed level of catch for fishing methods and the top species complex harvested in the coral reef and bottomfish fishery.

1.2.5.1 Catch by data stream

This describes the estimated total catch from the shore and boat-based creel survey program and the commercial landing from the commercial receipt book system. The difference between the creel total and the commercial landing is assumed to be the non-commercial component. However, there are cases where the commercial landing may be higher than the estimated creel total of the commercial receipt book program is able to capture the fishery better than the creel survey (e.g. night time spearfishing)

Calculations: Estimated landings are based on a pre-determined list of species (Appendix 3) identified as the BF Species Complex regardless of the gear used, for each data collection (shore-based creel, boat-based creel and the commercial purchase reports).

Table 27. Summary catch time series of the ALL SPECIES caught using the bottomfishing gear: estimated lbs (expanded) from the boat and shore-based creel surveys and estimated total lbs from the commercial purchase system

Year	**Creel survey Estimates**		**Creel Total**	**Commercial landings**
	Shore-based	**Boat-based**		
1982		40,318	40,318	6,947
1983		47,489	47,489	36,984
1984		57,659	57,659	23,291
1985	17,930	88,881	106,811	28,028
1986	12,843	39,509	52,352	12,110
1987	11,753	46,492	58,245	12,639
1988	15,348	72,891	88,239	15,933
1989	6,981	85,800	92,781	19,630
1990	8,258	155,452	163,710	18,916
1991	11,094	71,192	82,286	11,278

Year	Creel survey Estimates		Creel Total	Commercial landings
	Shore-based	Boat-based		
1992	10,707	86,120	96,827	10,668
1993	7,213	97,880	105,093	10,191
1994	7,750	108,648	116,398	30,356
1995	10,581	106,139	116,720	13,815
1996	7,381	153,236	160,617	7,389
1997	9,435	105,046	114,481	10,621
1998	14,202	101,829	116,031	14,737
1999	18,661	132,449	151,110	30,757
2000	9,064	145,522	154,586	21,924
2001	13,897	121,464	135,361	26,289
2002	9,293	74,149	83,442	18,297
2003	6,220	109,037	115,257	11,731
2004	8,636	101,116	109,752	25,054
2005	5,920	72,700	78,620	23,118
2006	5,319	72,626	77,945	17,208
2007	7,383	52,989	60,372	16,861
2008	4,574	67,849	72,423	11,526
2009	4,862	87,484	92,346	16,150
2010	3,375	59,040	62,415	13,181
2011	9,555	88,824	98,379	16,214
2012	7,188	36,851	44,039	10,162
2013	17,508	65,214	82,722	5,438
2014	8,971	71,633	80,604	5,210
2015	6,038	44,754	50,792	4,353
10-year avg.	**7,336**	**65,451**	**72,787**	**12,675**
10-year SD	**3,851**	**16,194**	**16,823**	**5,975**
20-year avg.	**8,955**	**89,045**	**98,001**	**15,240**
20-year SD	**4,101**	**31,992**	**33,732**	**7,212**

Calculations: Estimated landings are based on a pre-determined list of species (Appendix 3) identified as the BMUS Complex regardless of the gear used, for each data collection (shore-based creel, boat-based creel and the commercial purchase reports).

Table 28. Summary of the available Bottomfish Management Unit Species (BMUS) catch time series: estimated lbs (expanded) from the boat and shore-based creel surveys and estimated total lbs from the commercial purchase system

Year	Creel survey Estimates		Creel Total	Commercial landings***
	Shore-based	Boat-based		
1982		24,022	24,022	4,139
1983		38,794	38,794	30,212
1984		16,205	16,205	6,546
1985	2	46,574	46,576	12,222
1986	161	19,146	19,307	4,466
1987	5	27,831	27,836	6,040
1988	1,366	43,982	45,348	8,188
1989	34	57,580	57,614	12,190
1990	1,520	80,212	81,732	9,444
1991	1,059	36,751	37,810	5,182
1992	1,832	48,818	50,650	5,580
1993	417	53,078	53,495	5,187
1994	170	47,712	47,882	12,487

Year	Creel survey Estimates		Creel Total	Commercial landings***
	Shore-based	Boat-based		
1995	741	40,167	40,908	4,842
1996	1,148	52,484	53,632	2,467
1997	408	29,765	30,173	2,799
1998	179	36,728	36,907	4,688
1999	50	52,531	52,581	10,702
2000	576	65,623	66,199	9,389
2001	151	50,357	50,508	9,809
2002	1,791	23,658	25,449	5,580
2003	137	41,560	41,697	4,244
2004	298	36,008	36,306	8,288
2005	57	36,431	36,488	10,729
2006	199	37,704	37,903	8,368
2007	86	26,558	26,644	7,441
2008	71	36,847	36,918	5,875
2009	234	38,343	38,577	6,747
2010	109	26,821	26,930	5,687
2011	284	58,343	58,627	9,662
2012	51	21,718	21,769	5,023
2013	441	29,746	30,187	1,984
2014	213	23,464	23,677	1,530
2015	132	13,532	13,664	1,171
10-year avg.	**171**	**31,773**	**31,944**	**5,838**
10-year SD	**119**	**11,792**	**11,829**	**3,228**
20-year avg.	**350**	**37,066**	**37,416**	**6,049**
20-year SD	**426**	**13,099**	**13,132**	**3,057**

*** The old bottomfish report does not have estimates of commercial catch of BMUS-only species. Estimates derived from the ratio of the total catch to the commercial catch of all BF species.

Calculations: Estimated landings are based on a pre-determined list of species (Appendix 3) identified as the CREMUS Complex regardless of the gear used, for each data collection (shore-based creel, boat-based creel and the commercial purchase reports). Need to finalize the CREMUS list to use for Creel and commercial landings and verify non-overlap between Bottomfish Complex and CREMUS. Also need to verify all shallow bottomfish are not included in CREMUS list.

Table 29. Summary of the predefined "coral reef fishery" catch time series (for a discrete list of species – taken from CB lbs and CS lbs from the CREMUS module) from the boat and shore-based creel surveys and the commercial purchase system.

Year	Creel survey Estimates		Creel Total	Commercial landings
	Shore-based	Boat-based		
1980				7,037
1981				3,634
1982				2,598
1983				7,222
1984				24,281
1985	381,353	169,437	550,790	22,569
1986	246,604	79,178	325,782	13,732
1987	208,935	91,295	300,230	14,565
1988	209,214	140,620	349,834	16,786

1989	144,719	193,889	338,608	10,399
1990	125,299	281,868	407,167	12,036
1991	246,169	213,986	460,155	12,119
1992	175,981	159,037	335,018	14,933
1993	97,150	199,164	296,314	9,095
1994	141,542	181,015	322,557	11,576
1995	173,304	304,712	478,016	4,643
1996	96,969	421,901	518,870	30,897
1997	191,577	266,442	458,019	38,977
1998	218,885	293,068	511,953	124,747
1999	253,544	432,725	686,269	194,373
2000	127,956	298,474	426,430	205,031
2001	158,872	281,855	440,727	187,128
2002	83,998	137,303	221,301	139,101
2003	101,392	174,549	275,941	69,109
2004	76,521	183,602	260,123	86,913
2005	58,430	94,209	152,639	121,918
2006	87,305	85,574	172,879	127,420
2007	68,960	78,251	147,211	133,554
2008	48,597	114,709	163,306	128,059
2009	78,592	135,590	214,182	134,768
2010	70,898	98,996	169,894	122,832
2011	60,782	279,762	340,544	98,175
2012	149,418	99,922	249,340	62,195
2013	104,431	122,252	226,683	52,612
2014	44,476	160,295	204,771	40,655
2015	104,198	127,283	231,481	33,155
10-year avg.	**126,986**	**79,644**	**206,630**	**206,630**
10-year SD	**56,016**	**30,566**	**56,257**	**56,257**
20-year avg.	**199,594**	**112,338**	**311,932**	**311,932**
20-year SD	**109,248**	**57,982**	**152,872**	**152,872**

1.2.5.2 Expanded catch estimates by fishing methods

Catch information is provided for the top shore-based and boat-based fishing methods that contribute 88% and 83% of the annual catch, respectively.

Calculations: The creel survey time series of catch will be the sum of the estimated weight by selected gear in all strata for all species except for trolling which would exclude PMUS and any pelagic species complex.

Table 30. Expanded catch time series estimates using boat and shore-based creel survey data sets by gear type.

Year	Shore-based methods						Boat-based methods			
	H&L	Throw /Castnet	Gillnet	Spear	SCUBA	H&G	Bottom	Spear	SCUBA	Troll
1982							21,291	420		11,128
1983							26,905	1,355	4,380	13,552
1984							52,408	14,108	5,460	5,669
1985	73,768	34,983	58,126	83,182	3,136	6,900	69,342	18,737	12,719	11,039
1986	68,589	30,722	71,596	35,638		3,582	24,242	12,545	5,145	10,768
1987	67,061	25,807	74,894	31,650		2,076	38,114	12,448	7,474	10,094
1988	22,872	40,027	82,687	44,073	3,861	6,820	50,562	24,712	10,649	18,111

Year	Shore-based methods						Boat-based methods			
	H&L	Throw /Castnet	Gillnet	Spear	SCUBA	H&G	Bottom	Spear	SCUBA	Troll
1989	36,546	36,468	40,186	13,435	1,282	8,267	53,374	30,931	13,985	13,402
1990	32,070	41,634	36,667	10,477	441	1,883	79,480	29,102	40,951	14,511
1991	102,067	30,349	50,525	18,133	70	3,748	40,773	27,898	37,027	11,124
1992	36,716	34,909	65,974	26,380	260	1,484	62,159	35,162	25,226	7,726
1993	19,892	11,420	20,897	31,052	497	4,053	67,189	39,435	22,848	4,994
1994	41,293	28,943	26,515	25,452	1,247	3,386	69,234	37,554	27,244	9,627
1995	71,342	14,608	23,262	38,984	14,452	2,207	79,371	40,554	74,735	9,002
1996	42,665	18,379	12,879	14,505	688	1,952	96,142	67,446	91,393	31,192
1997	59,584	30,268	16,591	20,820	243	2,190	99,256	37,363	41,920	14,784
1998	46,007	20,727	14,885	88,137	1,844	20,082	86,406	56,442	68,198	16,620
1999	74,652	20,856	32,739	75,345	320	15,293	95,248	45,160	80,859	26,215
2000	34,352	25,358	27,855	30,526	234	1,525	74,965	42,403	115,918	15,947
2001	41,314	5,742	16,910	42,412	213	11,528	93,401	74,369	65,105	13,950
2002	31,260	17,397	8,985	20,558	145	697	41,232	21,712	34,766	9,528
2003	29,178	8,813	10,782	50,456	157	170	65,497	22,545	40,093	23,852
2004	27,834	10,914	6,419	27,395	70	200	46,253	33,601	50,442	39,874
2005	16,977	4,184	18,560	8,178	394	7,944	31,321	14,705	27,934	11,124
2006	24,999	33,868	6,845	18,223	579	825	50,792	12,121	4,129	13,041
2007	27,602	3,064	17,822	13,299	148	5,739	37,138	18,516	11,317	6,377
2008	16,139	9,020	17,991	3,579		371	28,747	29,715	24,647	5,956
2009	39,374	12,749	6,381	2,487		14,045	50,201	22,669	28,947	10,972
2010	6,051	7,779	52,709	2,380		748	38,071	23,533	1,775	12,088
2011	34,978	19,381	2,570	1,844	211	393	43,893	26,483	67,431	6,333
2012	96,899	2,808	35,116	6,680	31	7,185	29,319	23,986	12,204	1,630
2013	41,695	23,024	26,410	6,933	148	4,090	32,000	21,079	15,663	25,613
2014	34,979	6,444	563	1,077	30	181	61,567	28,088	32,316	16,262
2015	39,771	7,609	8,053	45,897		1,754	22,454	22,371	27,554	17,715
10-year avg.	**34,497**	**11,812**	**17,547**	**10,052**	**220**	**3,934**	**38,682**	**22,115**	**23,083**	**11,556**
10-year SD	**23,641**	**9,781**	**15,707**	**13,010**	**201**	**4,428**	**11,754**	**5,359**	**18,048**	**6,668**
20-year avg.	**39,888**	**14,428**	**17,349**	**24,748**	**1,171**	**4,720**	**57,299**	**32,612**	**43,683**	**15,623**
20-year SD	**21,103**	**9,020**	**12,468**	**24,495**	**3,449**	**5,852**	**25,788**	**16,710**	**30,795**	**9,281**

1.2.5.3 Top species in the catch for the boat and shore-based fisheries

The time series for catch is an indicator of fishery performance. Fluctuations in the catch can be attributed to various factors and there is no single explanatory variable for the trends. The 10 species group in the boat and shore-based catch for the coral reef fishery make up 67% and 76%, respectively, of the total annual catches.

Calculations: Catch by species complex can be summed directly from current boat-based expanded species composition data over all by gear or by gear and species, for all strata (geographic, temporal).

The averages for the table this year were calculated from catch estimates from the entire time series for each of the CREMUS groupings. The average catch for each grouping is ranked from the highest to lowest catch. The dominant groups that make up more than 67% of the catch are reported.

Table 31. Catch time series of the 11 managed species complexes (rank ordered by management importance and average catch of recent 10 years) from the boat-based creel data. The CREMUS complex comprise > 67% of the total boat based landing

YEAR	All BF	BMUS	Atulai	Emperor	Surgeon	Jacks	Parrot	Groupers	Snappers	Goatfish	Rabbitfish
1982	40,318	24,022	204	8,160	55	5,551	197	2,041	4,344	372	11
1983	47,489	38,794	28,099	9,899	948	6,573	1,049	3,526	2,827	804	
1984	57,659	16,205	37,342	13,616	1,023	3,413	1,770	2,431	1,517	378	
1985	106,811	46,576	51,624	21,357	3,864	11,136	9,016	9,616	8,832	1,811	141
1986	52,352	19,307	22,004	4,892	2,734	12,464	4,818	2,596	4,766	272	60
1987	58,245	27,836	14,913	16,307	1,430	8,364	6,074	5,984	6,503	612	105
1988	88,239	45,348	33,000	16,919	7,554	21,409	9,480	9,046	10,143	1,404	268
1989	92,781	57,614	60,346	21,771	14,073	13,063	9,912	5,022	14,617	4,612	1,769
1990	163,710	81,732	19,212	50,933	38,526	19,299	24,377	22,614	18,810	12,881	5,658
1991	82,286	37,810	34,100	20,433	13,071	8,801	24,146	9,076	10,872	5,324	925
1992	96,827	50,650	10,077	21,419	20,745	12,725	22,344	12,616	21,201	2,722	661
1993	105,093	53,495	29,291	13,927	12,304	14,839	15,688	18,738	15,407	10,340	2,534
1994	116,398	47,882	4,062	25,893	17,046	20,322	17,513	9,525	9,248	3,783	1,246
1995	116,720	40,908	52,170	30,395	40,059	20,029	24,167	17,332	11,675	9,209	3,736
1996	160,617	53,632	98,881	36,459	56,560	44,250	22,231	15,043	17,214	6,255	3,950
1997	114,481	30,173	32,958	33,742	28,155	16,522	19,362	16,181	9,572	7,809	2,866
1998	116,031	36,907	31,118	24,658	48,289	14,623	22,107	17,236	12,282	7,460	5,081
1999	151,110	52,581	135,337	27,503	46,776	31,615	25,786	14,616	11,843	10,097	3,926
2000	154,586	66,199	14,007	43,130	53,279	25,511	30,770	15,803	12,759	9,058	5,147
2001	135,361	50,508	7,975	48,252	33,193	19,300	27,854	15,351	9,758	3,774	8,545
2002	83,442	25,449	438	29,651	20,552	18,255	16,495	6,555	3,296	5,167	3,075
2003	115,257	41,697	501	22,148	18,642	39,145	18,238	24,609	6,485	2,990	1,554
2004	109,752	36,306	1,769	19,859	41,689	38,665	19,616	12,873	13,344	1,007	731
2005	78,620	36,488	160	12,107	18,842	18,157	8,952	6,080	7,471	3,656	156
2006	77,945	37,903	1,156	10,548	4,259	23,507	2,221	7,630	7,184	4,730	204
2007	60,372	26,644	848	14,107	8,696	13,559	7,968	6,722	4,124	1,274	19
2008	72,423	36,918	10,335	10,734	25,098	11,735	7,524	9,634	8,238	6,598	1,487
2009	92,346	38,577	11,337	23,057	24,789	8,181	7,988	7,478	4,130	2,356	272
2010	62,415	26,930	5,887	13,584	11,521	10,555	6,787	7,114	5,380	1,461	485
2011	98,379	58,627	120,766	14,608	12,234	12,970	4,395	7,562	6,392	566	303
2012	44,039	21,769	24,935	9,226	3,315	8,334	5,206	3,580	6,379	2,469	1,349
2013	82,722	30,187	19,864	12,326	14,199	25,104	15,582	9,967	5,463	1,148	1,290
2014	80,604	23,677	4,077	30,503	10,376	14,992	8,856	7,858	6,799	8,400	3,809
2015	50,792	13,664	28,707	8,539	4,966	19,043	1,439	4,542	5,061	3,145	781
10-year avg.	**72,787**	**31,944**	**20,734**	**14,485**	**12,572**	**15,103**	**6,993**	**7,106**	**6,056**	**3,255**	**923**
10-year SD	**16,823**	**11,829**	**34,619**	**6,587**	**7,628**	**5,729**	**3,833**	**1,897**	**1,343**	**2,454**	**1,091**
20-year avg.	**98,001**	**37,416**	**28,725**	**22,626**	**25,023**	**20,669**	**14,454**	**11,132**	**8,326**	**4,697**	**2,322**

YEAR	All BF	BMUS	Atulai	Emperor	Surgeon	Jacks	Parrot	Groupers	Snappers	Goatfish	Rabbit fish
20-year SD	**33,732**	**13,132**	**40,323**	**11,620**	**16,935**	**10,236**	**8,989**	**5,423**	**3,675**	**3,074**	**2,224**

Calculations: Catch by species complex can be summed directly from current shore-based expanded species composition data over all by gear or by gear and species, for all strata (geographic, temporal).

The averages for the table below were calculated from catch estimates from the entire time series for each of the CREMUS grouping. The average catch is ranked from the highest to lowest catch. The dominant groups that make up more than 91% of the catch are reported.

Table 32. Catch time series of the 10 managed species complexes (rank ordered by management importance and average catch of recent 10 years) from the shore-based creel data. The CREMUS complex comprise > 91% of the total boat based landing

Year	Shorebased methods									
	Surgeon	**Rabbit**	**Mollusk**	**Atulai**	**Goatfish**	**Jacks**	**Mullet**	**Emperor**	**Rudder**	**Parrot**
1980	59,033	37,838	93,253	34,218	17,300	7,499	8,741	21,337	5,303	14,966
1981	58,654	8,676	6,285	333	34,613	10,441	20,825	9,595	5,894	3,927
1982	65,211	21,249	4,931	6,373	35,969	13,686	27,056	5,150	5,345	1,378
1983	61,400	20,575	7,592		25,729	11,330	18,284	13,761	14,995	3,450
1984	31,663	15,335	9,309	110	27,601	5,374	10,317	5,772	7,414	552
1985	24,487	15,281	5,114	3,018	14,673	6,626	10,382	5,487	8,934	1,503
1986	20,254	17,799	40,657	67,834	13,363	11,309	7,117	4,959	18,016	11,921
1987	44,922	25,334	11,138	417	13,704	5,483	16,823	10,413	8,497	5,334
1988	15,267	8,147	6,994	935	9,260	4,102	6,711	5,145	1,975	3,295
1989	26,447	27,513	12,719	2,132	7,717	4,390	11,931	7,757	314	4,954
1990	60,197	13,167	8,076	11,952	9,703	6,471	4,948	9,872	2,224	8,117
1991	27,925	15,080	3,970	1,833	5,849	6,437	2,935	6,121	2,489	3,790
1992	23,063	18,137	7,732	22,254	5,164	8,243	5,851	7,037	3,276	4,518
1993	45,652	10,998	30,283	715	6,853	12,108	10,303	9,811	20,027	11,069
1994	59,217	21,305	22,347	475	7,824	27,038	7,197	8,034	4,899	19,721
1995	23,390	18,037	7,813	5,721	8,243	6,450	4,859	7,879	10,221	4,037
1996	27,768	9,293	20,738	803	7,155	16,507	3,103	9,661	1,494	2,601
1997	10,891	9,630	3,372	448	3,834	7,274	2,774	5,437	14,479	2,259
1998	23,152	9,511	16,597	2,506	5,810	5,594	1,743	4,156	1,499	8,121
1999	19,470	6,689	5,625	2,599	2,694	11,823	1,453	2,025	2,179	2,614
2000	8,926	3,203	11,478	1,664	5,610	7,997	1,629	2,399	737	1,925
2001	24,315	8,394	2,943	6,023	6,794	5,764	431	1,161	11,552	3,325
2002	18,670	10,221	7,664	4,391	1,318	9,656	906	4,594	932	1,019
2003	15,563	6,293	1,499	1,177	641	6,792	4,151	837	1,781	1,691
2004	8,642	5,852	15,307	26,698	1,515	7,077	2,396	2,621	891	787
2005	34,364	6,351	1,637	197	1,831	4,123	5,385	1,958	8,642	1,064
2006	7,953	5,294	1,204	13,503	5,171	16,572	1,646	3,935	172	1,938
2007	3,518	1,218	8,654	85,826	3,865	8,083	11,641	6,283	1,608	1,253
2008	16,651	10,667	5,591	4,013	8,721	34,364	8,010	2,479	150	634
2009	3,509	3,327	688	11,444	2,822	11,199	174	7,294	252	266
2010	14,329	5,115	22,151	1,319	8,439	7,497	1,282	3,986	841	2,524
2011	14,222	5,994	7,165	14,205	4,248	10,829	3,423	3,413	2,505	1,493
2012	9,289	2,910	6,873	25,000	2,896	8,462	3,617	2,041	3,846	897

Year	Shorebased methods									
	Surgeon	**Rabbit**	**Mollusk**	**Atulai**	**Goatfish**	**Jacks**	**Mullet**	**Emperor**	**Rudder**	**Parrot**
2013	22,722	9,418	9,779	9,789	5,231	10,813	3,944	5,123	4,302	3,965
2014	16,006	5,298	8,353	18,903	2,699	7,476	3,197	2,918	5,471	4,558
2015	59,033	37,838	93,253	34,218	17,300	7,499	8,741	21,337	5,303	14,966
10-year avg.	**58,654**	**8,676**	**6,285**	**333**	**34,613**	**10,441**	**20,825**	**9,595**	**5,894**	**3,927**
10-year SD	**65,211**	**21,249**	**4,931**	**6,373**	**35,969**	**13,686**	**27,056**	**5,150**	**5,345**	**1,378**
20-year avg.	**61,400**	**20,575**	**7,592**		**25,729**	**11,330**	**18,284**	**13,761**	**14,995**	**3,450**
20-year SD	**31,663**	**15,335**	**9,309**	**110**	**27,601**	**5,374**	**10,317**	**5,772**	**7,414**	**552**

1.2.6 Catch Per Unit Effort (CPUE) Statistics

This section summarizes the estimates for catch-per-unit effort in the boat and shore-based fisheries. The boat-based fisheries include the bottomfishing (handline gear), spearfishing (SCUBA and snorkel), gillnets, and troll that comprise 83% of the total catch. Trolling method are primarily a pelagic fishing method but also catches coral reef fishes like jacks and gray jobfish. The shore-based fisheries include the hook-and-line, throw or cast nets, gillnets, spear, and hook-and-gaff that comprise 88% of the total coral reef fish catch. CPUE is reported as pounds per gear-hours for the shore-based methods whereas in the boat-based methods it's pounds per trip.

Calculations: The previous CREPT report generated CPUE estimates for the top CREMUS groups by fishing method. The top three- to-four CREMUS groups that dominate the catch by fishing method were used to represent the CPUE by method. The proportion of the dominant CREMUS groups relative to the total catch is described in the method header. The representative CPUE by method was calculated from the average CPUE for these CREMUS groups.

Table 33. Catch per unit effort time series by dominant fishing methods from the shore-based fisheries. CPUE estimates were derived from the top three- to five-dominant taxonomic groups that make up more than 50% of the catch. The percentage of catch is shown in parenthesis beside the method.

Year	Shore-based methods (annual est. total lbs/est. gear-hr)				
	H&L (56%)	**Castnet (63%)**	**Gillnet (61%)**	**Spear (54%)**	**H&G**
1985	0.09	0.21	0.23	0.70	0.87
1986	0.11	0.17	0.44	0.24	0.74
1987	0.12	0.19	0.43	0.40	0.65
1988	0.07	0.34	0.56	0.42	0.64
1989	0.05	0.27	0.41	0.16	1.14
1990	0.04	0.28	0.44	0.17	0.33
1991	0.13	0.11	0.23	0.28	0.74
1992	0.03	0.22	0.33	0.38	0.30
1993	0.01	0.06	0.16	0.32	0.53
1994	0.03	0.24	0.23	0.34	0.81
1995	0.06	0.12	0.22	0.45	0.28
1996	0.03	0.22	0.18	0.19	0.24
1997	0.06	0.17	0.18	0.24	0.48
1998	0.04	0.05	0.08	0.59	1.95
1999	0.06	0.12	0.14	0.38	1.23
2000	0.03	0.13	0.29	0.25	0.27

Year	Shore-based methods (annual est. total lbs/est. gear-hr)				
	H&L (56%)	**Castnet (63%)**	**Gillnet (61%)**	**Spear (54%)**	**H&G**
2001	0.03	0.03	0.17	0.47	1.46
2002	0.02	0.03	0.13	0.27	0.32
2003	0.03	0.05	0.10	0.73	0.10
2004	0.03	0.12	0.08	0.33	0.12
2005	0.02	0.03	0.23	0.15	1.03
2006	0.04	0.16	0.08	0.16	0.13
2007	0.04	0.04	0.21	0.23	0.72
2008	0.02	0.09	0.35	0.04	0.10
2009	0.07	0.11	0.11	0.05	2.00
2010	0.01	0.06	0.90	0.04	0.14
2011	0.07	0.15	0.06	0.04	0.10
2012	0.16	0.02	0.39	0.08	1.43
2013	0.09	0.23	0.29	0.07	1.14
2014	0.13	0.10	0.01	0.03	0.10
2015	0.05	0.11	0.14	0.96	0.70
10-year Ave	**0.06**	**0.10**	**0.25**	**0.17**	**0.69**
10-year SD	**0.05**	**0.07**	**0.25**	**0.27**	**0.65**
20-year Ave	**0.05**	**0.10**	**0.21**	**0.27**	**0.67**
20-year SD	**0.04**	**0.06**	**0.19**	**0.25**	**0.64**

Table 34. Catch per unit effort time series by dominant fishing methods from the boat-based fisheries. CPUE estimates were derived from the top three to five dominant taxonomic groups that make up more than 50% of the catch. The percentage of catch is shown in parenthesis beside the method.

Year	Boat-based methods (annual est. total lbs/hour)				
	Bottom	**Spear (61%)**	**SCUBA (70%)**	**Gill (54%)**	**Troll (81%)**
1982	6.9	1.6	1.4		0.17
1983	5.8	0.4	1.7		0.14
1984	7.7	2.6	3.1		0.10
1985	5.7	3.6	2.7	1.1	0.15
1986	5.4	2.5	2.8	5.2	0.14
1987	6.1	2.1	2.8	0.6	0.10
1988	5.4	2.5	2.4	0.2	0.15
1989	5.2	1.7	6.3	0.3	0.12
1990	5	1.1	10.5	1.0	0.07
1991	5.1	2.4	4.8	1.3	0.02
1992	4.7	2.9	8.6	0.4	0.08
1993	4.7	0.9	6.4	2.6	0.05
1994	6.1	1.9	10.4	1.4	0.10
1995	3.2	1.7	9.2	1.9	0.07
1996	4.3	1.9	11.7	5.4	0.23
1997	3.5	2.1	8.8	2.0	0.07
1998	3.2	1.6	9.6	1.4	0.07
1999	3.9	1.5	9.1	3.2	0.21
2000	3.9	1.7	8.1	0.6	0.15
2001	4	3.6	4.6	2.3	0.12
2002	3.4	1.4	7.2	0.3	0.11
2003	4.7	2.3	11.2	0.1	0.37
2004	5.4	4.3	7.0	1.0	0.56
2005	5.5	1.1	0.1	0.3	0.21
2006	6.1	1.1	3.6		0.22
2007	6.3	2.4	5.9	0.2	0.12

Year	Boat-based methods (annual est. total lbs/hour)				
	Bottom	**Spear (61%)**	**SCUBA (70%)**	**Gill (54%)**	**Troll (81%)**
2008	4.5	2.2	4.0	1.6	0.09
2009	6	1.7	2.7	2.2	0.10
2010	3.5	1.5	15.0	10.0	0.11
2011	7.5	4.6	13.1	3.4	0.06
2012	4.9	7.5	12.5	7.9	0.03
2013	4.6	2.8	8.7	7.6	0.30
2014	5.3	1.3	6.5	0.2	0.16
2015	3.3	1.6	1.4		0.13
10-year Ave	**5.2**	**2.5**	**7.2**	**3.7**	**0.14**
10-year SD	**1.2**	**1.9**	**4.7**	**3.8**	**0.08**
20-year Ave	**4.6**	**2.4**	**8.1**	**2.7**	**0.17**
20-year SD	**1.2**	**1.5**	**3.7**	**2.9**	**0.12**

NOTE: CPUE value for troll and spear are in lbs/hr

1.2.7 Effort Statistics

This section summarizes the effort trends in the coral reef and bottomfish fishery. Fishing effort trends provide insights on the level of fishing pressure through time. Effort information is provided for the top shore-based and boat-based fishing methods that contribute 88% and 83% of the annual catch. Trolling method is included in this report because coral reef MUS is also caught using trolling method. Pelagic MUS caught using trolling method is reported in the Pelagic Annual/SAFE report module.

Calculations: The values were derived from the shore and boat-based CPUE estimates and catch estimates extracted from the previous CREPT reports. For the bottomfish effort, values were derived from the old bottomfish fishery modules.

Effort estimates for the coral reef shore-based fisheries and boat-based non-bottomfish fisheries (expressed in gear-hours) were derived from the CPUE and catch of the dominant CREMUS groups per method. The catch (expressed in pounds) of the top three to four CREMUS groups per method was divided by its corresponding CPUE (expressed in pounds per gear-hours) from Table 10 and 11 to derive effort (expressed in gear-hours). For the bottomfish fishery, the sum of the total number of recorded trips constitutes the fishing effort.

Table 35. Time series of effort estimates from the coral reef and bottomfish fisheries. Shore-based fisheries are expressed in gear-hours (expanded total number of hours fishing by total number of gears used). The boat-based fisheries are expressed in number of trips for bottomfish and number of gear hours for spear, SCUBA, gillnet and troll)

	Estimated Effort by Gear or Fishing Method									
	# of SB gear-hours (estimated annual expanded)					**# of BB trips (estimated annual expanded)**				
	H&L	**Castnet**	**Gillnet**	**Spear**	**H&G**	**Bottom**	**Spear**	**SCUBA**	**Gillnet**	**Troll**
1982						1,530	62			29,720
1983						2,062	484	617		30,280
1984						2,159	1,413	707		28,617
1985	170,568	38,462	24,247	25,517	7,327	3,315	1,251	966	215	36,810
1986	126,691	31,110	28,411	23,190	4,855	1,561	1,003	453	57	38,563
1987	121,556	29,962	29,487	17,589	3,192	1,936	1,295	535	858	34,753
1988	104,495	30,116	20,994	22,412	10,702	3,372	1,841	761	296	59,035
1989	134,841	32,915	17,607	12,183	7,268	3,567	3,767	986	2,009	50,190
1990	105,223	28,917	15,139	9,826	5,036	6,157	5,558	1,286	10,894	93,226

	Estimated Effort by Gear or Fishing Method									
	# of SB gear-hours (estimated annual expanded)					# of BB trips (estimated annual expanded)				
	H&L	**Castnet**	**Gillnet**	**Spear**	**H&G**	**Bottom**	**Spear**	**SCUBA**	**Gillnet**	**Troll**
1991	212,851	44,153	26,120	12,757	5,017	3,109	2,504	902	4,418	44,012
1992	191,120	43,314	33,782	16,312	4,878	3,218	2,941	928	3,786	43,769
1993	157,621	37,166	21,185	14,974	7,510	5,677	5,849	466	2,660	43,337
1994	196,872	29,962	18,676	13,583	4,191	4,322	3,911	718	3,642	46,026
1995	214,749	33,577	19,998	16,035	7,782	9,365	4,733	1,589	4,205	57,727
1996	242,930	24,918	12,408	11,535	8,143	7,694	6,007	2,540	4,009	64,459
1997	237,796	38,233	15,879	12,721	3,619	7,539	4,356	946	2,096	57,094
1998	197,231	54,035	27,018	24,763	10,056	8,862	7,759	1,728	2,797	62,651
1999	248,608	34,545	24,918	40,624	12,337	9,814	6,918	2,047	3,830	57,528
2000	197,129	31,882	17,408	22,911	5,639	7,111	5,769	2,783	3,870	53,055
2001	221,386	40,078	16,770	19,851	7,820	7,741	5,290	2,060	1,271	57,565
2002	155,846	31,244	10,744	11,484	2,094	4,363	3,172	1,628	1,199	40,961
2003	148,043	41,748	12,017	15,301	1,652	4,316	1,868	1,243	1,364	31,986
2004	154,622	27,399	12,925	16,082	1,631	3,732	2,948	1,447	617	34,624
2005	146,804	36,350	11,193	11,337	7,712	2,966	2,473	1,477	655	25,743
2006	132,072	45,355	15,573	16,850	6,457	3,382	2,181	770		29,246
2007	126,263	24,411	10,281	14,350	7,969	2,680	2,257	595	958	27,618
2008	129,740	29,330	8,850	12,888	3,803	3,295	2,759	1,311	568	32,387
2009	159,389	35,587	11,017	8,534	7,030	3,794	3,241	1,702	1,361	51,069
2010	130,252	29,526	10,121	13,400	5,467	3,958	3,828	647	642	53,602
2011	137,095	28,767	8,350	9,340	4,031	2,755	1,581	1,469	656	44,859
2012	189,159	29,686	16,889	11,899	5,026	2,130	998	298	504	27,816
2013	133,496	30,618	13,798	18,260	3,588	2,618	2,278	480	813	42,435
2014	57,903	13,625	4,151	7,318	1,853	2,621	3,066	717	688	48,890
2015	58,879	14,385	7,536	10,582	2,516	2,130	3,095	1,330		62,571
10-year Avg.	**127,368**	**28,876**	**10,705**	**12,251**	**5,041**	**2,939**	**2,523**	**981**	**761**	**40,567**
10-year SD	**38,609**	**9,161**	**3,665**	**3,373**	**2,075**	**609**	**797**	**482**	**261**	**12,652**
20-year Avg.	**162,828**	**32,157**	**13,707**	**15,527**	**5,535**	**4,898**	**3,647**	**1,372**	**1,690**	**45,899**
20-year SD	**53,363**	**9,251**	**5,557**	**7,284**	**2,961**	**2,603**	**1,819**	**661**	**1,342**	**13,175**

NOTE: Table below shows fishing effort in gear-hours divided by the number of gear per year.

	Estimated Effort by Gear or Fishing Method									
	# of SB gear-hours (estimated annual expanded)					# of BB trips (estimated annual expanded)				
	H&L	**Castnet**	**Gillnet**	**Spear**	**H&G**	**Bottom**	**Spear**	**SCUBA**	**Gillnet**	**Troll**
1982						10	5	*		20
1983						19	44	36		22
1984						15	19	39	*	21
1985	738	631	332	188	366	21	20	12	*	19
1986	1,030	635	360	374	373	13	31	24	*	26
1987	765	526	590	187	39	14	35	21	50	20
1988	581	436	382	311	713	17	25	16	74	21
1989	265	354	367	312	454	16	59	17	402	20
1990	162	286	172	172	296	27	121	26	681	29
1991	225	409	300	260	119	13	52	14	245	15
1992	201	433	282	408	139	14	41	8	421	13

	Estimated Effort by Gear or Fishing Method									
	# of SB gear-hours (estimated annual expanded)					# of BB trips (estimated annual expanded)				
	H&L	**Castnet**	**Gillnet**	**Spear**	**H&G**	**Bottom**	**Spear**	**SCUBA**	**Gillnet**	**Troll**
1993	151	404	241	306	119	16	67	6	296	13
1994	224	476	191	170	110	15	43	9	140	14
1995	203	271	142	184	324	23	36	10	88	14
1996	218	383	203	189	679	19	40	18	87	15
1997	240	294	114	177	172	23	41	12	48	16
1998	168	403	114	201	359	25	37	14	78	16
1999	239	306	145	239	441	24	54	15	174	17
2000	202	272	118	214	269	23	49	24	54	17
2001	397	331	150	320	489	23	80	25	45	25
2002	228	386	129	239	524	12	50	54	75	29
2003	290	298	240	450	110	9	30	34	195	31
2004	307	330	308	459	272	11	66	40	103	26
2005	362	387	415	567	1,285	13	48	74	60	18
2006	226	630	305	674	717	13	40	86	*	19
2007	199	555	490	652	1,594	8	73	*	87	19
2008	242	407	206	678	1,268	12	36	77	47	22
2009	389	539	734	711	469	12	47	170	97	24
2010	372	416	595	1,117	421	11	55	*	92	24
2011	303	449	439	1,334	*	9	35	105	*	29
2012	533	366	704	541	718	9	48	*	101	34
2013	326	486	657	676	449	9	57	*	41	28
2014	125	213	297	457	463	9	49	143	69	28
2015	2,944	248	164	235	210	10	36	*	0	26
10-year Avg.	**548**	**427**	**455**	**695**	**759**	**10**	**48**	**109**	**66**	**25**
10-year SD	**802**	**126**	**199**	**300**	**462**	**2**	**11**	**39**	**33**	**5**
20-year Avg.	**405**	**380**	**318**	**491**	**562**	**15**	**48**	**56**	**81**	**23**
20-year SD	**589**	**107**	**209**	**313**	**395**	**6**	**13**	**49**	**45**	**6**

1.2.8 Participants

This section summarizes the estimated number of participants in each fishery type. The information presented here can be used in the impact analysis of potential amendments in the FEPs associated with the bottomfish and coral reef fisheries. The trend in the number of participants over time can also be used as an indicator for fishing pressure.

Calculations:

For Boat-based – estimated number of participants is calculated by using an average number of boats out fishing [check to see if we can use number of fishers instead?] per day multiplied by the number of dates in the calendar year by gear type. The total is a combination of weekend and weekday stratum estimates.

For Shore-based – estimated number of participants is calculated by using an average number of fishers out fishing per day multiplied by the number of dates in the calendar year by gear type. The total is a combination of weekend, weekday, day and night stratum estimates.

Table 36. Number of boats participating in the bottomfish fishery and number of gear in the boat and shore-based coral reef fishery. Cells marked with * indicates data is confidential due to less than three entities surveyed or reported.

Year	Bottomfish		Coral Reef BB				Coral Reef SB Fishery				
	No. of boats	No. of gears	Spear	SCUBA	Gillnet	Troll	H&L	Throw	Gill	Spear	H&G
1982	154	212	13	*		1,498	20	5		13	
1983	106	173	11	17		1,373	47				
1984	144	287	76	18	*	1,392	304	14	15	*	*
1985	161	525	62	78	*	1,890	231	61	73	136	20
1986	118	224	32	19	*	1,489	123	49	79	62	13
1987	139	259	37	26	17	1,758	159	57	50	94	81
1988	198	427	75	48	4	2,820	180	69	55	72	15
1989	223	445	64	59	5	2,566	508	93	48	39	16
1990	226	380	46	50	16	3,230	651	101	88	57	17
1991	246	351	48	63	18	2,951	948	108	87	49	42
1992	236	368	71	110	9	3,332	953	100	120	40	35
1993	360	409	87	72	9	3,251	1047	92	88	49	63
1994	298	480	91	83	26	3,314	880	63	98	80	38
1995	402	1055	131	166	48	4,110	1059	124	141	87	24
1996	408	1182	149	141	46	4,380	1115	65	61	61	12
1997	332	1031	106	79	44	3,657	990	130	139	72	21
1998	354	1130	210	122	36	3,878	1175	134	238	123	28
1999	411	1083	127	134	22	3,298	1040	113	172	170	28
2000	312	722	118	118	72	3,176	977	117	147	107	21
2001	337	582	66	81	28	2,319	557	121	112	62	16
2002	351	426	63	30	16	1,433	683	81	83	48	4
2003	481	320	62	37	7	1,034	511	140	50	34	15
2004	347	343	45	36	6	1,320	503	83	42	35	6
2005	233	320	52	20	11	1,437	405	94	27	20	6
2006	261	275	54	9	*	1,544	584	72	51	25	9
2007	320	238	31	*	11	1,480	633	44	21	22	5
2008	286	270	77	17	12	1,486	536	72	43	19	3
2009	322	409	69	10	14	2,128	410	66	15	12	15
2010	355	470	70	*	7	2,251	350	71	17	12	13
2011	295	277	45	14	*	1,521	452	64	19	7	*
2012	250	138	21	*	5	823	355	81	24	22	7
2013	285	189	40	*	20	1,505	409	63	21	27	8
2014	282	318	63	5	10	1,752	462	64	14	16	4
2015	224	237	85	*	5	2,384	20	58	46	45	12
10-year Avg.	**283**	**286**	**55**	**13**	**11**	**1,665**	**420**	**68**	**27**	**21**	**8**
10-	**40**	**94**	**20**	**6**	**5**	**444**	**161**	**13**	**13**	**10**	**4**

Year	Bottomfish		Coral Reef BB				Coral Reef SB Fishery				
	No. of boats	No. of gears	Spear	SCUBA	Gillnet	Troll	H&L	Throw	Gill	Spear	H&G
year SD											
20-year Avg.	326	525	80	64	22	2,234	630	88	71	49	13
20-year SD	64	353	45	56	19	1,080	310	29	63	42	8

1.2.9 Bycatch estimates

This section focuses on MSA § 303(a)(11), which requires that all FMPs establish a standardized reporting methodology to assess the amount and type of bycatch occurring in the fishery, and include conservation and management measures that, to the extent practicable, minimize bycatch and bycatch mortality. The MSA § 303(a)(11) standardized reporting methodology is commonly referred to as a ''Standardized Bycatch Reporting Methodology'' (SBRM) and was added to the MSA by the Sustainable Fisheries Act of 1996 (SFA). The Council implemented omnibus amendments to FMPs in 2003 to address MSA bycatch provisions and established SBRMs at that time.

Calculations:

Numbers caught = Sum of the total number of fish or invertebrates found in the raw interview (catch) data.

Numbers kept = Sum of values in the number of fish or invertebrates field from data records that are not marked as bycatch.

Numbers released = caught - kept

Coral reef fishery bycatch = Sum of the number of fish or invertebrates from data records that are marked as bycatch (unknown, alive or dead), for which the fishing method is not trolling or bottomfishing (or for American Samoa also Troll-bottom Mix).

% bycatch should be % of numbers caught for the included gears. Need to discuss with FEPT. If coral reef is defined based on species, as opposed to by gear, the calculations may need to be adjusted.

"Total Bycatch:" Sum of the number of pieces field from all data records found in the interview database (all fishing methods are counted!)

Table 37. Time series of bycatch estimates in the boat-based fisheries. Percent bycatch is calculated from the numbers caught and identified as bycatch versus all caught in the fishery.

Year	Numbers caught	Kept	# ID's as bycatch	Released	% bycatch	% release
1982	6,985	6,985	0	0	0.0	0.0
1983	5,088	5,088	0	0	0.0	0.0

Year	Numbers caught	Kept	# ID's as bycatch	Released	% bycatch	% release
1984	8,931	8,931	0	0	0.0	0.0
1985	12,978	12,978	0	0	0.0	0.0
1986	6,453	6,453	0	0	0.0	0.0
1987	7,414	7,414	0	0	0.0	0.0
1988	11,115	11,115	0	0	0.0	0.0
1989	15,955	15,955	0	0	0.0	0.0
1990	10,515	10,515	0	0	0.0	0.0
1991	12,121	12,121	0	0	0.0	0.0
1992	9,879	9,879	0	0	0.0	0.0
1993	12,291	12,291	0	0	0.0	0.0
1994	13,573	13,573	0	0	0.0	0.0
1995	22,761	22,761	0	0	0.0	0.0
1996	26,175	26,175	0	0	0.0	0.0
1997	23,450	23,450	0	0	0.0	0.0
1998	21,566	21,566	0	0	0.0	0.0
1999	24,765	24,765	0	0	0.0	0.0
2000	27,278	26,708	570	570	2.1	2.1
2001	14,305	13,617	688	688	4.8	4.8
2002	8,064	7,671	393	393	4.9	4.9
2003	10,431	10,235	196	196	1.9	1.9
2004	7,655	7,521	134	134	1.8	1.8
2005	5,718	5,646	72	72	1.3	1.3
2006	9,364	9,215	149	149	1.6	1.6
2007	6,983	6,771	212	212	3.0	3.0
2008	10,998	10,876	122	122	1.1	1.1
2009	14,561	14,481	80	80	0.5	0.5
2010	11,176	11,147	29	29	0.3	0.3
2011	23,360	23,314	46	46	0.2	0.2
2012	13,123	13,086	37	37	0.3	0.3
2013	13,056	12,984	72	72	0.6	0.6
2014	11,266	11,072	194	194	1.7	1.7
2015	10,415	10,345	70	70	0.7	0.7
10-year Ave.	**11,820**	**11,722**	**98.5**	**98.5**	**1.0**	**1.0**
10-year SD	**4,625**	**4,653**	**62.5**	**62.5**	**0.9**	**0.9**
20-year Ave.	**15,070**	**14,924**	**145.9**	**145.9**	**1.3**	**1.3**

Year	Numbers caught	Kept	# ID's as bycatch	Released	% bycatch	% release
20-year SD	**7,051**	**7,074**	**188.1**	**188.1**	**1.5**	**1.5**

Table 38. Time series of bycatch estimates in the bottomfish fishery. Percent bycatch is calculated from the numbers caught and identified as bycatch versus all caught in the fishery.

Year	Numbers caught	Released	Kept	All caught	% Bycatch
2001	3,896	623	3,273	3,896	16.0
2002	2,504	356	2,148	2,504	14.2
2003	1,888	191	1,697	1,888	10.1
2004	1,795	122	1,673	1,795	6.8
2005	1,669	66	1,603	1,669	3.95
2006	5,666	145	5,521	5,666	2.55
2007	5,361	139	5,222	5,361	2.59
2008	5,618	121	5,497	5,618	2.15
2009	2,702	77	2,625	2,702	2.84
2010	2,587	29	2,558	2,587	1.12
2011	2,081	45	2,036	2,081	2.16
2012	961	37	924	961	3.85
2013	288	44	244	288	15.28
2014	2,452	169	2,283	2,452	6.89
2015	1,420	70	1,350	1,420	4.92
10-year Avg.	**2,800**	**86**	**2,715**	**2,800**	**4**
10-year SD	**1,905**	**49**	**1,871**	**1,905**	**4**
20-year Avg.	**NA**	**NA**	**NA**	**NA**	**NA**
20-year SD	**NA**	**NA**	**NA**	**NA**	**NA**

1.2.10 Number of federal permit holders

In Guam, the following Federal permits are required for fishing in the EEZ:

1.2.10.1 Guam Large Vessel Bottomfish Permit

This permit is required for any large vessel (50 feet or longer in overall length) fishing for, landing, or transshipping bottomfish management unit species in the EEZ seaward of the Territory of Guam. The permit expires one year after the date of issuance. Large vessels are prohibited from bottomfishing in the Guam large vessel prohibited area. Vessel operators must submit a logbook to NOAA Fisheries within 72 hours after landing.

1.2.10.2 Special Coral Reef Ecosystem Permit

The coral reef ecosystem special permit is required for anyone fishing for coral reef ecosystem management unit species in a low-use MPA, fishing for species on the list of Potentially Harvested Coral Reef Taxa, or using fishing gear not specifically allowed in the regulations. The permit expires one year after the date of issuance. Permit holder must submit a logbook to NOAA Fisheries within 30 days of each landing of coral reef harvest.

A transshipment permit is required for any receiving vessel used to land or transship potentially harvested coral reef taxa, or any coral reef ecosystem management unit species caught in a low-use MPA. Exceptions to this permit requirement are made for anyone issued a permit to fish under the other western Pacific fishery management plans (pelagic, bottomfish and seamount groundfish, crustacean, or precious corals) who catch coral reef management unit species incidentally while fishing for the management unit species covered by the permit they possess. Permit holders must submit a logbook to NOAA Fisheries within seven days following the date the vessel arrived in port to land transshipped fish. Regulations governing this fishery can be found in the Code of Federal Regulations, Title 50, Part 665.

Note: The estimates were not available for this report but will be included in next year's report.

Table 39. Number of federal permits holders over time

Year	Coral reef	Bottomfish
Start year		
2014		
10-year Avg.?		
20-year Avg.?		

1.2.11 Status Determination Criteria

1.2.11.1 Bottomfish Fishery

Overfishing criteria and control rules are specified and applied to individual species within the multi-species stock whenever possible. When this is not possible, they are based on an indicator species for the multi-species stock. It is important to recognize that individual species would be affected differently based on this type of control rule, and it is important that for any given species fishing, mortality does not currently exceed a level that would result in excessive depletion of that species. No indicator species are being used for the bottomfish multi-species stock complexes and the coral reef species complex. Instead, the control rules are applied to each stock complex as a whole.

The MSY control rule is used as the maximum fishing mortality threshold (MFMT). The MFMT and minimum stock size threshold (MSST) are specified based on recommendations in 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.

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 17.

Table 40. Overfishing threshold specifications for the bottomfish management unit species in Guam

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 (SSB_{Pt}) to a given reference level (SSB_{PREF}) 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 SSB_{Pt}/SSB_{PREF}, 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 SSB_{PRMIN}. 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 18. Again, E_{MSY} is used as a proxy for F_{MSY}.

Table 41. Rebuilding control rules for the bottomfish management unit species in Guam

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

1.2.11.2 Coral Reef Fishery

Available biological and fishery data are poor for all coral reef ecosystem management unit species in the Mariana Islands. 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 can 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.

Individual species that are 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 depletion.

For the coral reef fishery, 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 are used to evaluate the status of individual MUS stocks in order to prevent recruitment overfishing. When better data and the appropriate multi-species stock assessment methodologies become available, all stocks will be evaluated independently, without proxy.

Establishing Reference Point Values

Standardized values of catch per unit effort (CPUE) and effort (E) are used to establish limit and reference point values, which act as proxies for relative biomass and fishing mortality, respectively. Limits and reference points are calculated in terms of $CPUE_{MSY}$ and E_{MSY} included in Table 19.

Table 42. Status determination criteria for the coral reef management unit species using CPUE based proxies

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

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

1.2.11.3 Current Stock Status

1.2.11.3.1 Bottomfish

Biological and other fishery data are poor for all bottomfish species in the Mariana Archipelago. 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 most recent stock assessment update (Yau et al. 2015) for the Guam bottomfish management unit species complex (comprised of 17 species of shallow and deep species of snapper, grouper, jacks, and emperors) was based on estimate of total catch, an abundance index derived from the nominal CPUE generated from the creel surveys, and a fishery-independent point estimate of MSY from the Our Living Oceans Report (Humphreys and Moffitt 1999, Moffitt & Humphreys 2009). The assessment utilized a state-space surplus production model with explicit process and observation error terms (Meyer and Millar 1999). Determinations of overfishing and overfished status can then be made by comparing current biomass and harvest rates to MSY level reference points. To date, the Guam BMUS is not subject to overfishing and is not overfished (Table 20).

Table 43. Stock assessment parameters for the Guam BMUS complex (Yau et al 2015)

Parameter	Value	Notes	Status
MSY	56.13 ± 7.79	Expressed in 1000 lbs (± std error)	
H_{2013}	0.123	Expressed in percentage	
H_{MSY}	0.352 ± 0.059	Expressed in percentage (± std error)	
H/H_{MSY}	0.356		No overfishing occurring
B_{2013}	264.7	Expressed in thousand pounds	
B_{MSY}	162.3 ± 23.8	Expressed in 1000 lbs (± std error)	
B/ B_{MSY}	1.63		Not overfished

1.2.11.3.2 Coral reef

The application of the SDCs for the management unit species in the coral reef fisheries is limited due to various challenges. First, the thousands of species included in the coral reef MUS makes the SDC and status determination impractical. Second, the CPUE derived from the creel survey is based on the fishing method and there is no species-specific CPUE information available. In order to allocate the fishing method level CPUE to individual species, the catch data (the value of catch is derived from CPUE hence there is collinearity) will have to be identified to species level and CPUE will be parsed out by species composition. The third challenge is that there is very little species-level identification applied to the creel surveys. There has been no attempt to estimate MSY for the coral reef MUS until the 2007 re-authorization of MSA that requires the Council to specify ACLs for species in the FEPs.

For ACL specification purposes, MSYs in the coral reef fisheries are determined by using the Biomass-Augmented Catch-MSY approach (Sabater and Kleiber 2014). This method estimates MSY using plausible combination rates of population increase (denoted by r) and carrying capacity (denoted by k) assumed from the catch time series, resilience characteristics (from FishBase), and biomass from existing underwater census surveys done by the Pacific Island Fisheries Science Center. This method was applied to species complexes grouped by taxonomic families. The most recent MSY estimates are found in Table 21. The SSC utilized the MSYs for the coral reef MUS complexes as the OFLs.

Table 44. Best available MSY estimates for the coral reef MUS in Guam

Coral Reef MUS Complex	MSY (lbs)
Selar crumenophthalmus – atulai or bigeye scad	61,300
Acanthuridae – surgeonfish	118,000

Coral Reef MUS Complex	MSY (lbs)
Carangidae – jacks	31,700
Crustaceans – crabs	8,600
Holocentridae – squirrelfish	13,900
Kyphosidae – chubs/rudderfish	10,300
Labridae – wrasses[1]	28,500
Lethrinidae – emperors	78,000
Lutjanidae – snappers	21,800
Mollusks – turbo snail; octopus; giant clams	29,000
Mugilidae – mullets	26,200
Mullidae – goatfish	16,400
Scaridae – parrotfish[2]	87,100
Serranidae – groupers	28,600
Siganidae – rabbitfish	19,700
All Other CREMUS Combined - Other CRE-finfish - Other invertebrates - Misc. bottomfish - Misc. reef fish - Misc. shallow bottomfish	211,300
Cheilinus undulatus – humphead (Napoleon) wrasse	N.A.
Bolbometopon muricatum – bumphead parrotfish	N.A.
Carcharhinidae – reef sharks	2,900

1.2.12 Overfishing Limit, Acceptable Biological Catch, and Annual Catch Limits

1.2.12.1 Brief description of the ACL process

The Council developed a Tiered system of control rules to guide the specification of ACLs and Accountability Measures (AMs) (WPRFMC 2011). The process starts with the use of the best scientific information available (BSIA) in the form of, but not limited to, stock assessments, published paper, reports, or available data. These information are classified to the different Tiers in the control rule ranging from Tier 1 (most information available typically an assessment) to Tier 5 (catch-only information). The control rules are applied to the BSIA. Tiers 1 to 3 would involve conducting a Risk of Overfishing Analysis (denoted by P*) to quantify the scientific uncertainties around the assessment to specify the Acceptable Biological Catch (ABC). This would lower the ABC from the OFL (MSY-based). A Social, Ecological, Economic, and Management (SEEM) Uncertainty Analysis is performed to quantify the uncertainties from the SEEM factors. The buffer is used to lower the ACL from the ABC. For Tier 4 which are stocks with MSY estimates but no active fisheries, the control rule is 91% of MSY. For Tier 5 which has catch-only information, the control rule is a third reduction in the median catch depending on the qualitative evaluation on what the stock status is based on expert opinion. ACL specification can choose from a variety of method including the above-mentioned SEEM analysis or a percentage buffer (% reduction from ABC based on expert opinion) or the use of an Annual Catch Target. Specifications are done on an annual basis but the Council normally specifies a multi-year specification.

The Accountability Measure for the coral reef and bottomfish fisheries in Guam is an overage adjustment. The ACL is downward adjusted with the amount of overage from the ACL based on a three-year running average.

1.2.12.2 Current OFL, ABC, ACL, and recent catch

The most recent multiyear specification of OFL, ABC, and ACL for the coral reef fishery was completed in the 160th Council meeting on June 25 to 27, 2014. The specification covers fishing year 2015, 2016, 2017, and 2018 for the coral reef MUS complexes. A P* and SEEM analysis was performed for this multiyear specification (NMFS 2015). For the bottomfish, it was a roll over from the previous specification since an assessment update was not available for fishing year 2015.

Table 45. Mariana Archipelago – Guam ACL table with 2015 catch (values are in pounds)

Fishery	**MUS**	**OFL**	**ABC**	**ACL**	**Catch**
Bottomfish	Bottomfish multi-species complex	71,000	66,800	66,800	21,582
Crustacean	Deepwater shrimp	N.A.	48,488	48,488	NAF
	Spiny lobster	4,600	3,300	3,135	876
	Slipper lobster	N.A.	20	20	0
	Kona crab	N.A.	1,900	1,900	NAF
Precious coral	Black coral	8,250	700	700	NAF
	Precious coral in CNMI expl. area	N.A.	2,205	2,205	NAF
Coral Reef	*Selar crumenophthalmus*	61,300	52,300	50,200	23,141
	Acanthuridae-surgeonfish	118,000	101,700	97,600	21,344
	Carangidae-jacks	31,700	29,900	29,300	37,399
	Crustaceans-crabs	8,600	7,600	7,300	1,870
	Holocentridae-squirrelfish	13,900	12,000	11,400	3,894
	Kyphosidae-rudderfish	10,300	9,800	9,600	5,819
	Labridae-wrasse	28,500	25,800	25,200	1,903
	Lethrinidae-emperors	78,000	58,000	53,000	21,709
	Lutjanidae-snappers	21,800	18,600	18,000	6,987
	Mollusk-turbo snails; octopus; clams	29,000	25,000	23,800	10,179
	Mugilidae-mullets	26,200	19,400	17,900	3,226
	Mullidae-goatfish	16,400	15,600	15,300	10,892
	Scaridae-parrotfish	87,100	75,000	71,600	9,767
	Serranidae-groupers	28,600	23,700	22,500	7,865
	Siganidae-rabbitfish	19,700	19,500	18,600	8,329
	All other CREMUS combined	211,300	191,300	185,000	42,305
	Cheilinus undulatus	N.A.	1,960	1,960	188
	Bolbometopon muricatum	N.A.	797	797*	0
	Carcharhinidae-reef sharks	2,900	2,000	1,900	1,575

NOTE: *The ACL for *B. muricatum* is shared with CNMI (1 ACL for the whole archipelago)

The catch shown in Table 22 takes the average of the recent three years as recommended by the Council at its 160th meeting to avoid large fluctuations in catch due to data quality and outliers. NAF indicates no active fisheries as of date.

1.2.13 Best scientific information available

1.2.13.1 Bottomfish fishery

1.2.13.1.1 Stock assessment benchmark

The benchmark stock assessment for the Territory Bottomfish Management Unit Species complex was developed and finalized in October 2007 (Moffitt et al. 2007). This benchmark utilized a Bayesian statistical framework to estimate parameters of a Schaefer model fit to a time series of annual CPUE statistics. The surplus production model included process error in biomass production dynamics and observation error in the CPUE data. This was an improvement to the previous approach of using index-based proxies for B_{MSY} and F_{MSY}. Best available information for the bottomfish stock assessment is as follows:

Input data: The CPUE and catch data used were from the Guam off-shore creel survey. The catch and CPUE were expanded on an annual level. CPUE was expressed in line-hours. The data was screened for trips that landed more than 50% BMUS species using the handline gear.

Model: state-space model with explicit process and observation error terms (see Meyer and Millar, 1999).

Fishery independent source for biomass: point estimate of MSY from the Our Living Oceans Report (Humphreys and Moffitt 1999, Moffitt & Humphreys 2009)

1.2.13.1.2 Stock assessment updates

Updates to the 2007 benchmark done in 2012 (Brodziak et al. 2012) and 2015 (Yau et al. 2015). These included a three-year stock projection table used for selecting the level of risk the fishery will be managed under ACLs. Yau et al. (2015) is considered the best scientific information available for the Territory bottomfish MUS complex after undergoing a WPSAR Tier 3 panel review (Franklin et al. 2015). This was the basis for the P* analysis and SEEM analysis that determined the risk levels to specify ABCs and ACLs.

1.2.13.1.3 Other information available

Approximately every five years PIFSC administers a socioeconomic survey to small boat fishermen in Guam. This survey consists of about 60 questions regarding a variety of topics, including fishing experiences, market participation, vessels and gear, demographics and household income, and fishermen perspectives. The survey requests participants to identify which MUS they primarily targeted during the previous 12 months, by percentage of trips. Full reports of these surveys can be found at the PIFSC Socioeconomics webpage (Hospital and Beavers 2011)

1.2.13.2 Coral reef fishery

1.2.13.2.1 Stock assessment benchmark

No stock assessment has been generated for the coral reef fisheries. The SDCs using index-based proxies were tested for its applicability in the different MUS in the coral reef fisheries (Hawhee 2007). This analysis was done on a gear level. It paints a dire situation for the shore-based fishery with 43% of the gear/species combination falling below Bflag and 33% below MSST with most catch and CPUE trends showing a decline over time. The off-shore fisheries were shown to be less dire with 50% of the gear/species combination falling below Bflag and 38% below MSST - but the catch and CPUE trends were increasing over time. The inconsistency in the CPUE and catch trends with the SDC results makes this type of assessment to be unreliable.

The first attempt to use a model-based approach in assessing the coral reef MUS complexes was done in 2014 using a biomass-based population dynamics model (Sabater and Kleiber 2014). This model was based on the original Martell and Froese (2012) model but was augmented with biomass information to relax the assumption behind carrying capacity. It estimates MSY based on a range of rate of population growth (*r*) and carrying capacity (K) values. The best available information for the coral reef stock assessment is as follows:

Input data: The catch data was derived from the inshore and off-shore creel surveys. Commercial receipt book information was also used in combination with the creel data. A downward adjustment was done to address for potential overlap due to double reporting.

Model: Biomass Augmented Catch MSY approach based on the original catch-MSY model (Martell and Froese 2012; Sabater and Kleiber 2014).

Fishery independent source for biomass: biomass density from the Rapid Assessment and Monitoring Program of NMFS-CREP was expanded to the hard bottom habitat from 0-30 m (Williams 2010).

This model had undergone a CIE review in 2014 (Cook 2014; Haddon 2014; Jones 2014). This was the basis for the P* analysis that determined the risk levels to specify ABCs

1.2.13.2.2 Stock assessment updates

No updates available for the coral reef MUS complex. However, NMFS-PIFSC is finalizing a length-based model for estimating sustainable yield levels and various biological reference points (Nadon et al. 2015). This can be used on a species level. The Council is also working with a contractor to enhance the BAC-MSY model to incorporate catch, biomass, CPUE, effort, and length-based information in an integrated framework (Martell 2015)

1.2.13.2.3 Other information available

Approximately every five years PIFSC administers a socioeconomic survey to small boat fishermen in Guam. This survey consists of about 60 questions regarding a variety of topics, including fishing experiences, market participation, vessels and gear, demographics and household income, and fishermen perspectives. The survey requests participants to identify which MUS they primarily targeted during the previous 12 months, by percentage of trips. Full reports of these surveys can be found at the PIFSC Socioeconomics webpage (Hospital and Beavers 2011).

PIFSC and the Council conducted a workshop with various stakeholders in CNMI to identify factors and quantify uncertainties associated with the social, economic, ecological, and management of the coral reef fisheries (Sievanen and McCaskey 2014). This was the basis for the SEEM analysis that determined the risk levels to specify ACLs.

1.2.14 Harvest capacity and extent

The MSA defines the term “optimum,” with respect to the yield from a fishery, as the amount of fish which:

- 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.
- is prescribed on the basis of the MSY from the fishery, as reduced by any relevant social, economic, or ecological factor.
- in the case of an overfished fishery, provides for rebuilding to a level consistent with producing the MSY in such a fishery [50 CFR §600.310(f)(1)(i)].

Optimum yield in the coral reef and bottomfish fisheries is prescribed based on the MSY from the stock assessment and the best available scientific information. In the process of specifying ACLs, social, economic, and ecological factors were considered and the uncertainties around those factors defined the management uncertainty buffer between the ABC and ACL. OY for the bottomfish and coral reef fish MUS complexes is defined to be the level of harvest equal to the ACL consistent with the goals and objectives of the Fishery Ecosystem Plans and used by the Council to manage the stock.

The Council recognizes that MSY and OY are long-term values whereas the ACLs are yearly snapshots based on the level of fishing mortality at F_{MSY}. There are situations when the long-term means around MSY are going to be lower than ACLs especially if the stock is known to be productive or relatively pristine or lightly fished. One can have catch levels and catch rates exceeding that of MSY over short-term enough to lower the biomass to a level around the estimated MSY and still not jeopardize the stock. This situation is true for the territory bottomfish multi-species complex.

The harvest extent, in this case, is defined as the level of catch harvested in a fishing year relative to the ACL or OY. The harvest capacity is the level of catch remaining in the annual catch limit that can potentially be used for TALLF. Table 23 summarizes the harvest extent and harvest capacity information for Guam in 2015

Table 46. Mariana Archipelago – Guam proportion of harvest extent (values are in percentage), defined as the proportion of fishing year landing relative to the ACL or OY, and the harvest capacity, defined as the remaining portion of the ACL or OY that can potentially be harvested in a given fishing year.

Fishery	MUS	ACL	Catch	Harvest extent (%)	Harvest capacity (%)
Bottomfish	Bottomfish multi-species complex	66,800	13,664	20.5	67.7
Crustacean	Deepwater shrimp	48,488	N.A.F	#VALUE!	#VALUE!
	Spiny lobster	3,135	0	0.0	72.1
	Slipper lobster	20	0	0.0	100.0
	Kona crab	1,900	N.A.F	#VALUE!	#VALUE!
Precious coral	Black coral	700	N.A.F	#VALUE!	#VALUE!
	Precious coral in CNMI expl. area	2,205	N.A.F	#VALUE!	#VALUE!
Coral Reef	*Selar crumenophthalmus*	50,200	30,026	59.8	53.9
	Acanthuridae-surgeonfish	97,600	19,295	19.8	78.1
	Carangidae-jacks	29,300	26,540	90.6	-27.6
	Crustaceans-crabs	7,300	968	13.3	74.4

	Holocentridae-squirrelfish	11,400	3,772	33.1	65.8
	Kyphosidae-rudderfish	9,600	1,544	16.1	39.4
	Labridae-wrasse	25,200	2,482	9.8	92.4
	Lethrinidae-emperors	53,000	12,525	23.6	59.0
	Lutjanidae-snappers	18,000	6,241	34.7	61.2
	Mollusk-turbo snails; octopus; clams	23,800	22,634	95.1	57.2
	Mugilidae-mullets	17,900	1,282	7.2	82.0
	Mullidae-goatfish	15,300	11,584	75.7	28.8
	Scaridae-parrotfish	71,600	3,964	5.5	86.4
	Serranidae-groupers	22,500	5,189	23.1	65.0
	Siganidae-rabbitfish	18,600	5,896	31.7	55.2
	All other CREMUS combined	185,000	73,969	40.0	77.1
	Cheilinus undulatus	1,960	143	7.3	90.4
	Bolbometopon muricatum	797*	0	#VALUE!	100.0
	Carcharhinidae-reef sharks	1,900	1,817	95.6	17.1

1.2.15 Other relevant ocean uses and fishery-related information

1.2.15.1 Marine preserves

Guam has five locally-managed Marine Preserves (MPAs): Achang Reef Flat, in Merizo, Sasa Bay in Piti, Piti Bombholes in Piti, Tumon Bay in Tumon, and Pati Point, located in Yigo. A total of 11.8% of Guam's coastline is within the MPAs.

In 2015, there were 16 cases (31 individuals) of illegal fishing in the MPAs. Five cases (6) in the Piti Bombholes MPA, four cases (6) in the Achang Reef Flat MPA, and seven cases (19) in the Tumon Bay MPA. Total weight of fish and invertebrates caught in the MPA arrests during 2015 was 89.20 pounds.

1.2.15.2 Local environmental co-variates

There were 21 separate weather events covering 122 high surf advisory days in 2015, an increase from 102 in 2014. Of these, 119 involved the north and west sides of Guam. Guam was struck by Typhoon Dolphin in May.

In early 2010, the U.S. military began exercises in an area south and southeast of Guam designated W-517. W-517 is a special use airspace (SUA) (approximately 14,000 nm2) that overlays deep open ocean approximately 50 miles south-southwest of Guam. Exercises in W-517 generally involve live fire and/or pyrotechnics. When W-517 is in use, a notice to mariners (NTM) is issued, and vessels attempting to use the area are advised to be cautious of objects in the water and other small vessels. This discourages access to virtually all banks south of Guam, including Galvez, Santa Rosa, White Tuna, and other popular fishing areas. From 1982-2015, DAWR surveys recorded more than 2930 trolling and bottom fishing trips to these southern banks, an average of more than 83 trips per year. The number of NTM in 2015 was 69, equaling 109 closure days. This certainly impacted the number of available fishing days south of Guam.

1.2.16 Administrative and Regulatory Actions

This summary describes management actions PIRO has taken since the April 2015 Joint FEP Plan Team meeting, as reported to the 163rd to 165th Western Pacific Fishery Management Council meetings held June 2015, October 2015, and March 2016.

On August 31, 2015, NMFS published a final rule to implement annual catch limits for 2015 Pacific Island bottomfish, crustacean, precious coral, and coral reef ecosystem fisheries, and accountability measures to correct or mitigate any overages of catch limits (80 FR 52415). The catch limits and accountability measures.

On November 6, 2015, NMFS specified a limit of 2,000 mt of longline-caught bigeye tuna for Guam, and allowed the territory to allocate up to 1,000 mt to U.S. longline fishing vessels in a specified fishing agreement (80 FR 68778). On November 25, 2015, the Governor of Guam transmitted a specified fishing agreement that NMFS determined met the criteria set forth at 50 CFR 665.819, and NMFS immediately began attributing bigeye tuna caught by those vessels to Guam. Preliminary data indicate these vessels did not harvest the entire 1,000-mt allocation by the end of 2015.

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2 ECOSYSTEM CONSIDERATIONS

2.1 Coral Reef Ecosystem Parameters

2.1.1 Regional Reef Fish Biomass

Description: 'Reef fish biomass' is mean biomass of reef fishes per unit area derived from visual survey data (details of survey program below) between 2009 and 2015.

Category:

- ✓ Fishery independent
- ☐ Fishery dependent
- ☐ Biological

Timeframe: Triennial

Jurisdiction:

- ✓ American Samoa
- ✓ Guam
- ✓ Commonwealth of Northern Mariana Islands
- ✓ Main Hawaiian Islands
- ✓ Northwest Hawaiian Islands
- ✓ Pacific Remote Island Areas

Spatial Scale:

- ✓ Regional
- ☐ Archipelagic
- ☐ Island
- ☐ Site

Data Source: Data used to generate biomass estimates comes from visual surveys conducted by NOAA PIFSC Coral Reef Ecosystem and partners, as part of the Pacific Reef Assessment and Monitoring Program (http://www.pifsc.noaa.gov/cred/pacific_ramp.php). Survey methods are described in detail elsewhere (http://www.pifsc.noaa.gov/library/pubs/admin/PIFSC_Admin_Rep_15-07.pdf), but in brief involve teams of divers conducting stationary point count cylinder (SPC) surveys within a target domain of <30m hard-bottom habitat at each island, stratified by depth zone and, for larger islands, by section of coastline. For consistency among islands, only data from forereef habitats is used here. At each SPC, divers record the number, size and species of all fishes within or passing through paired 15m-diameter cylinders in the course of a standard count procedure. Fish sizes and abundance are converted to biomass using standard length-to-weight conversion parameters, taken largely from FishBase (http://www.fishbase.org), and converted to biomass per unit area, by dividing by the area sampled per survey. Site-level data were pooled into island-scale values by first calculating mean and variance within strata, and then calculating weighted island-scale mean and variance using the formulas given in (Smith et al., 2011), with strata weighted by their respective sizes.

Rationale: Reef Fish biomass, i.e. the weight of fish per unit area has been widely used as an indicator of relative status, and has repeatedly been shown to be changes in fishing pressure, habitat quality, and oceanographic regime.

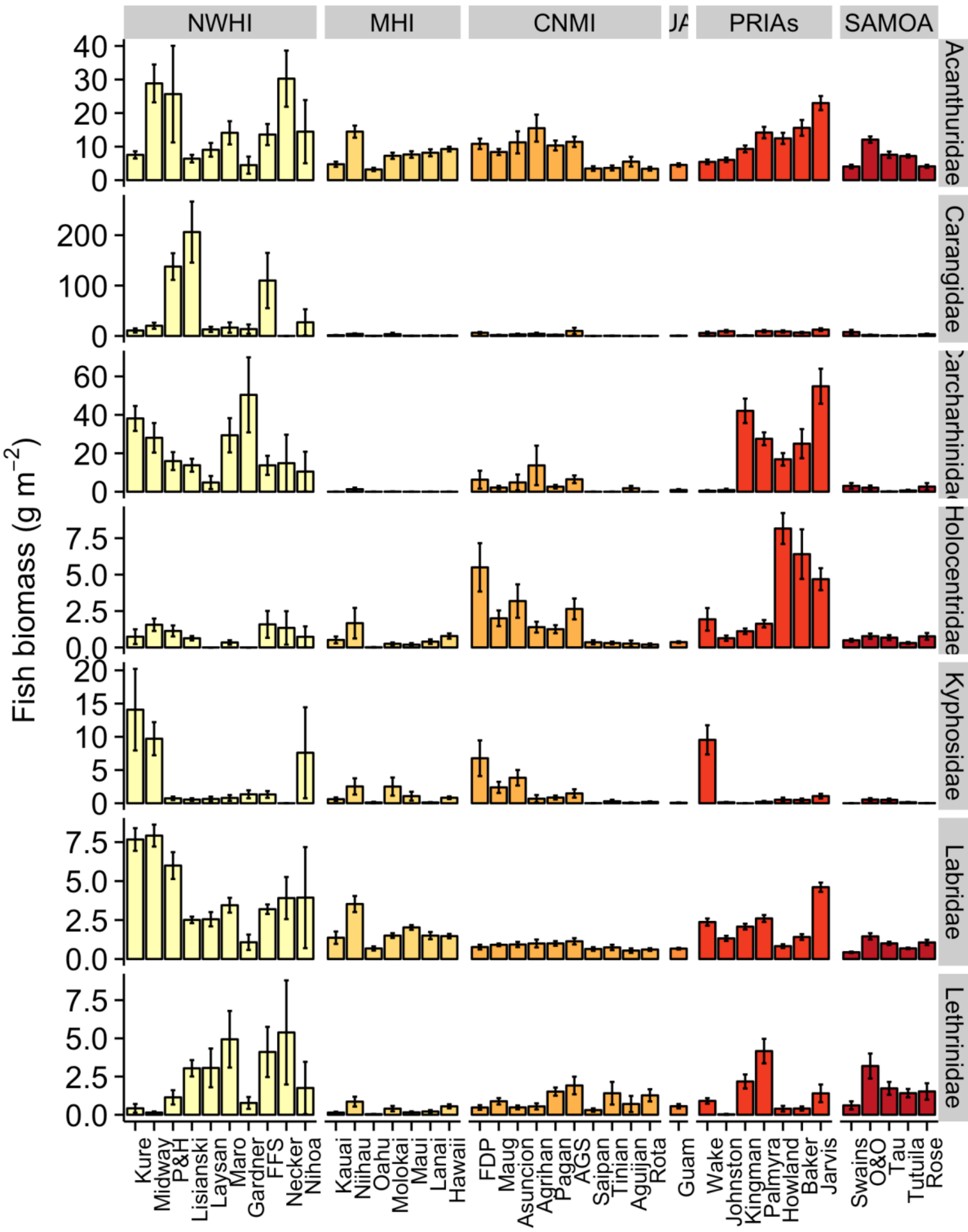
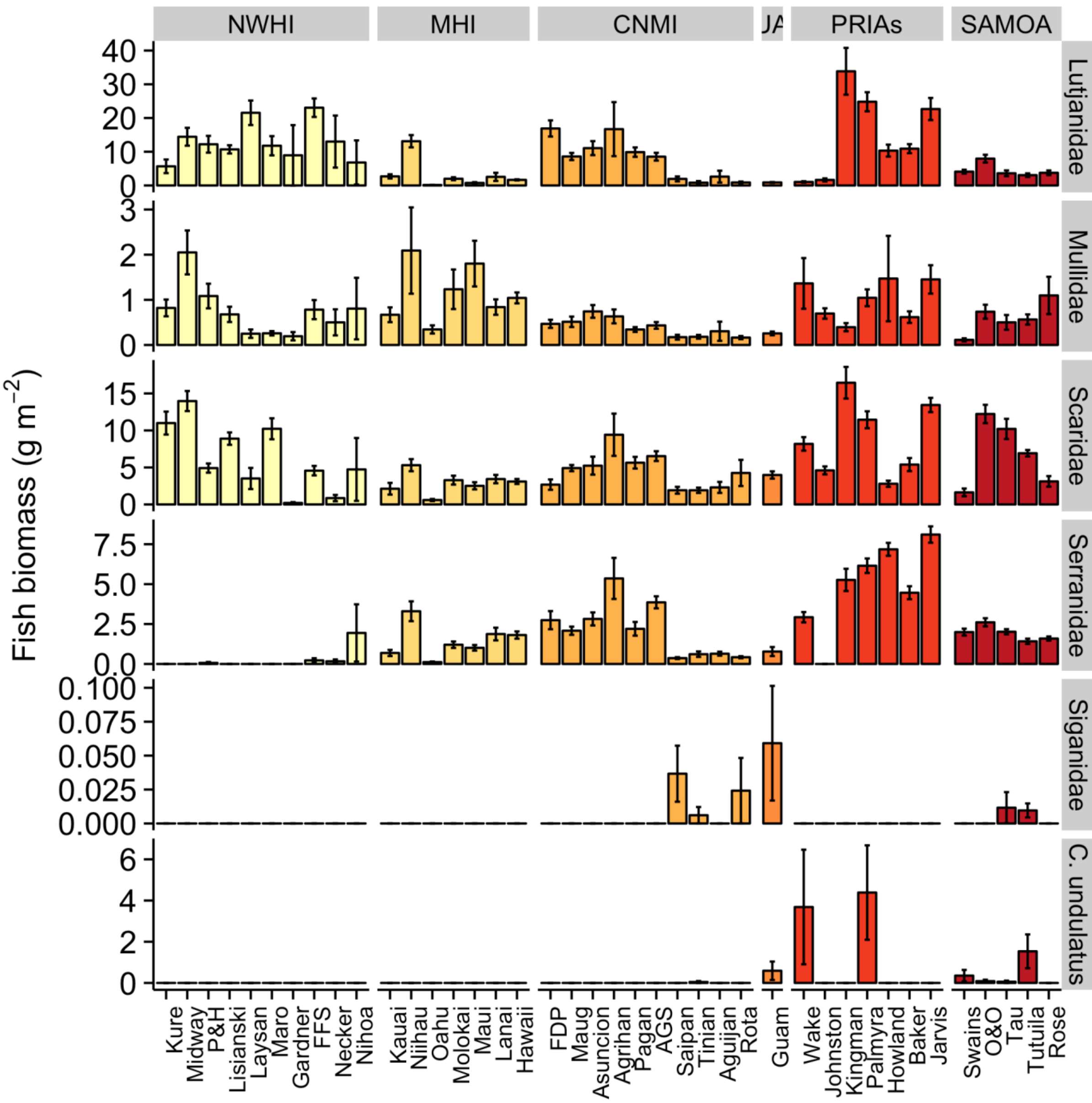


Figure 1. Mean fish biomass by Coral Reef Management Unit Species (CREMUS) grouping per US Pacific reef area. Mean fish biomass (± standard error) per CREMUS grouping per reef area pooled across survey years (2009-2015). Islands ordered within region by latitude. Continues to next page.



2.1.2 CNMI Reef Fish Biomass

Description: 'Reef fish biomass' is mean biomass of reef fishes per unit area derived from visual survey data (details of survey program below) between 2009 and 2015.

Category:

- ✓ Fishery independent
- ☐ Fishery dependent
- ☐ Biological

Timeframe: Triennial

Jurisdiction:

- ☐ American Samoa
- ☐ Guam
- ✓ Commonwealth of Northern Mariana Islands
- ☐ Main Hawaiian Islands
- ☐ Northwest Hawaiian Islands
- ☐ Pacific Remote Island Areas

Scale:

- ☐ Regional
- ☐ Archipelagic
- ✓ Island
- ☐ Site

Data Source: Data used to generate biomass estimates comes from visual surveys conducted by NOAA PIFSC Coral Reef Ecosystem and partners, as part of the Pacific Reef Assessment and Monitoring Program (http://www.pifsc.noaa.gov/cred/pacific_ramp.php). Survey methods are described in detail elsewhere (http://www.pifsc.noaa.gov/library/pubs/admin/PIFSC_Admin_Rep_15-07.pdf), but in brief involve teams of divers conducting stationary point count cylinder (SPC) surveys within a target domain of <30m hard-bottom habitat at each island, stratified by depth zone and, for larger islands, by section of coastline. For consistency among islands, only data from forereef habitats is used here. At each SPC, divers record the number, size and species of all fishes within or passing through paired 15m-diameter cylinders in the course of a standard count procedure. Fish sizes and abundance are converted to biomass using standard length-to-weight conversion parameters, taken largely from FishBase (http://www.fishbase.org), and converted to biomass per unit area, by dividing by the area sampled per survey. Site-level data were pooled into island-scale values by first calculating mean and variance within strata, and then calculating weighted island-scale mean and variance using the formulas given in (Smith et al., 2011), with strata weighted by their respective sizes.

Rationale: Reef Fish biomass, i.e. the weight of fish per unit area, has been widely used as an indicator of relative status, and has repeatedly been shown to be changes in fishing pressure, habitat quality, and oceanographic regime.

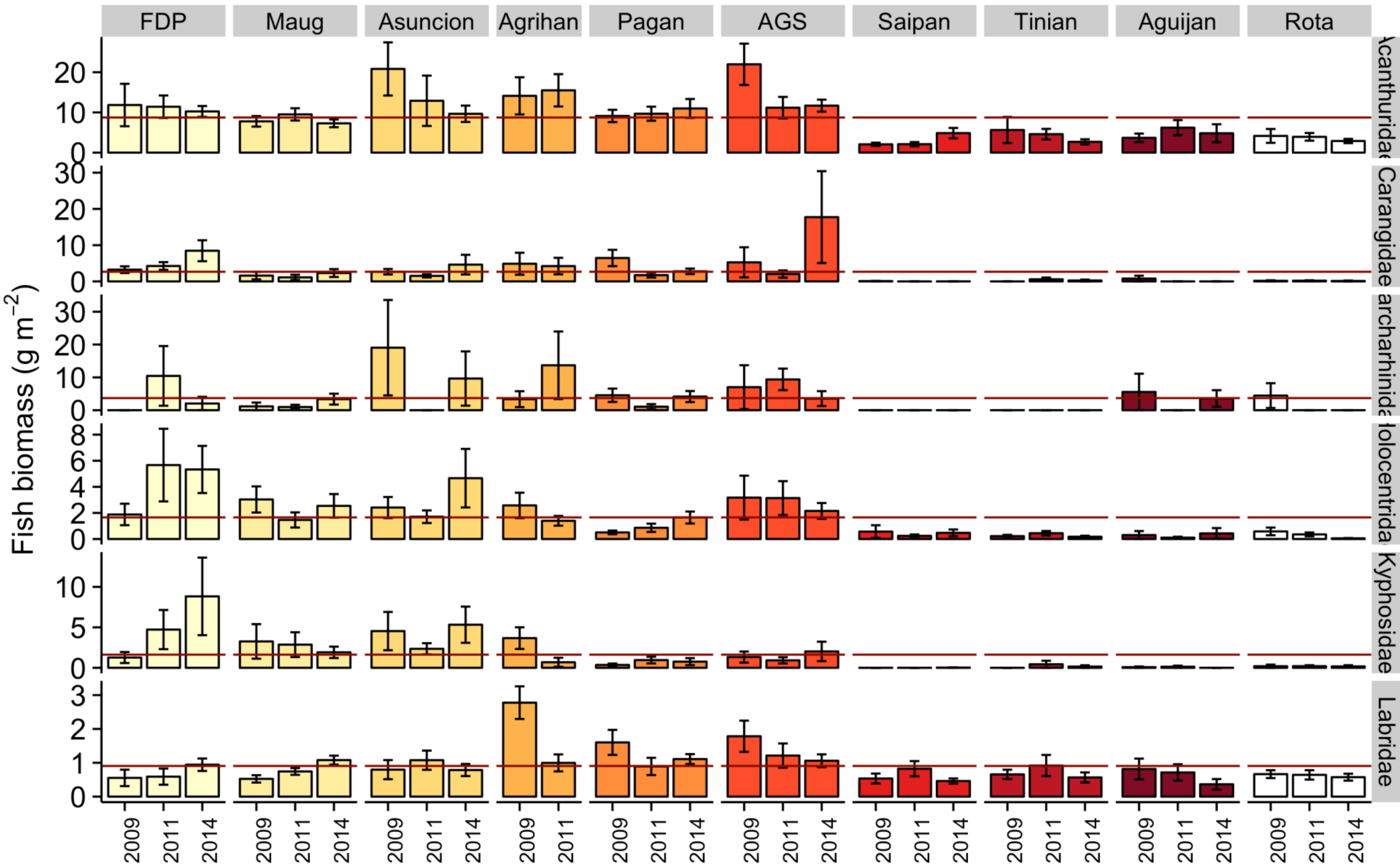
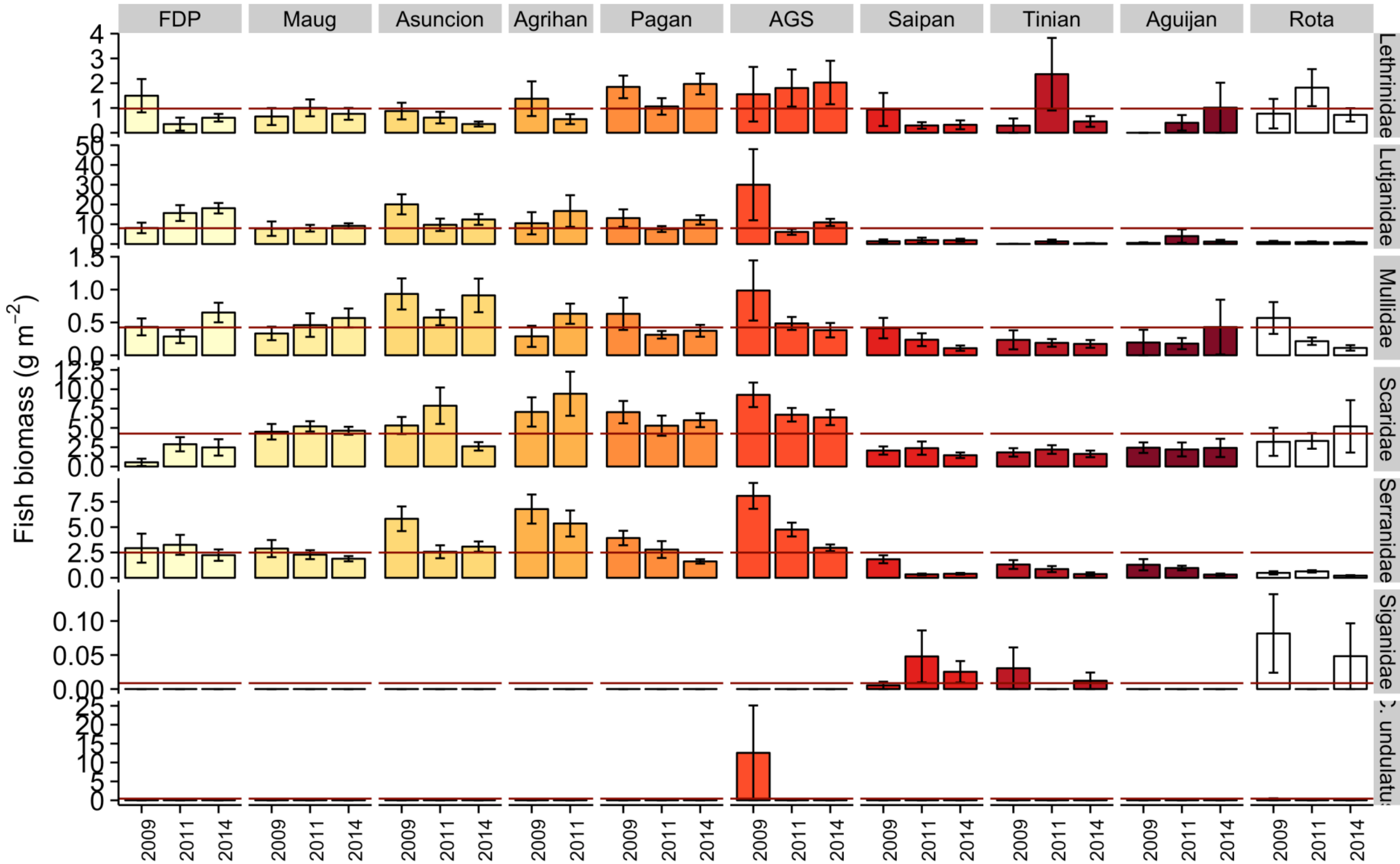


Figure 2. Mariana archipelago mean reef fish biomass. Anatahan, Guguan, and Sarigan have been grouped. Continues to next page.


FDP
Maug
Asuncion
Agrihan
Pagan
AGS
Saipan
Tinian
Aguijan
Rota
Lethrinidae
Lutjanidae
Mullidae
Scaridae
Serranidae
Siganidae
C. undulatus
Fish biomass (g m^{-2})
2009
2011
2014

2.1.3 CNMI Archipelagic Mean Fish Size

Description: 'Mean fish size' is mean size of reef fishes > 10 cm TL (i.e. excluding small fishes) derived from visual survey data (details of survey program below) between 2009 and 2015.

Category:

- ✓ Fishery independent
- ☐ Fishery dependent
- ☐ Biological

Timeframe: Triennial

Jurisdiction:

- ☐ Regional
- ☐ American Samoa
- ☐ Guam
- ✓ Commonwealth of Northern Mariana Islands
- ☐ Main Hawaiian Islands
- ☐ Northwest Hawaiian Islands
- ☐ Pacific Remote Island Areas

Scale:

- ☐ Regional
- ☐ Archipelagic
- ✓ Island
- ☐ Site

Data Source: Data used to generate mean size estimates comes from visual surveys conducted by NOAA PIFSC Coral Reef Ecosystem and partners, as part of the Pacific Reef Assessment and Monitoring Program (http://www.pifsc.noaa.gov/cred/pacific_ramp.php). Survey methods are described in detail elsewhere (http://www.pifsc.noaa.gov/library/pubs/admin/PIFSC_Admin_Rep_15-07.pdf), but in brief involve teams of divers conducting stationary point count cylinder (SPC) surveys within a target domain of <30m hard-bottom habitat at each island, stratified by depth zone and, for larger islands, by section of coastline. For consistency among islands, only data from forereef habitats is used here. At each SPC, divers record the number, size (total length, TL) and species of all fishes within or passing through paired 15m-diameter cylinders in the course of a standard count procedure. Fishes smaller than 10 cm TL are excluded so that the fish assemblage measured more closely reflects fishes that are potentially fished, and so that mean sizes are not overly influenced by variability in space and time of recent recruitment. Site-level data were pooled into island-scale values by first calculating mean and variance within strata, and then calculating weighted island-scale mean and variance using the formulas given in (Smith et al., 2011), with strata weighted by their respective sizes.

Rationale: Mean size is important as mean size is widely used as an indicator of fishing pressure – not only do fishers sometimes preferentially target large individuals, but also because one effect of fishing is to reduce the number of fishes reaching older (and larger) size classes. Large fishes also contribute disproportionately to community fecundity and can have important ecological roles – for example, excavating bites by large parrotfishes probably have a longer lasting impact on reef benthos than bites by smaller fishes.

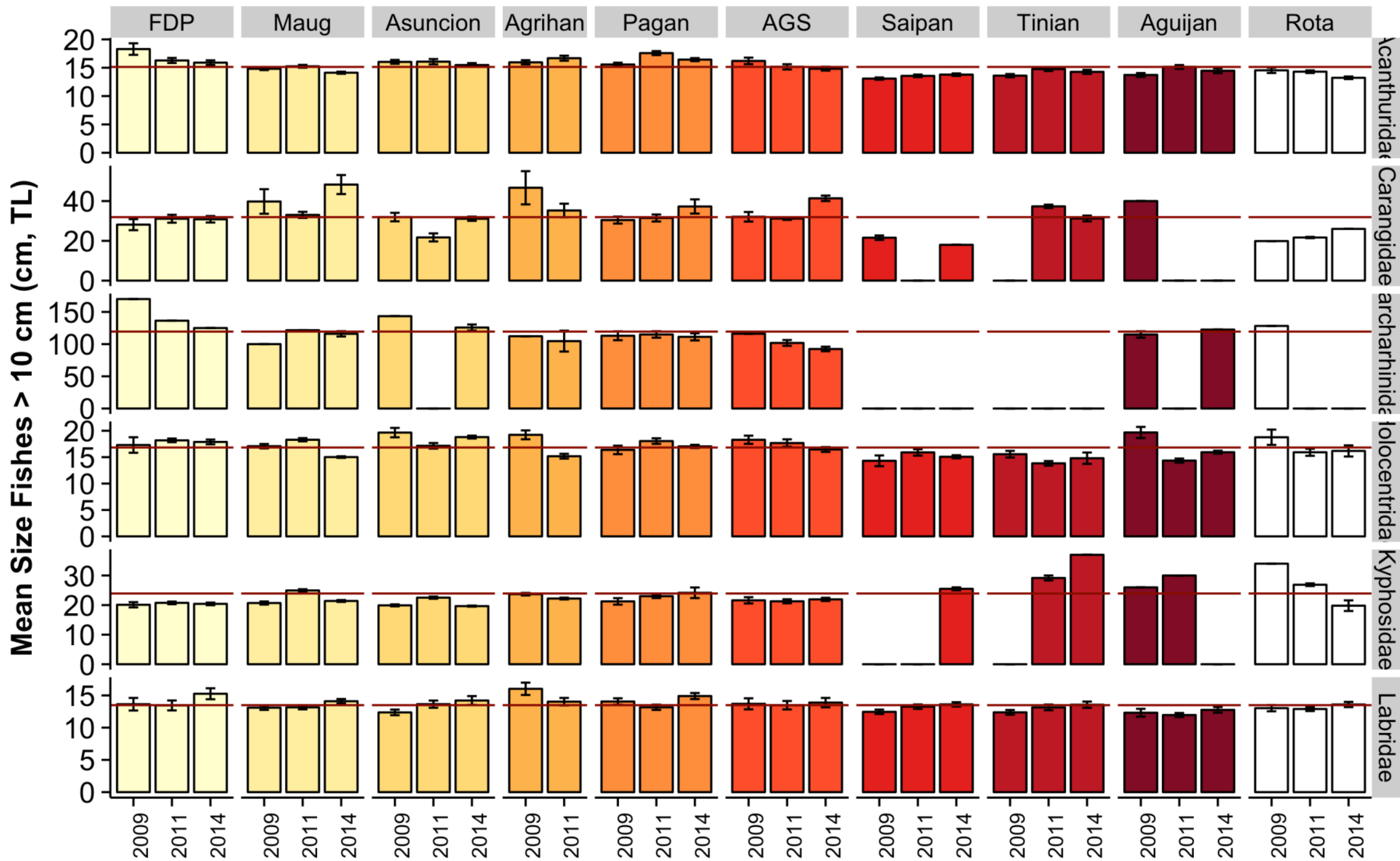
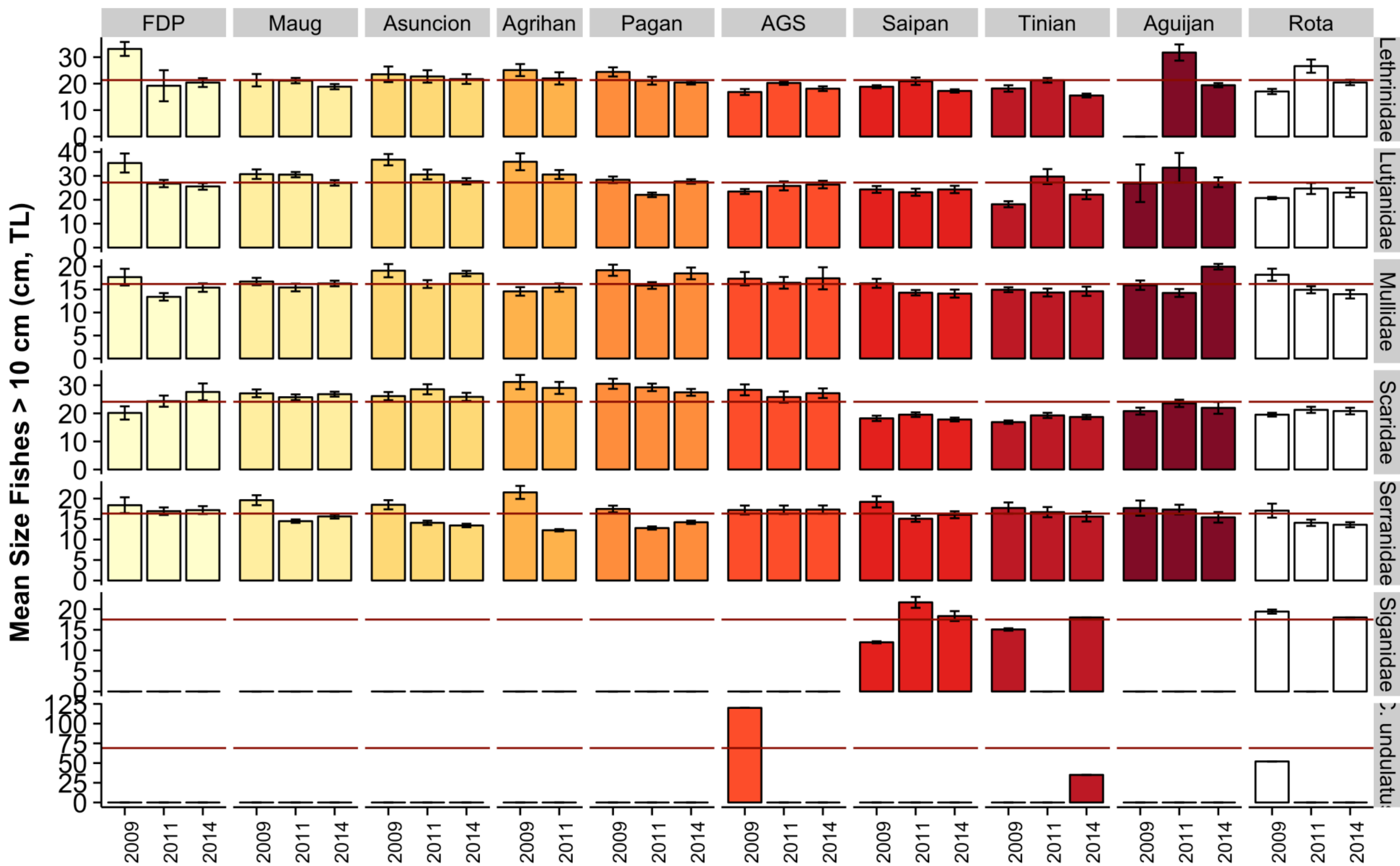


Figure 3. Mariana Archipelago mean fish size. anatahan, Guguan, and Sarigan have been grouped. Continues to next page.



FDP
Maug
Asuncion
Agrihan
Pagan
AGS
Saipan
Tinian
Aguijan
Rota
Lethrinidae
Lutjanidae
Mullidae
Scaridae
Serranidae
Siganidae
Mean Size Fishes > 10 cm (cm, TL)
2009
2011
2014

2.1.4 CNMI Reef Fish Population Estimates

Description: Reef fish population estimates are made by multiplying mean biomass per unit area by estimated area of hardbottom in a consistent habitat across all islands (specifically, the area of hardbottom forereef habitat in < 30m water).

Category:

- ✓ Fishery independent
- ☐ Fishery dependent
- ☐ Biological

Timeframe: Triennial

Jurisdiction:

- ☐ Regional
- ☐ American Samoa
- ☐ Guam
- ✓ Commonwealth of Northern Mariana Islands
- ☐ Main Hawaiian Islands
- ☐ Northwest Hawaiian Islands
- ☐ Pacific Remote Island Areas

Scale:

- ☐ Regional
- ☐ Archipelagic
- ✓ Island
- ☐ Site

Data Source: Data used to generate mean size estimates comes from visual surveys conducted by NOAA PIFSC Coral Reef Ecosystem and partners, as part of the Pacific Reef Assessment and Monitoring Program (http://www.pifsc.noaa.gov/cred/pacific_ramp.php). Survey methods and sampling design, and methods to generate reef fish biomass are described above (SECTION: REEF FISH BIOMASS). Those estimates are converted to population estimates by multiplying biomass (g/m2) per island by the estimated area of hardbottom habitat <30m deep at the island, which is the survey domain for the monitoring program that biomass data comes from. Estimated habitat areas per island are derived from GIS bathymetry and habitat maps maintained by NOAA Coral Reef Ecosystems Program. It is important to recognize that many reef fishes taxa are present in other habitats and in deeper water than is surveyed by that program, and even that some taxa likely have the majority of their populations in deeper water. Additionally, fish counts have the potential to be biased by the nature of fish responses to divers: curious fishes, particularly in locations where divers are not perceived as a threat, will tend to be overcounted by visual survey, and skittish fishes will tend to be undercounted. Likely numbers of jacks and sharks in some locations (particularly the NWHI) are overcounted by visual survey. Nevertheless, in spite of these issues, the data shown here are consistently gathered across space and time.

Rationale: These data have utility in understanding the size of populations from which fishery harvests are extracted.

Table 47. Reef fish population estimates for CNMI. Fish species are pooled by CREMUS groupings. Estimated population biomass is for 0-30 m hardbottom habitat only. (n) is number of sites surveyed per island. Each site is surveyed by means of two to four, 7.5 m diameter SPCs. However, those are not considered to be independent samples, so data from those is pooled to site level before other analysis. 'AGS' is a combined value for Alamagan, Guguan, and Sarigan. Those three small islands situated between Saipan and Pagan are treated as a single unit by the monitoring program which is the source of visual survey data here.

			ESTIMATED POPULATION BIOMASS (metric Tonnes) in SURVEY DOMAIN OF <30m HARDBOTTOM					
ISLAND	Total Area of reef (Ha)	N	Acanthuridae	Carangidae	Carcharhinids	Holocentridae	Kyphosidae	Labridae
Farallon de Pajaros	138.5	23	15.0	8.8	8.7	7.6	9.4	1.1
Maug	313.9	70	26.4	5.4	6.8	6.3	7.5	2.9
Asuncion	248.6	41	28.0	7.7	12.0	7.9	9.5	2.3
Agrihan	850.6	20	131.9	36.0	116.4	11.9	5.8	8.5
Pagan	1,512.9	72	156.3	34.2	39.6	19.0	13.0	15.1
AGS	743.9	57	85.0	73.6	48.0	19.7	11.0	8.5
Saipan	4,846.6	78	168.5	0.3	-	17.3	0.7	31.2
Tinian	1,414.2	38	51.4	5.9	-	4.4	4.2	10.5
Aguijan	405.6	23	22.4	-	7.2	1.1	0.3	2.2
Rota	1,331.4	52	45.4	2.1	-	2.7	2.5	8.1
TOTAL	**11,806.1**	**474**	**689.4**	**164.1**	**186.0**	**95.5**	**63.5**	**88.8**
ISLAND	Total Area of reef (Ha)	N	Lethrinidae	Lutjanidae	Mullidae	Scaridae	Serranidae	Siganidae
Farallon de Pajaros	138.5	23	0.7	23.4	0.6	3.7	3.8	-
Maug	313.9	70	2.8	27.0	1.6	15.4	6.5	-
Asuncion	248.6	41	1.2	27.5	1.8	13.0	7.0	-
Agrihan	850.6	20	4.7	142.1	5.4	80.1	45.6	-
Pagan	1,512.9	72	22.9	149.6	5.2	85.3	33.3	-
AGS	743.9	57	14.3	63.5	3.2	48.6	28.7	-
Saipan	4,846.6	78	14.9	94.4	8.4	93.1	17.8	1.8
Tinian	1,414.2	38	19.9	11.7	2.6	27.1	8.7	0.1
Aguijan	405.6	23	2.9	10.7	1.2	9.4	2.6	-
Rota	1,331.4	52	16.9	11.9	2.2	56.6	5.6	0.3
TOTAL	**11,806.1**	**474**	**102.1**	**508.8**	**30.5**	**405.3**	**140.4**	**2.3**

Note (1): No *Bolbometopon muricatum* were observed during these surveys in CNMI
(2) *Cheilinus undulatus* were recorded at Tinian (0.7 t)

2.1.5 Guam Reef Fish Biomass

Description: 'Reef fish biomass' is mean biomass of reef fishes per unit area derived from visual survey data (details of survey program below) between 2009 and 2015.

Category:

- ✓ Fishery independent
- ☐ Fishery dependent
- ☐ Biological

Timeframe: Triennial

Jurisdiction:

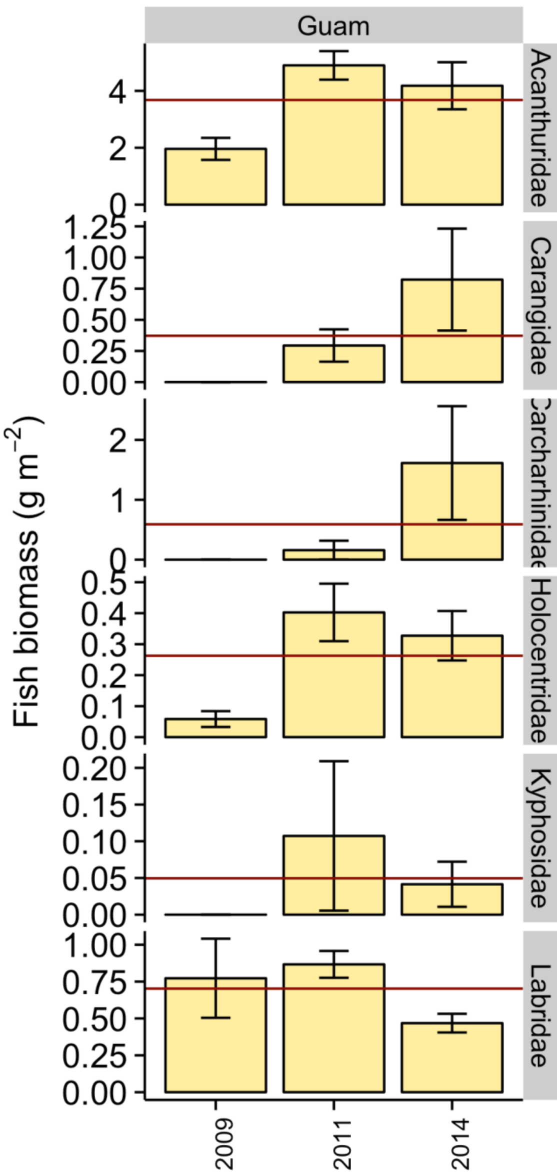
- ☐ American Samoa
- ✓ Guam
- ☐ Commonwealth of Northern Mariana Islands
- ☐ Main Hawaiian Islands
- ☐ Northwest Hawaiian Islands
- ☐ Pacific Remote Island Areas

Scale:

- ☐ Regional
- ☐ Archipelagic
- ✓ Island
- ☐ Site

Data Source: Data used to generate biomass estimates comes from visual surveys conducted by NOAA PIFSC Coral Reef Ecosystem and partners, as part of the Pacific Reef Assessment and Monitoring Program (http://www.pifsc.noaa.gov/cred/pacific_ramp.php). Survey methods are described in detail elsewhere (http://www.pifsc.noaa.gov/library/pubs/admin/PIFSC_Admin_Rep_15-07.pdf), but in brief involve teams of divers conducting stationary point count cylinder (SPC) surveys within a target domain of <30m hard-bottom habitat at each island, stratified by depth zone and, for larger islands, by section of coastline. For consistency among islands, only data from forereef habitats is used here. At each SPC, divers record the number, size and species of all fishes within or passing through paired 15m-diameter cylinders in the course of a standard count procedure. Fish sizes and abundance are converted to biomass using standard length-to-weight conversion parameters, taken largely from FishBase (http://www.fishbase.org), and converted to biomass per unit area, by dividing by the area sampled per survey. Site-level data were pooled into island-scale values by first calculating mean and variance within strata, and then calculating weighted island-scale mean and variance using the formulas given in (Smith et al., 2011), with strata weighted by their respective sizes.

Rationale: Reef Fish biomass, i.e. the weight of fish per unit area has been widely used as an indicator of relative status, and has repeatedly been shown to be changes in fishing pressure, habitat quality, and oceanographic regime.



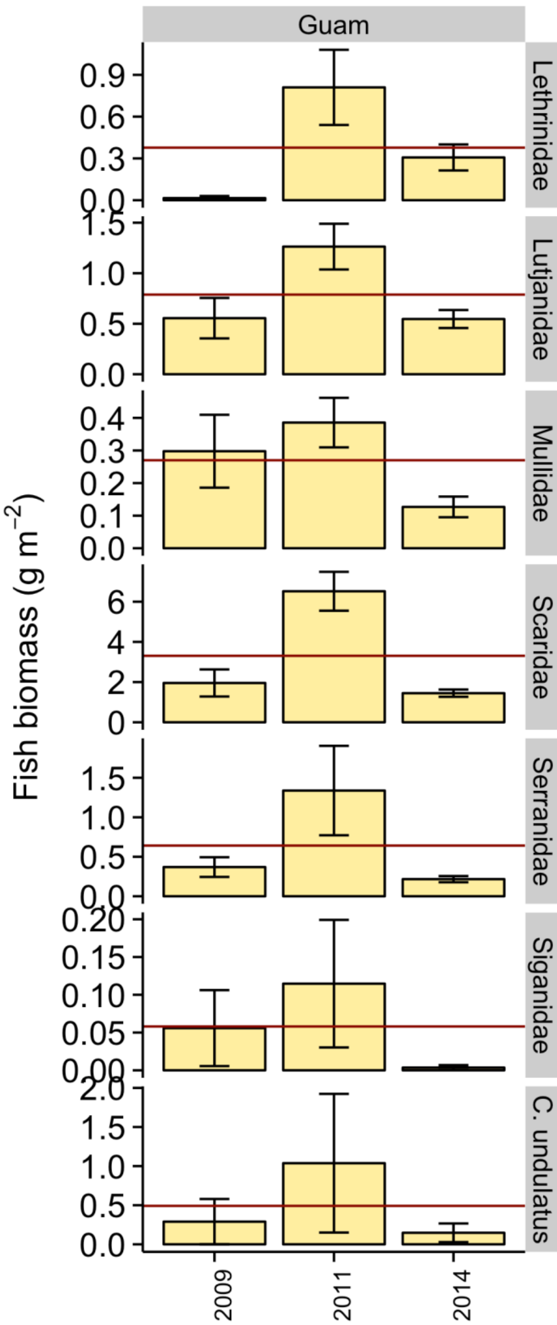


Figure 4. Guam reef fish biomass.

2.1.6 Guam Archipelagic Mean Size

Description: 'Mean fish size' is mean size of reef fishes > 10 cm TL (i.e. excluding small fishes) derived from visual survey data (details of survey program below) between 2009 and 2015 .

Category:

- ✓ Fishery independent
- ☐ Fishery dependent
- ☐ Biological

Timeframe: Triennial

Jurisdiction:

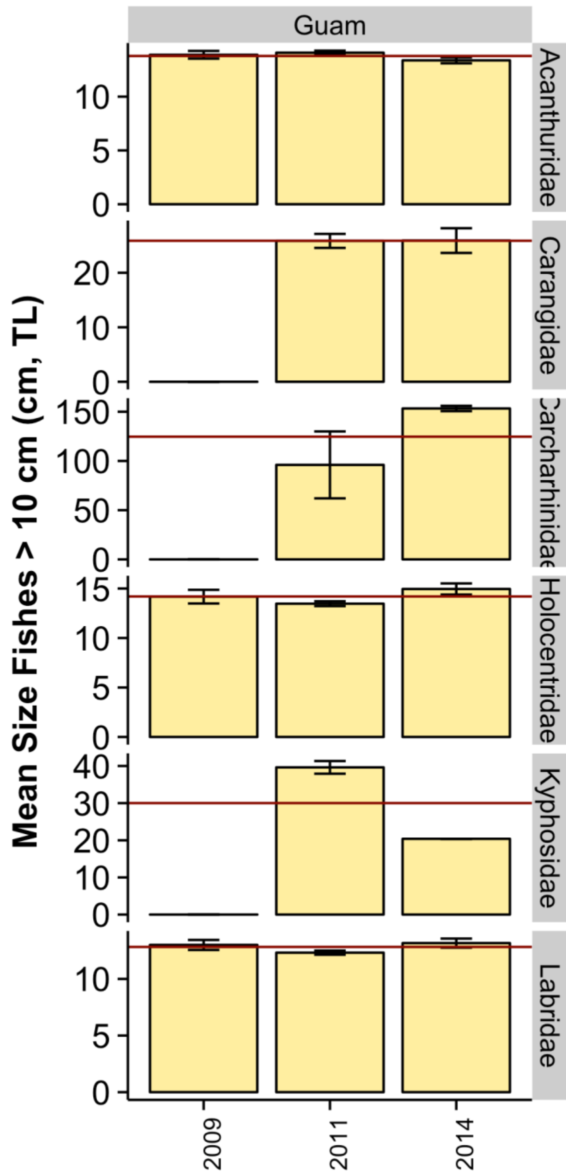
- ☐ Regional
- ☐ American Samoa
- ✓ Guam
- ☐ Commonwealth of Northern Mariana Islands
- ☐ Main Hawaiian Islands
- ☐ Northwest Hawaiian Islands
- ☐ Pacific Remote Island Areas

Scale:

- ☐ Regional
- ☐ Archipelagic
- ✓ Island
- ☐ Site

Data Source: Data used to generate mean size estimates comes from visual surveys conducted by NOAA PIFSC Coral Reef Ecosystem and partners, as part of the Pacific Reef Assessment and Monitoring Program (http://www.pifsc.noaa.gov/cred/pacific_ramp.php). Survey methods are described in detail elsewhere (http://www.pifsc.noaa.gov/library/pubs/admin/PIFSC_Admin_Rep_15-07.pdf), but in brief involve teams of divers conducting stationary point count cylinder (SPC) surveys within a target domain of <30m hard-bottom habitat at each island, stratified by depth zone and, for larger islands, by section of coastline. For consistency among islands, only data from forereef habitats is used here. At each SPC, divers record the number, size (total length, TL) and species of all fishes within or passing through paired 15m-diameter cylinders in the course of a standard count procedure. Fishes smaller than 10 cm TL are excluded so that the fish assemblage measured more closely reflects fishes that are potentially fished, and so that mean sizes are not overly influenced by variability in space and time of recent recruitment. Site-level data were pooled into island-scale values by first calculating mean and variance within strata, and then calculating weighted island-scale mean and variance using the formulas given in (Smith et al., 2011), with strata weighted by their respective sizes.

Rationale: Mean size is important as\mean size is widely used as an indicator of fishing pressure – not only do fishers sometimes preferentially target large individuals, but also because one effect of fishing is to reduce the number of fishes reaching older (and larger) size classes. Large fishes also contribute disproportionately to community fecundity and can have important ecological roles – for example, excavating bites by large parrotfishes probably have a longer lasting impact on reef benthos than bites by smaller fishes.



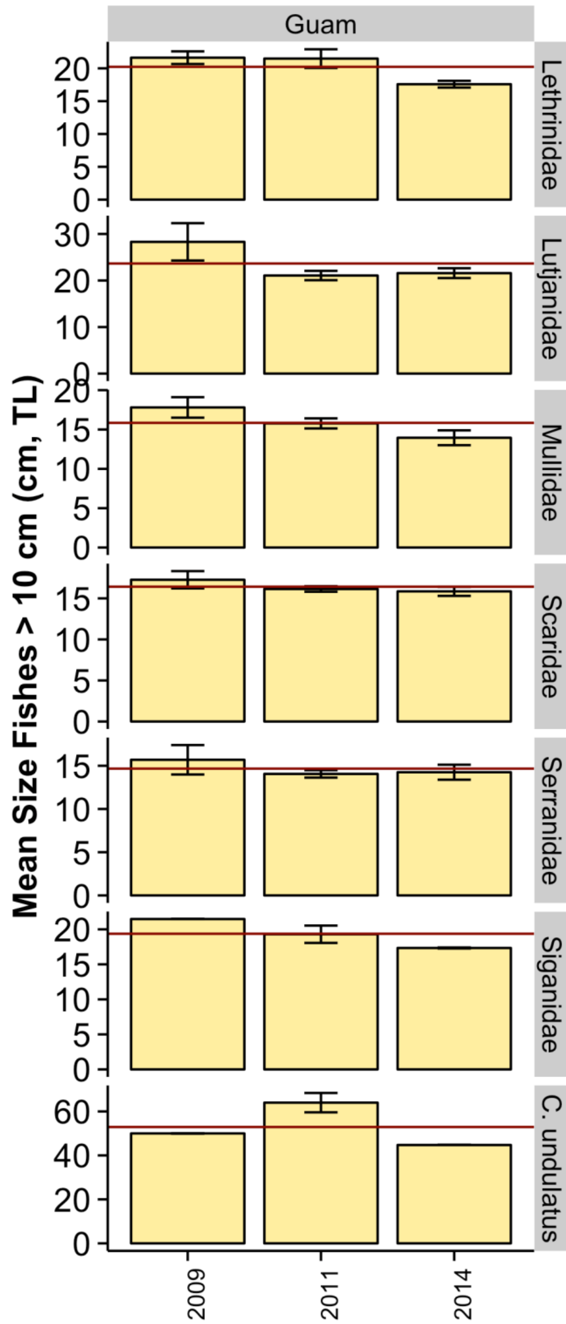


Figure 5. Guam mean fish size.

2.1.7 Guam Reef Fish Population Estimates

Description: Reef fish population estimates are made by multiplying mean biomass per unit area by estimated area of hardbottom in a consistent habitat across all islands (specifically, the area of hardbottom forereef habitat in < 30m water).

Category:

- ✓ Fishery independent
- ☐ Fishery dependent
- ☐ Biological

Timeframe: Triennial

Jurisdiction:

- ☐ Regional
- ☐ American Samoa
- ✓ Guam
- ☐ Commonwealth of Northern Mariana Islands
- ☐ Main Hawaiian Islands
- ☐ Northwest Hawaiian Islands
- ☐ Pacific Remote Island Areas

Scale:

- ☐ Regional
- ☐ Archipelagic
- ✓ Island
- ☐ Site

Data Source: Data used to generate mean size estimates comes from visual surveys conducted by NOAA PIFSC Coral Reef Ecosystem and partners, as part of the Pacific Reef Assessment and Monitoring Program (http://www.pifsc.noaa.gov/cred/pacific_ramp.php). Survey methods and sampling design, and methods to generate reef fish biomass are described above (SECTION: REEF FISH BIOMASS). Those estimates are converted to population estimates by multiplying biomass (g/m2) per island by the estimated area of hardbottom habitat <30m deep at the island, which is the survey domain for the monitoring program that biomass data comes from. Estimated habitat areas per island are derived from GIS bathymetry and habitat maps maintained by NOAA Coral Reef Ecosystems Program. It is important to recognize that many reef fishes taxa are present in other habitats and in deeper water than is surveyed by that program, and even that some taxa likely have the majority of their populations in deeper water. Additionally, fish counts have the potential to be biased by the nature of fish responses to divers: curious fishes, particularly in locations where divers are not perceived as a threat, will tend to be overcounted by visual survey, and skittish fishes will tend to be undercounted. Likely numbers of jacks and sharks in some locations (particularly the NWHI) are overcounted by visual survey. Nevertheless, in spite of these issues, the data shown here are consistently gathered across space and time.

<u>Rationale:</u> These data have utility in understanding the size of populations from which fishery harvests are extracted.

Table 48. Reef fish population estimates for Guam. Fish species are pooled by CREMUS groupings. Estimated population biomass is for 0-30 m hardbottom habitat only. (n) is number of sites surveyed per island. Each site is surveyed by means of two to four 7.5 m diameter SPCs. However, those are not considered to be independent samples, so data from those is pooled to site level before other analysis.

ISLAND	Total Area of reef (Ha)	N	ESTIMATED POPULATION BIOMASS (metric Tonnes) in SURVEY DOMAIN OF <30m HARDBOTTOM					
			Acanthuridae	Carangidae	Carcharhinids	Holocentridae	Kyphosidae	Labridae
Guam	7,295.7	238	331.1	40.7	64.6	26.6	5.4	48.7
			Lethrinidae	Lutjanidae	Mullidae	Scaridae	Serranidae	Siganidae
			40.8	66.0	18.7	290.6	56.7	4.3

Note (1): No *Bolbometopon muricatum* were observed during these surveys in Guam
(2) *Cheilinus undulatus* were recorded at Guam (43.2 t)

2.2 Life History and Length Derived Parameters

The SAFE Report will serve as the repository of available life history information for the Western Pacific region. Life history data - particularly age and growth information - inform the stock assessment on fish productivity and population dynamics. Some assessments - particularly for data-poor stocks like coral reefs - utilize information from other areas that introduce errors and uncertainties in the population estimates. An archipelago-specific life history parameter ensures accuracy in the input parameters used in the assessment. The NMFS BioSampling Program allows for significant collection of life history samples like otoliths and gonads from priority species in the bottomfish and coral reef fisheries. These life history samples, once processed and data extracted, will contribute to the body of scientific information for the two data-poor fisheries in the region. The life history information available from the region will be monitored by the Fishery Ecosystem Plan Team and will be tracked through this section of the report.

This section will be divided into two fisheries: 1) coral reef; and 2) bottomfish. Within each fishery, the available life history information will be described under the age, growth, and reproductive maturity section. The section labelled fish length-derived parameters summarizes available information derived from sampling the fish catch or the market. Monitoring length information provides insight on the state of the fish stock where the change in length can be used as an indicator of population level mortality. Length-weight conversion coefficients provide area-specific values to convert length from fishery dependent and fishery independent data collection to weight or biomass.

2.2.1 CNMI Coral Reef Ecosystem – Reef Fish Life History

2.2.1.1 Age & Growth and Reproductive Maturity

__Description__: Age determination is based on counts of yearly growth marks (annuli) and/or daily growth increments (DGIs) internally visible within transversely-cut, thin sections of sagittal otoliths. Validated age determination, particularly for long-lived (≥30 years) fish, is based on an environmental signal (bomb radiocarbon ^{14}C) produced during previous atmospheric thermonuclear testing in the Pacific and incorporated into the core regions of sagittal otolith and other aragonite-based calcified structures such as hermatypic corals. This technique relies on developing a regionally-based aged coral core reference series for which the rise, peak, and decline of ^{14}C values is available over the known age series of the coral core. Estimates of fish age are determined by projecting the ^{14}C otolith core values back in time from its capture date to where it intersects with the known age ^{14}C coral reference series. This technique provides age estimates independent of age estimates based on visual counts of annuli or DGIs. The relation between age and fish length is evaluated by fitting this data to a von Bertalanffy growth function based on statistical analyses. The resulting von Bertalanffy growth function predicts the pattern of growth over time for that particular species. This function typically uses three coefficients (L_∞, k, and t_0) which together characterize the shape of the length-at-age growth relationship. The ^{14}C derived ages typically provide more accurate estimates of older ages (≥30 years) and hence more realistic values of T_{max} compared to annuli or DGI-based counts of otolith sections.

Length at reproductive maturity is based on the histological analyses of small tissue samples of gonad material that are typically collected along with otoliths when a fish is processed for life history studies. The gonad tissue sample is preserved then subsequently cut into five micron sections, stained, and sealed onto a glass slide for subsequent examination. Based on standard cell structure features and developmental stages within ovaries and testes, the gender, developmental stage, and maturity status (immature or mature) is determined via microscopic evaluation. The percent of mature samples for a given length interval are assembled for each sex and these data are fitted to a three- or four-parameter logistic function to determine the best fit of these data based on statistical analyses. The mid-point of this fitted function provides an estimate of the length at which 50% of fish have achieved reproductive maturity (L_{50}). For species that undergo sex reversal (primarily female to male in the tropical Pacific region) - such as groupers and deeper-water emperors among the bottomfishes, and for parrotfish, shallow-water emperors, and wrasses among the coral reef fishes - standard histological criteria are used to determine gender and reproductive developmental stages that indicate the transitioning or completed transition from one sex to another. These data are similarly analyzed using a three or four-parameter logistic function to determine the best fit of the data based on statistical analyses. The mid-point of this fitted function provides an estimate of the length at which 50% of fish of a particular species have or are undergoing sex reversal ($L\Delta_{50}$).

Age at 50% maturity (A_{50}) and 50% sex reversal ($A\Delta_{50}$) is typically derived by referencing the von Bertalanffy growth function for that species and using the corresponding L_{50} and $L\Delta_{50}$ values to obtain the corresponding age value from this growth function. In studies where both age & growth and reproductive maturity are concurrently determined, estimates of A_{50} and $A\Delta_{50}$ are derived directly by fitting the percent of mature samples for each age (one-year) interval to a three- or four-parameter logistic function using statistical analyses. The mid-point of this fitted logistic function provides a direct estimate of the age at which 50% of fish of a particular species have achieved reproductive maturity (A_{50}) and sex reversal ($A\Delta_{50}$).

Category:

- ☐ Fishery independent
- ☐ Fishery dependent
- ✓ Biological

Timeframe: N/A

Jurisdiction:

- ☐ American Samoa
- ☐ Guam
- ✓ Commonwealth of Northern Mariana Islands
- ☐ Main Hawaiian Islands
- ☐ Northwest Hawaiian Islands
- ☐ Pacific Remote Island Areas

Spatial Scale:

- ☐ Regional
- ☐ Archipelagic
- ✓ Island
- ☐ Site

Data Source: Sources of data are directly derived from market samples collected by the CNMI contracted bio-sampling team which samples the catch of fishermen and local fish vendors. Laboratory analyses and data generated from these analyses reside with the PIFSC Life History Program. Refer to the “Reference” column in Table 49 for specific details on data sources by species.

Parameter definitions:

***T_{max}* (maximum age) –** The maximum observed age revealed from an otolith-based age determination study. T_{max} values can be derived from ages determined by annuli counts of sagittal otolith sections and/or bomb radiocarbon (^{14}C) analysis of otolith core material.

***L_{∞}* (asymptotic length) –** One of three coefficients of the von Bertalanffy growth function (VBGF) that measures the mean maximum length at which the growth curve plateaus and no longer increases in length with increasing age. This coefficient reflects the mean maximum length and not the observed maximum length.

***k* (growth coefficient) –** One of three coefficients of the VBGF that measures the shape and steepness by which the initial portion of the growth function approaches its mean maximum length (L_{∞}).

***t_0* (hypothetical age at length zero) –** One of three coefficients of the VBGF whose measure is highly influenced by the other two VBGF coefficients (*k* and L_{∞}) and typically assumes a negative value when specimens representing early growth phases (0+ to 1+ ages) are not available for age determination.

***M* (natural mortality) –** This is a measure of mortality rate for a fish stock not under the influence of fishing pressure and is considered to be directly related to stock productivity (i.e., high *M* indicates high productivity and low *M* indicates low stock productivity). *M* can be derived through use of various equations that link *M* to T_{max} and *k*, or in some instances, by calculating the value of the slope from a regression fit to a declining catch curve (regression of the natural logarithm of abundance versus age class) derived from fishing an unfished or lightly fished population.

***A_{50}* (age at 50% maturity) –** Age at which 50% of the sampled stock under study has attained reproductive maturity. This parameter is best determined based on studies that concurrently determine both age (otolith-based age data) and reproductive maturity status (logistic function fitted to percent mature by age class with maturity determined via microscopic analyses of gonad histology preparations). A more approximate means of estimating A_{50} is to use an existing L_{50} estimate to find the corresponding age (A_{50}) from an existing VBGF curve.

***$A\Delta_{50}$* (age of sex switching) –** Age at which 50% of the immature and adult females of the sampled stock under study is undergoing or has attained sex reversal. This parameter is best determined based on studies that concurrently determines both age (otolith-based age data) and reproductive sex reversal status (logistic function fitted to percent sex reversal by age class with sex reversal determined via microscopic analyses of gonad histology preparations). A more approximate means of estimating $A\Delta_{50}$ is to use an existing $L\Delta_{50}$ estimate to find the corresponding age ($A\Delta_{50}$) from the VBGF curve.

***L_{50}* (length at which 50% of a fish species are capable of spawning) –** Length (usually in terms of fork length) at which 50% of the females of a sampled stock under study has attained reproductive maturity; this is the length associated with A_{50} estimates. This parameter is derived using a logistic function to fit the percent mature data by length class with maturity status best determined via microscopic analyses of gonad histology preparations). L_{50} information is typically more available than A_{50} since L_{50} estimates do not require knowledge of age & growth.

$L\Delta_{50}$ (length of sex switching) – Length (usually in terms of fork length) at which 50% of the immature and adult females of the sampled stock under study is undergoing or has attained sex reversal; this is the length associated with $A\Delta_{50}$ estimates. This parameter is derived using a logistic function to fit the percent sex reversal data by length class with sex reversal status best determined via microscopic analyses of gonad histology preparations). $L\Delta_{50}$ information is typically more available than $A\Delta_{50}$ since $L\Delta_{50}$ estimates do not require knowledge of age & growth.

Rationale: These nine life-history parameters provide basic biological information at the species level to evaluate the productivity of a stock - an indication of the capacity of a stock to recover once it has been depleted. Currently, the assessment of coral reef fish resources in American Samoa is data-limited. Knowledge of these life-history parameters support current efforts to characterize the resilience of these resources and also provide important biological inputs for future stock assessment efforts and enhance our understanding of the specieslikely role and status as a component of the overall ecosystem. Furthermore, knowledge of life histories across species at the taxonomic level of families or among different species that are ecologically or functionally similar can provide important information on the diversity of life histories and the extent to which species can be grouped (based on similar life histories) for future multi-species assessments.

Table 49. Available age, growth, and reproductive maturity information for coral reef species targeted for life history sampling (otoliths and gonads) in CNMI. Parameter estimates are for females unless otherwise noted (F=females, M=males). Parameters T_{max}, t_0, A_{50}, and $A\Delta_{50}$ are in units of years; L_∞, L_{50}, and $L\Delta_{50}$ are in units of mm fork length (FL); k in units of year^{-1}; X=parameter estimate too preliminary or Y=published age and growth parameter estimates based on DGI numerical integration technique and likely to be inaccurate; NA=not applicable. Superscript letters indicate status of parameter estimate (see footnotes below table). Published or in press publications ([d]) are denoted in "Reference" column.

Species	*Age, growth, and reproductive maturity parameters*									Reference
	T_{max}	L_∞	k	t_0	M	A_{50}	$A\Delta_{50}$	L_{50}	$L\Delta_{50}$	
Calotomus carolinus										
Chlorurus spilurus										
Lethrinus atkinsoni								213[b]	X[a]	
Lethrinus obsoletus	15[b]	X[a]	X[a]	X[a]		X[a]	X[a]	X[a]	X[a]	
Mulloidichthys flavolineatus										
Naso unicornis							NA	238[b]	NA	
Parupeneus barberinus							NA		NA	
Sargocentron tiere							NA		NA	
Siganus argenteus	7[c]	274[c]	0.9[c]	-0.3[c]		1.3[c]	NA	218[c]	NA	

[a] signifies estimate pending further evaluation in an initiated and ongoing study
[b] signifies a preliminary estimate taken from ongoing analyses
[c] signifies an estimate documented in an unpublished report or draft manuscript
[d] signifies an estimate documented in a finalized report or published journal article (including in

press)

2.2.1.2 Fish Length Derived Parameters

<u>Description</u>: The NMFS Commercial Fishery BioSampling Program started in 2009. This program has two components: First is the Field/Market Sampling Program and the second is the Life History Program, details of which are described in a separate section of this report. The goals of the Field/Market Sampling Program are:

- Broad scale look at commercial landings (by fisher/trip, gear & area fished)
- Length and weight frequencies of whole commercial landings per fisher-trip (with an effort to also sample landings not sold commercially)
- Accurate species identification
- Develop accurate local length-weight curves

In CNMI, the BioSampling is focused on the commercial coral reef spear fishery with occasional sampling of the bottomfish fishery occurring locally and less frequently at the northern islands. Sampling is conducted in partnership with the fish vendors. The Market Sampling information includes (but not limited to): 1) fish length; 2) fish weight; 3) species identification; and 4) basic effort information. Specific for CNMI, the program collects Daily Vendor Logs for reef fish that includes basic catch and effort information.

<u>Category:</u>

- ☐ Fishery independent
- ☐ Fishery dependent
- ✓ Biological

<u>Timeframe:</u> N/A

<u>Jurisdiction:</u>

- ☐ American Samoa
- ☐ Guam
- ✓ Commonwealth of Northern Mariana Islands
- ☐ Main Hawaiian Islands
- ☐ Northwest Hawaiian Islands
- ☐ Pacific Remote Island Areas

<u>Spatial Scale:</u>

- ☐ Regional
- ☐ Archipelagic
- ✓ Island
- ☐ Site

<u>Data Source</u>: NMFS BioSampling Program

<u>Parameter definitions</u>:
***L_{max}* – maximum fish length** is the longest fish per species recorded in the BioSampling

Program from the commercial spear fishery. This value is derived from measuring the fork length of individual samples for species occurring in the spear fishery.

L_{bar} – mean length is the average value of all lengths recorded from the commercial spear fishery. This can be influenced by gear selectivity since the commercial spear fishery has a typical size target based on customer demand. This can also be influenced by size regulations.

n – sample size is the total number of samples accumulated for each species recorded in the commercial spear fishery.

$N_{L\text{-}W}$ – sample size for L-W regression is the number of samples used to generate the a & b coefficients.

a & b – length-weight coefficients are the coefficients derived from the regression line fitted to all length- and weight-measured per species in the commercial spear fishery. These values are used to convert length information to weight. Values are influenced by the life history characteristics of the species, geographic location, population status, and nature of the fisheries from which the species are harvested.

Rationale: Length-derived information is being used as an indicator of population status particularly for data poor stocks like coral reef fish. Average length (L_{bar}) was used as a principal stock assessment indicator variable for exploited reef fish population (Nadon et al 2015). Average length was also shown to be correlated with population size (Kerr and Dickle 2001). Maximum length (L_{max}), typically coupled with maximum age, is typically used as a proxy for fish longevity which has implications on the productivity and susceptibility of a species to fishing pressure. The length-weight coefficients (a & b values) are used to convert length to weight for fishery-dependent and fishery-independent data collection where length are typically recorded but weight is the factor being used for management. This section of the report presents the best available information for the length-derived variables for the CNMI coral reef and bottomfish fisheries.

Table 50. Available length-derived information for various coral reef species in CNMI.

Species	***Length derived parameters***						**Reference**
	L_{max}	L_{bar}	*N*	*L-W*	*a*	*b*	
Naso lituratus	30.1	20.26	17,478	3,813	0.0167	3.1022	
Acanthurus lineatus	23.5	18.33	15,772	4,901	0.0383	2.8718	
Siganus argenteus	34.1	20.82	11,867	3,662	0.0133	3.1007	
Mulloidichthys flavolineatus	31.4	18.08	9,596	2,357	0.0137	3.0547	
Naso unicornis	53.6	29.62	8,323	4,349	0.0266	2.9115	
Siganus spinus	25.6	16.64	7,685	1,078	0.0118	3.1459	
Parupeneus barberinus	37.3	21.73	7,597	2,706	0.0175	3.0119	
Selar crumenophthalmus	26.5	19.08	4922	2654	0.0051	3.3958	
Scarus ghobban	38.1	24.07	4,964	1,502	0.0124	3.1271	
Lethrinus atkinsoni	35.1	21.06	4,306	2,095	0.0163	3.0971	
Lethrinus obsoletus	29.0	21.10	3,673	1,472	0.0171	3.0313	
Mulloidichthys vanicolensis	28.0	18.94	3233	701	0.0103	3.1948	
Scarus rubroviolaceus	52.6	34.49	3141	1,791	0.0087	3.2447	

Species	***Length derived parameters***						**Reference**
	L_{max}	L_{bar}	***N***	***L-W***	***a***	***b***	
Chlorurus sordidus	30.8	22.33	3346	956	0.0173	3.0795	
Siganus punctatus	34.8	20.82	2798	833	0.0129	3.1911	
Sargocentron spiniferum	34.6	20.31	2589	684	0.0245	2.9780	
Myripristis murdjan	22.3	16.84	2488	823	0.1699	2.3426	
Scarus psittacus	28.9	21.24	2466	771	0.0212	2.9928	
Acanthurus nigricauda	26.3	20.07	2354	799	0.0217	3.0583	
Cheilinus trilobatus	35.2	24.06	2223	1,196	0.0470	2.7156	
Hipposcarus longiceps	52.0	29.10	2194	615	0.0149	3.0624	
Panulirus penicillatus	17.0	9.05	2043	1,119	1.4849	2.6925	
Leptoscarus vaigiensis	35.2	26.31	1982	807	0.0234	2.8648	
Calotomus carolinus	31.0	24.21	1734	662	0.0156	3.1012	
Myripristis violacea	20.6	15.54	1796	514	0.1361	2.4356	

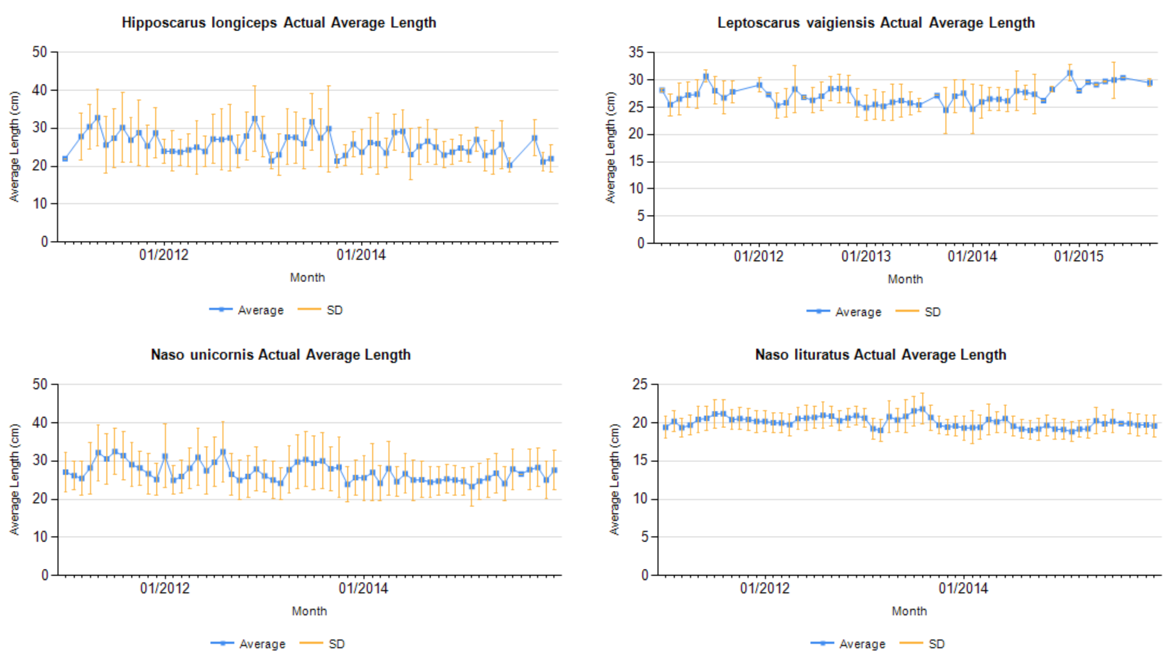
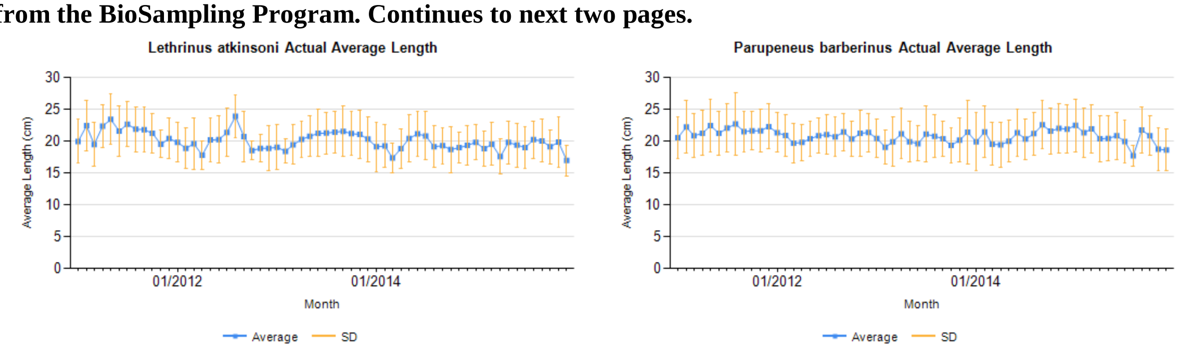
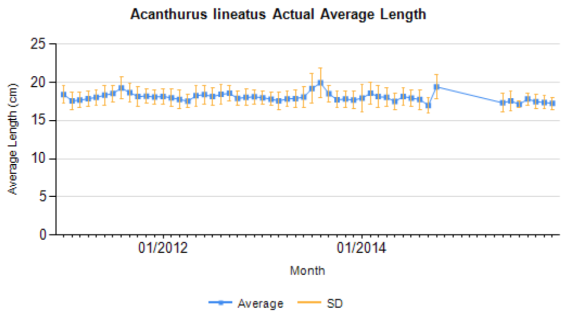
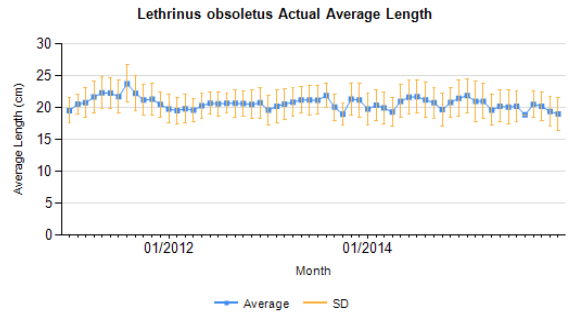
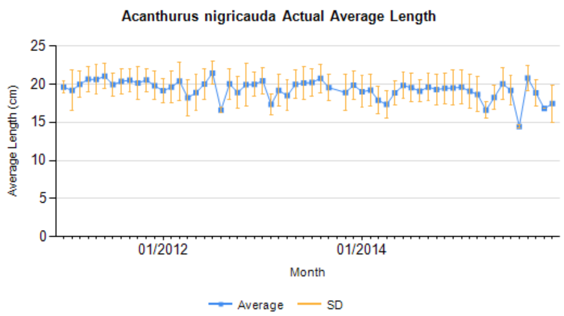


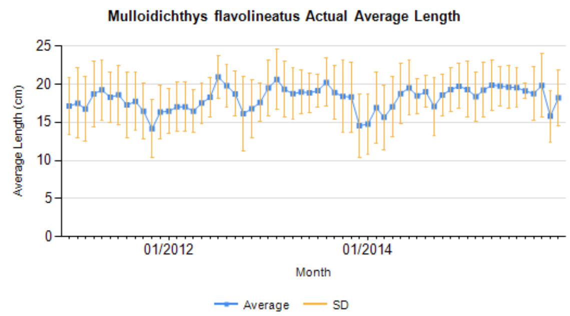
Figure 6. Average length over time of representative CNMI coral reef fish management unit species derived from the BioSampling Program. Continues to next two pages.

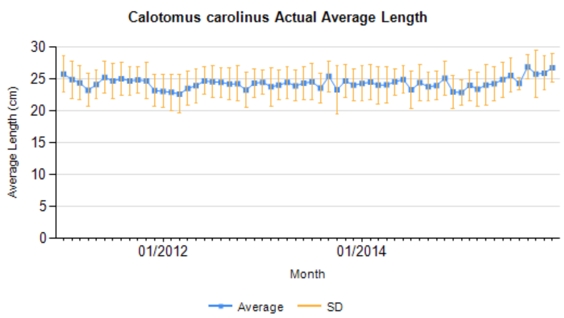


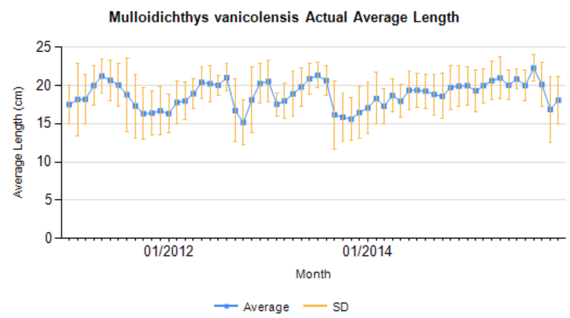

Acanthurus lineatus Actual Average Length
Average Length (cm)
0
5
10
15
20
25
01/2012
01/2014
Month
Average
SD

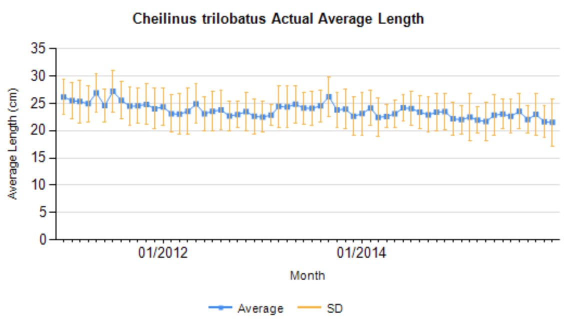

Lethrinus obsoletus Actual Average Length
Average Length (cm)
0
5
10
15
20
25
30
01/2012
01/2014
Month
Average
SD

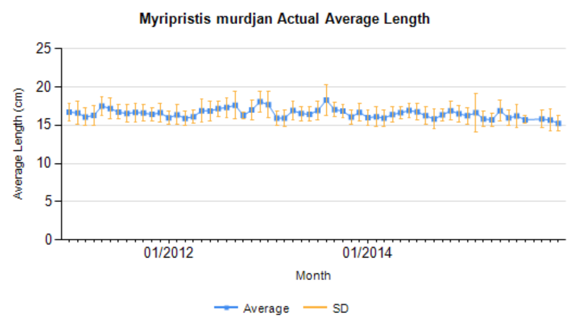

Acanthurus nigricauda Actual Average Length
Average Length (cm)
0
5
10
15
20
25
01/2012
01/2014
Month
Average
SD

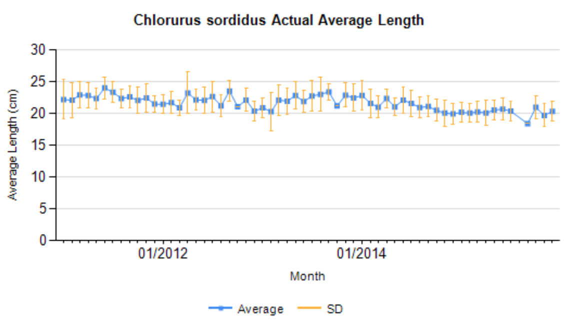

Mulloidichthys flavolineatus Actual Average Length
Average Length (cm)
0
5
10
15
20
25
01/2012
01/2014
Month
Average
SD

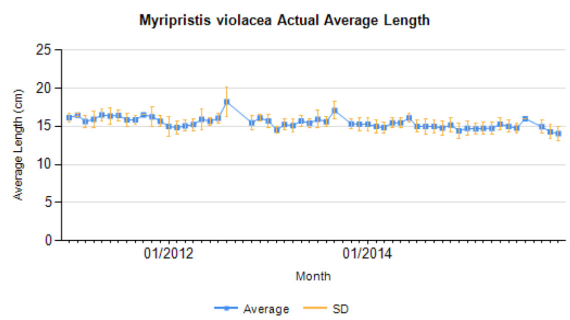

Calotomus carolinus Actual Average Length
Average Length (cm)
0
5
10
15
20
25
30
01/2012
01/2014
Month
Average
SD

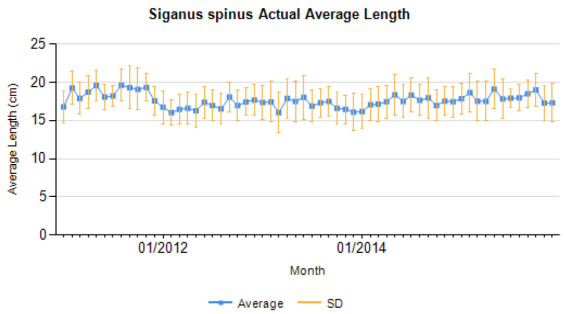

Mulloidichthys vanicolensis Actual Average Length
Average Length (cm)
0
5
10
15
20
25
01/2012
01/2014
Month
Average
SD

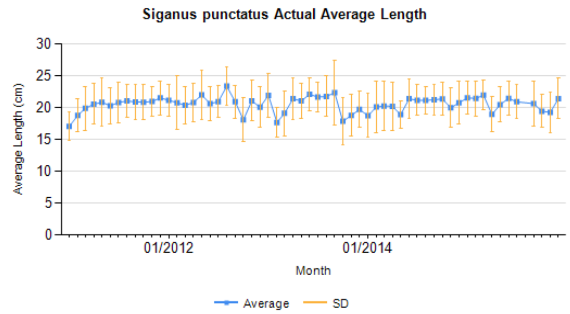

Cheilinus trilobatus Actual Average Length
Average Length (cm)
0
5
10
15
20
25
30
35
01/2012
01/2014
Month
Average
SD

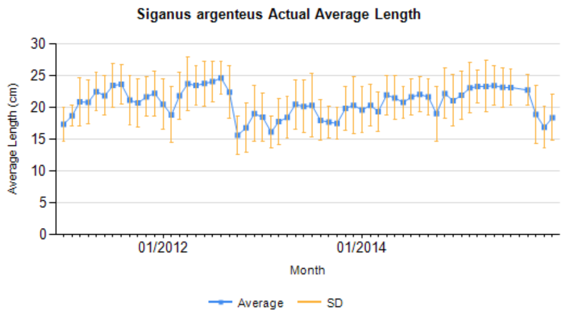

Myripristis murdjan Actual Average Length
Average Length (cm)
0
5
10
15
20
25
01/2012
01/2014
Month
Average
SD

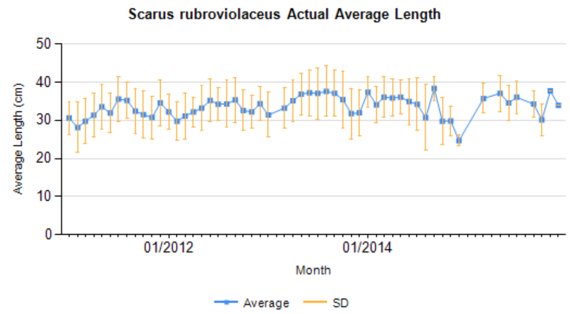

Chlorurus sordidus Actual Average Length
Average Length (cm)
0
5
10
15
20
25
30
01/2012
01/2014
Month
Average
SD

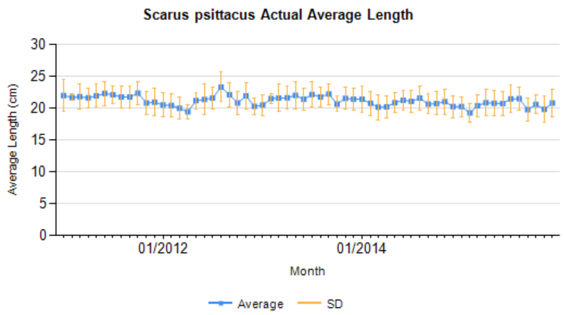

Myripristis violacea Actual Average Length
Average Length (cm)
0
5
10
15
20
25
01/2012
01/2014
Month
Average
SD

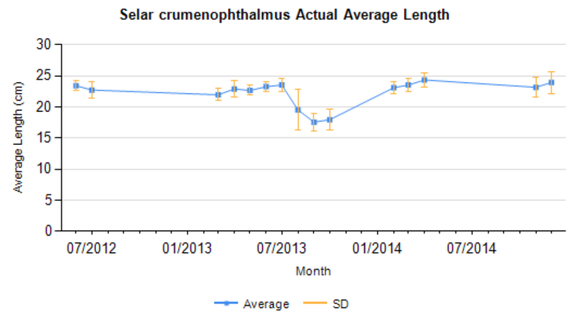

Siganus spinus Actual Average Length
Average Length (cm)
25
20
15
10
5
0
01/2012
01/2014
Month
Average
SD

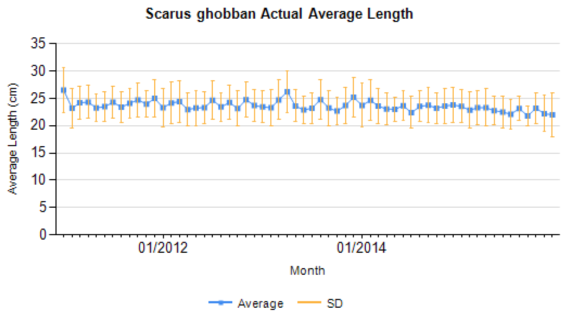

Siganus punctatus Actual Average Length
Average Length (cm)
30
25
20
15
10
5
0
01/2012
01/2014
Month
Average
SD

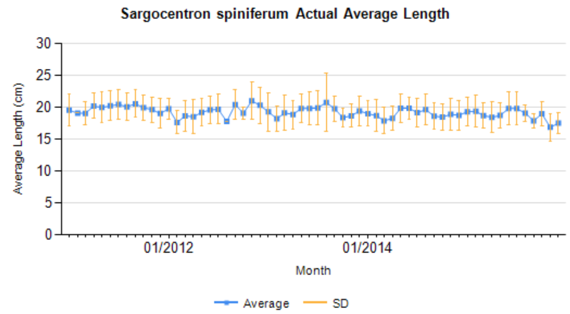

Siganus argenteus Actual Average Length
Average Length (cm)
30
25
20
15
10
5
0
01/2012
01/2014
Month
Average
SD


Scarus rubroviolaceus Actual Average Length
Average Length (cm)
50
40
30
20
10
0
01/2012
01/2014
Month
Average
SD


Scarus psittacus Actual Average Length
Average Length (cm)
30
25
20
15
10
5
0
01/2012
01/2014
Month
Average
SD


Selar crumenophthalmus Actual Average Length
Average Length (cm)
30
25
20
15
10
5
0
07/2012
01/2013
07/2013
01/2014
07/2014
Month
Average
SD


Scarus ghobban Actual Average Length
Average Length (cm)
35
30
25
20
15
10
5
0
01/2012
01/2014
Month
Average
SD


Sargocentron spiniferum Actual Average Length
Average Length (cm)
30
25
20
15
10
5
0
01/2012
01/2014
Month
Average
SD

2.2.2 CNMI Bottomfish Ecosystem – Bottomfish Life History

2.2.2.1 Age & Growth and Reproductive Maturity

Description: Age determination is based on counts of yearly growth marks (annuli) and/or daily growth increments (DGIs) internally visible within transversely-cut, thin sections of sagittal otoliths. Validated age determination, particularly for long-lived (≥30 years) fish, is based on an environmental signal (bomb radiocarbon ^{14}C) produced during previous atmospheric thermonuclear testing in the Pacific and incorporated into the core regions of sagittal otolith and other aragonite-based calcified structures such as hermatypic corals. This technique relies on developing a regionally-based aged coral core reference series for which the rise, peak, and decline of ^{14}C values is available over the known age series of the coral core. Estimates of fish age are determined by projecting the ^{14}C otolith core values back in time from its capture date to where it intersects with the known age ^{14}C coral reference series. This technique provides age estimates independent of age estimates based on visual counts of annuli or DGIs. The relation between age and fish length is evaluated by fitting this data to a von Bertalanffy growth function based on statistical analyses. The resulting von Bertalanffy growth function predicts the pattern of growth over time for that particular species. This function typically uses three coefficients (L_∞, k, and t_0) which together characterize the shape of the length-at-age growth relationship. The ^{14}C derived ages typically provide more accurate estimates of older ages (≥30 years) and hence more realistic values of T_{max} compared to annuli or DGI-based counts of otolith sections.

Length at reproductive maturity is based on the histological analyses of small tissue samples of gonad material that are typically collected along with otoliths when a fish is processed for life history studies. The gonad tissue sample is preserved then subsequently cut into five-micron sections, stained, and sealed onto a glass slide for subsequent examination. Based on standard cell structure features and developmental stages within ovaries and testes, the gender, developmental stage, and maturity status (immature or mature) is determined via microscopic evaluation. The percent of mature samples for a given length interval are assembled for each sex and these data are fitted to a three- or four-parameter logistic function to determine the best fit of these data based on statistical analyses. The mid-point of this fitted function provides an estimate of the length at which 50% of fish have achieved reproductive maturity (L_{50}). For species that undergo sex reversal (primarily female to male in the tropical Pacific region), such as groupers and deeper-water emperors among the bottomfishes, and for parrotfish, shallow-water emperors, and wrasses among the coral reef fishes, standard histological criteria are used to determine gender and reproductive developmental stages that indicate the transitioning or completed transition from one sex to another. These data are similarly analyzed using a 3- or 4-parameter logistic function to determine the best fit of the data based on statistical analyses. The mid-point of this fitted function provides an estimate of the length at which 50% of fish of a particular species have or are undergoing sex reversal ($L\Delta_{50}$).

Age at 50% maturity (A_{50}) and 50% sex reversal ($A\Delta_{50}$) is typically derived by referencing the von Bertalanffy growth function for that species and using the corresponding L_{50} and $L\Delta_{50}$ values to obtain the corresponding age value from this growth function. In studies where both age & growth and reproductive maturity are concurrently determined, estimates of A_{50} and $A\Delta_{50}$ are derived directly by fitting the percent of mature samples for each age (one-year) interval to a three- or four-parameter logistic function using statistical analyses. The mid-point of this fitted logistic function provides a direct estimate of the age at which 50% of fish of a particular species have achieved reproductive maturity (A_{50}) and sex reversal ($A\Delta_{50}$).

Category:

- ☐ Fishery independent
- ☐ Fishery dependent
- ✓ Biological

Timeframe: N/A

Jurisdiction:

- ☐ American Samoa
- ☐ Guam
- ✓ Commonwealth of Northern Mariana Islands
- ☐ Main Hawaiian Islands
- ☐ Northwest Hawaiian Islands
- ☐ Pacific Remote Island Areas

Spatial Scale:

- ☐ Regional
- ☐ Archipelagic
- ✓ Island
- ☐ Site

Data Source: Sources of data are directly derived from field samples collected at sea on NOAA research vessels and from the CNMI contracted bio-sampling team which samples the catch of fishermen and local fish vendors. Laboratory analyses and data generated from these analyses reside with the PIFSC Life History Program. Refer to the "Reference" column in Table 51 for specific details on data sources by species.

Parameter definitions:

T_{max} (maximum age) – The maximum observed age revealed from an otolith-based age determination study. T_{max} values can be derived from ages determined by annuli counts of sagittal otolith sections and/or bomb radiocarbon (^{14}C) analysis of otolith core material.

L_∞ (asymptotic length) – One of three coefficients of the von Bertalanffy growth function (VBGF) that measures the mean maximum length at which the growth curve plateaus and no longer increases in length with increasing age. This coefficient reflects the mean maximum length and not the observed maximum length.

k (growth coefficient) – One of three coefficients of the VBGF that measures the shape and steepness by which the initial portion of the growth function approaches its mean maximum length (L_∞).

t_0 (hypothetical age at length zero) – One of three coefficients of the VBGF whose measure is highly influenced by the other two VBGF coefficients (k and L_∞) and typically assumes a negative value when specimens representing early growth phases (0+ to 1+ ages) are not available for age determination.

M (natural mortality) – This is a measure of mortality rate for a fish stock not under the influence of fishing pressure and is considered to be directly related to stock productivity (i.e., high *M* indicates high productivity and low *M* indicates low stock productivity). *M* can be derived through use of various equations that link *M* to T_{max} and *k*, or in some instances, by calculating the value of the slope from a regression fit to a declining catch curve (regression of the natural logarithm of abundance versus age class) derived from fishing an unfished or lightly fished population.

A_{50} (age at 50% maturity) – Age at which 50% of the sampled stock under study has attained reproductive maturity. This parameter is best determined based on studies that concurrently determine both age (otolith-based age data) and reproductive maturity status (logistic function fitted to percent mature by age class with maturity determined via microscopic analyses of gonad histology preparations. A more approximate means of estimating A_{50} is to use an existing L_{50} estimate to find the corresponding age (A_{50}) from an existing VBGF curve.

$A\Delta_{50}$ (age of sex switching) – Age at which 50% of the immature and adult females of the sampled stock under study is undergoing or has attained sex reversal. This parameter is best determined based on studies that concurrently determines both age (otolith-based age data) and reproductive sex reversal status (logistic function fitted to percent sex reversal by age class with sex reversal determined via microscopic analyses of gonad histology preparations). A more approximate means of estimating $A\Delta_{50}$ is to use an existing $L\Delta_{50}$ estimate to find the corresponding age ($A\Delta_{50}$) from the VBGF curve.

L_{50} (length at which 50% of a fish species are capable of spawning) – Length (usually in terms of fork length) at which 50% of the females of a sampled stock under study has attained reproductive maturity; this is the length associated with A_{50} estimates. This parameter is derived using a logistic function to fit the percent mature data by length class with maturity status best determined via microscopic analyses of gonad histology preparations. L_{50} information is typically more available than A_{50} since L_{50} estimates do not require knowledge of age & growth.

$L\Delta_{50}$ (length of sex switching) – Length (usually in terms of fork length) at which 50% of the immature and adult females of the sampled stock under study is undergoing or has attained sex reversal; this is the length associated with $A\Delta_{50}$ estimates. This parameter is derived using a logistic function to fit the percent sex reversal data by length class with sex reversal status best determined via microscopic analyses of gonad histology preparations. $L\Delta_{50}$ information is typically more available than $A\Delta_{50}$ since $L\Delta_{50}$ estimates do not require knowledge of age & growth.

Rationale: These nine life history parameters provide basic biological information at the species level to evaluate the productivity of a stock - an indication of the capacity of a stock to recover once it has been depleted. Currently, the assessment of coral reef fish resources in American Samoa is data-limited. Knowledge of these life history parameters support current efforts to characterize the resilience of these resources and also provide important biological inputs for future stock assessment efforts and enhance our understanding of the species likely role and status as a component of the overall ecosystem. Furthermore, knowledge of life histories across species at the taxonomic level of families or among different species that are ecologically or functionally similar can provide important information on the diversity of life histories and the extent to which species can be grouped (based on similar life histories) for future multi-species assessments.

Table 51. Available age, growth, and reproductive maturity information for bottomfish species targeted for life history sampling (otoliths and gonads) in CNMI. Parameter estimates are for females unless otherwise noted (F=females, M=males). Parameters T_{max}, t_0, A_{50}, and $A\Delta_{50}$ are in units of years; L_∞, L_{50}, and $L\Delta_{50}$ are in units of mm fork length (FL); *k* in units of year^{-1}; X=parameter estimate too preliminary or Y=published age and growth parameter estimates based on DGI numerical integration technique and likely to be inaccurate; NA=not applicable. Superscript letters indicate status of parameter estimate (see footnotes below table). Published or in press publications ([d]) are denoted in "Reference" column.

Species	Age, growth, and reproductive maturity parameters									Reference
	T_{max}	L_∞	k	t_0	M	A_{50}	$A\Delta_{50}$	L_{50}	$L\Delta_{50}$	
Aphareus rutilans	Y	Y	Y	Y			NA		NA	Y-Ralston & Williams (1988)
Aprion virescens							NA		NA	
Etelis carbunculus							NA		NA	
Etelis coruscans	Y	Y	Y	Y			NA		NA	Y-Ralston & Williams (1988)
Monotaxis grandoculis										
Pristipomoides auricilla	Y	Y	Y	Y			NA		NA	Y-Ralston & Williams (1988)
Pristipomoides filamentosus							NA		NA	
Pristipomoides flavipinnis							NA		NA	
Pristipomoides sieboldii	Y	Y	Y	Y			NA		NA	Y-Ralston & Williams (1988)
Pristpomoides zonatus	Y	Y	Y	Y			NA		NA	Y-Ralston & Williams (1989)
Variola louti										

[a] signifies estimate pending further evaluation in an initiated and ongoing study
[b] signifies a preliminary estimate taken from ongoing analyses
[c] signifies an estimate documented in an unpublished report or draft manuscript
[d] signifies an estimate documented in a finalized report or published journal article (including in press)

2.2.2.2 Fish Length Derived Parameters

Description: The NMFS Commercial Fishery BioSampling Program started in 2009. This program has two components: First is the Field/Market Sampling Program and the second is the Life History Program, details of which are described in a separate section of this report. The goals of the Field/Market Sampling Program are:

- Broad scale look at commercial landings (by fisher/trip, gear & area fished)
- Length and weight frequencies of whole commercial landings per fisher-trip (with an effort to also sample landings not sold commercially)
- Accurate species identification
- Develop accurate local length-weight curves

In CNMI, the BioSampling is focused on the commercial coral reef spear fishery with occasional sampling of the bottomfish fishery occurring locally and less frequently at the northern islands. Sampling is conducted in partnership with the fish vendors. The Market Sampling information includes (but not limited to): 1) fish length; 2) fish weight; 3) species identification; and 4) basic effort information. Specific for CNMI, the program collects Daily Vendor Logs for bottomfish that includes basic catch and effort information.

Category:

- ☐ Fishery independent
- ☐ Fishery dependent
- ✓ Biological

Timeframe: N/A

Jurisdiction:

- ☐ American Samoa
- ☐ Guam
- ✓ Commonwealth of Northern Mariana Islands
- ☐ Main Hawaiian Islands
- ☐ Northwest Hawaiian Islands
- ☐ Pacific Remote Island Areas

Spatial Scale:

- ☐ Regional
- ☐ Archipelagic
- ✓ Island
- ☐ Site

Data Source: NMFS BioSampling Program

Parameter definitions:

***L_{max}* – maximum fish length** is the longest fish per species recorded in the BioSampling Program from the commercial bottomfish fishery. This value is derived from measuring the fork length of individual samples for species occurring in the spear fishery.

***L_{bar}* – mean length** is the average value of all lengths recorded from the commercial spear fishery. This can be influenced by gear selectivity since the commercial bottomfish fishery has a typical size target based on customer demand. This can also be influenced by size regulations.

***n* – sample size** is the total number of samples accumulated for each species recorded in the commercial bottomfish fishery.

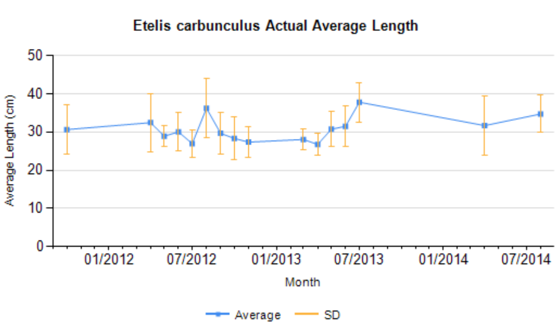
***$N_{L\text{-}W}$* – sample size for L-W regression** is the number of samples used to generate the a & b coefficients.

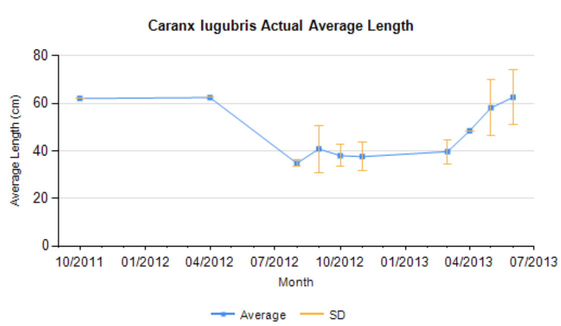
***a & b* – length-weight coefficients** are the coefficients derived from the regression line fitted to all length and weight measured per species in the commercial bottomfish fishery. These values are used to convert length information to weight. Values are influenced by the life history characteristics of the species, geographic location, population status, and nature of the fisheries from which the species are harvested from.

Rationale: Length-derived information is being used as an indicator of population status particularly for data poor stocks like coral reef fish. Average length (L_{bar}) was used as a principal stock assessment indicator variable for exploited reef fish population (Nadon et al 2015). Average length was also shown to be correlated with population size (Kerr and Dickle 2001). Maximum length (L_{max}), typically coupled with maximum age, is typically used as a proxy for fish longevity which has implications on the productivity and susceptibility of a species to fishing pressure. The length-weight coefficients (a & b values) are used to convert length to weight for fishery-dependent and fishery-independent data collection where length are typically recorded but weight is the factor being used for management. This section of the report presents the best available information for the length-derived variables for the bottomfish fisheries.

Table 52. Available length-derived information for various bottomfish species in CNMI.

Species	*Length derived parameters*						Reference
	L_{max}	L_{bar}	*N*	*L-W*	*a*	*b*	
Lethrinus rubrioperculatus	38.0	28.01	1,353	1,021	0.0185	2.9897	
Etelis carbunculus	53.5	30.18	685	685	0.0150	3.0430	
Pristipomoides auricilla	39.5	28.59	465	465	0.0189	3.0060	
Pristipomoides zonatus	45.4	32.99	371	370	0.0180	3.0411	
Etelis coruscans	96.4	72.50	325	325	0.0716	2.6147	
Lutjanus kasmira	32.5	24.84	258	258	0.0087	3.2307	
Pristipomoides flavipinnis	51.5	37.05	168	168	0.0133	3.0762	
Pristipomoides argyrogrammicus	31.6	24.44	150	150	0.0174	3.0464	
Pristipomoides filamentosus	58.5	39.97	123	123	0.0773	2.5914	
Caranx lugubris	82.5	46.07	122	122	0.0309	2.8768	





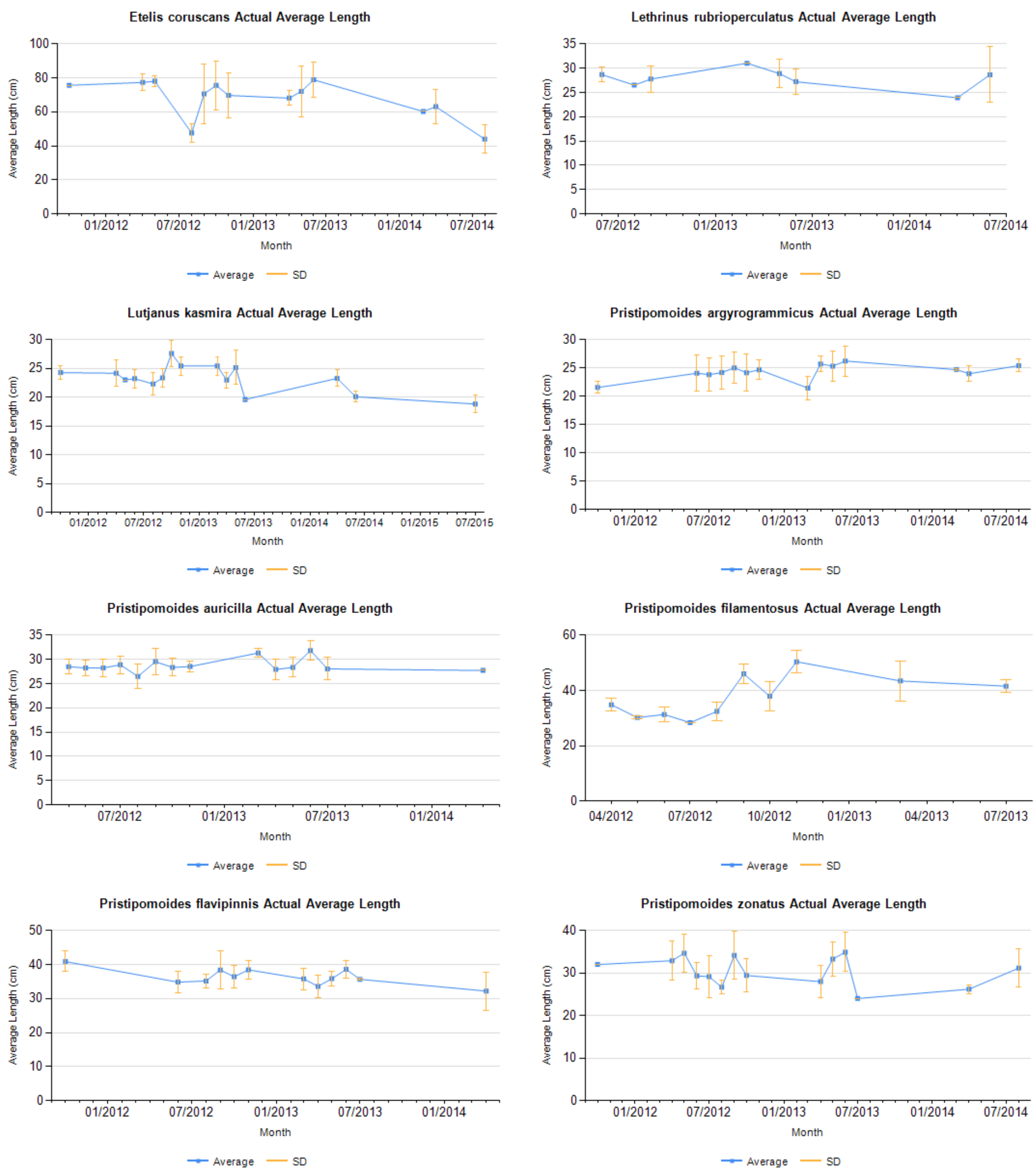


Figure 7. Average length over time of representative CNMI bottomfish management unit species derived from the BioSampling Program.

2.2.2.3 References

Nadon, Marc O., et al. "Length-based assessment of coral reef fish populations in the Main and northwestern Hawaiian islands." *PloS one* 10.8 (2015): e0133960.

Kerr, Stephen R., and Lloyd Merlin Dickie. *The biomass spectrum: a predator-prey theory of aquatic production*. Columbia University Press, 2001.

2.2.3 Guam Coral Reef Ecosystem – Reef Fish Life History

2.2.3.1 Age & Growth and Reproductive Maturity

Description: Age determination is based on counts of yearly growth marks (annuli) and/or daily growth increments (DGIs) internally visible within transversely-cut thin sections of sagittal otoliths. Validated age determination, particularly for long-lived (≥30 years) fish, is based on an environmental signal (bomb radiocarbon ^{14}C) produced during previous atmospheric thermonuclear testing in the Pacific and incorporated into the core regions of sagittal otolith and other aragonite-based calcified structures such as hermatypic corals. This technique relies on developing a regionally-based aged coral core reference series for which the rise, peak, and decline of ^{14}C values is available over the known age series of the coral core. Estimates of fish age are determined by projecting the ^{14}C otolith core values back in time from its capture date to where it intersects with the known age ^{14}C coral reference series. This technique provides age estimates independent of age estimates based on visual counts of annuli or DGIs. The relation between age and fish length is evaluated by fitting this data to a von Bertalanffy growth function based on statistical analyses. The resulting von Bertalanffy growth function predicts the pattern of growth over time for that particular species. This function typically uses three coefficients (L_∞, k, and t_0) which together characterize the shape of the length-at-age growth relationship. The ^{14}C derived ages typically provide more accurate estimates of older ages (≥30 years) and hence more realistic values of T_{max} compared to annuli or DGI-based counts of otolith sections.

Length at reproductive maturity is based on the histological analyses of small tissue samples of gonad material that are typically collected along with otoliths when a fish is processed for life history studies. The gonad tissue sample is preserved then subsequently cut into five-micron sections, stained, and sealed onto a glass slide for subsequent examination. Based on standard cell structure features and developmental stages within ovaries and testes, the gender, developmental stage, and maturity status (immature or mature) is determined via microscopic evaluation. The percent of mature samples for a given length interval are assembled for each sex and these data are fitted to a three- or four-parameter logistic function to determine the best fit of these data based on statistical analyses. The mid-point of this fitted function provides an estimate of the length at which 50% of fish have achieved reproductive maturity (L_{50}). For species that undergo sex reversal (primarily female to male in the tropical Pacific region), such as groupers and deeper-water emperors among the bottomfishes, and for parrotfish, shallow-water emperors, and wrasses among the coral reef fishes, standard histological criteria are used to determine gender and reproductive developmental stages that indicate the transitioning or completed transition from one sex to another. These data are similarly analyzed using a 3- or 4-parameter logistic function to determine the best fit of the data based on statistical analyses. The mid-point of this fitted function provides an estimate of the length at which 50% of fish of a particular species have or are undergoing sex reversal ($L\Delta_{50}$).

Age at 50% maturity (A_{50}) and 50% sex reversal ($A\Delta_{50}$) is typically derived by referencing the von Bertalanffy growth function for that species and using the corresponding L_{50} and $L\Delta_{50}$ values to obtain the corresponding age value from this growth function. In studies where both age & growth and reproductive maturity are concurrently determined, estimates of A_{50} and $A\Delta_{50}$ are derived directly by fitting the percent of mature samples for each age (one-year) interval to a three- or four-parameter logistic function using statistical analyses. The mid-point of this fitted logistic function provides a direct estimate of the age at which 50% of fish of a particular species have achieved reproductive maturity (A_{50}) and sex reversal ($A\Delta_{50}$).

Category:

- ☐ Fishery independent
- ☐ Fishery dependent
- ✓ Biological

Timeframe: N/A

Jurisdiction:

- ☐ American Samoa
- ✓ Guam
- ☐ Commonwealth of Northern Mariana Islands
- ☐ Main Hawaiian Islands
- ☐ Northwest Hawaiian Islands
- ☐ Pacific Remote Island Areas

Spatial Scale:

- ☐ Regional
- ☐ Archipelagic
- ✓ Island
- ☐ Site

Data Source: Sources of data are directly derived from market samples collected by the Guam contracted bio-sampling team which samples the catch of fishermen and local fish vendors. Laboratory analyses and data generated from these analyses reside with the PIFSC Life History Program. Refer to the "Reference" column in Table 53 for specific details on data sources by species.

Parameter definitions:

T_{max} (maximum age) – The maximum observed age revealed from an otolith-based age determination study. T_{max} values can be derived from ages determined by annuli counts of sagittal otolith sections and/or bomb radiocarbon (^{14}C) analysis of otolith core material.

L_∞ (asymptotic length) – One of three coefficients of the von Bertalanffy growth function (VBGF) that measures the mean maximum length at which the growth curve plateaus and no longer increases in length with increasing age. This coefficient reflects the mean maximum length and not the observed maximum length.

k (growth coefficient) – One of three coefficients of the VBGF that measures the shape and steepness by which the initial portion of the growth function approaches its mean maximum length (L_∞).

t_0 (hypothetical age at length zero) – One of three coefficients of the VBGF whose measure is highly influenced by the other two VBGF coefficients (k and L_∞) and typically assumes a negative value when specimens representing early growth phases (0+ to 1+ ages) are not available for age determination.

M (natural mortality) – This is a measure of mortality rate for a fish stock not under the influence of fishing pressure and is considered to be directly related to stock productivity (i.e., high *M* indicates high productivity and low *M* indicates low stock productivity). *M* can be derived through use of various equations that link *M* to T_{max} and *k*, or in some instances, by calculating the value of the slope from a regression fit to a declining catch curve (regression of the natural logarithm of abundance versus age class) derived from fishing an unfished or lightly fished population.

A_{50} (age at 50% maturity) – Age at which 50% of the sampled stock under study has attained reproductive maturity. This parameter is best determined based on studies that concurrently determine both age (otolith-based age data) and reproductive maturity status (logistic function fitted to percent mature by age class with maturity determined via microscopic analyses of gonad histology preparations). A more approximate means of estimating A_{50} is to use an existing L_{50} estimate to find the corresponding age (A_{50}) from an existing VBGF curve.

$A\Delta_{50}$ (age of sex switching) – Age at which 50% of the immature and adult females of the sampled stock under study is undergoing or has attained sex reversal. This parameter is best determined based on studies that concurrently determines both age (otolith-based age data) and reproductive sex reversal status (logistic function fitted to percent sex reversal by age class with sex reversal determined via microscopic analyses of gonad histology preparations). A more approximate means of estimating $A\Delta_{50}$ is to use an existing $L\Delta_{50}$ estimate to find the corresponding age ($A\Delta_{50}$) from the VBGF curve.

L_{50} (length at which 50% of a fish species are capable of spawning) – Length (usually in terms of fork length) at which 50% of the females of a sampled stock under study has attained reproductive maturity; this is the length associated with A_{50} estimates. This parameter is derived using a logistic function to fit the percent mature data by length class with maturity status best determined via microscopic analyses of gonad histology preparations). L_{50} information is typically more available than A_{50} since L_{50} estimates do not require knowledge of age & growth.

$L\Delta_{50}$ (length of sex switching) **–** Length (usually in terms of fork length) at which 50% of the immature and adult females of the sampled stock under study is undergoing or has attained sex reversal; this is the length associated with $A\Delta_{50}$ estimates. This parameter is derived using a logistic function to fit the percent sex reversal data by length class with sex reversal status best determined via microscopic analyses of gonad histology preparations. $L\Delta_{50}$ information is typically more available than $A\Delta_{50}$ since $L\Delta_{50}$ estimates do not require knowledge of age & growth.

Rationale: These nine life history parameters provide basic biological information at the species level to evaluate the productivity of a stock - an indication of the capacity of a stock to recover once it has been depleted. Currently, the assessment of coral reef fish resources in American Samoa is data-limited. Knowledge of these life history parameters support current efforts to characterize the resilience of these resources and also provide important biological inputs for future stock assessment efforts and enhance our understanding of the species-likely role and status as a component of the overall ecosystem. Furthermore, knowledge of life histories across species at the taxonomic level of families or among different species that are ecologically or functionally similar can provide important information on the diversity of life histories and the extent to which species can be grouped (based on similar life histories) for future multi-species assessments.

Table 53. Available age, growth, and reproductive maturity information for coral reef species targeted for life history sampling (otoliths and gonads) in Guam. Parameter estimates are for females unless otherwise noted (F=females, M=males). Parameters T_{max}, t_0, A_{50}, and $A\Delta_{50}$ are in units of years; L_∞, L_{50}, and $L\Delta_{50}$ are in units of mm fork length (FL); k in units of $year^{-1}$; X=parameter estimate too preliminary or Y=published age and growth parameter estimates based on DGI numerical integration technique and likely to be inaccurate; NA=not applicable. Superscript letters indicate status of parameter estimate (see footnotes below table). Published or in press publications ([d]) are denoted in "Reference" column.

Species	*Age, growth, and reproductive maturity parameters*									Reference
	T_{max}	L_∞	k	t_0	M	A_{50}	$A\Delta_{50}$	L_{50}	$L\Delta_{50}$	
Calatomus carolinus	3[d]	263[d]	0.91[d]	-0.065[d]		1.14[d]		168[d]	213[d]	[d]Taylor & Choat (2014)
Oxycheilinus unifasciatus										
Chlorurus frontalis	11[d]	372[d]	0.71[d]	-0.058[d]		1.55[d]		240[d]	343[d]	[d]Taylor & Choat (2014)
Chlorurus microrhinos	11[d]	457[d]	0.34[d]	-0.097[d]		3.7[d]		308[d]	378[d]	[d]Taylor & Choat (2014)
Chlorurus spilurus	9[d]	218[d]	0.95[d]	-0.075[d]		1.3[d]		144[d]	207[d]	[d]Taylor & Choat (2014)
Hipposcarus longiceps	10[b]	433[b]	0.81[b]	-0.029[b]						
Scarus altipinnis	14[d]	339[d]	0.66[d]	-0.069[d]		2.89[d]		251[d]	337[d]	[d]Taylor & Choat (2014)
Scarus forsteni	12[d]	281[d]	0.88[d]	-0.062[d]		1.79[d]		216[d]	271[d]	[d]Taylor & Choat (2014)
Scarus psittacus	6[d]	207[d]	0.91[d]	-0.083[d]		1.36[d]		103[d]	193[d]	[d]Taylor & Choat (2014)
Scarus rubroviolaceus	6[d]	376[d]	0.66[d]	-0.062[d]		1.91[d]		271[d]	329[d]	[d]Taylor & Choat (2014)
Scarus schlegeli	8[d]	252[d]	1.03[d]	-0.06[d]		1.99[d]		197[d]	220[d]	[d]Taylor & Choat (2014)
Siganus punctatus							NA		NA	

[a] signifies estimate pending further evaluation in an initiated and ongoing study
[b] signifies a preliminary estimate taken from ongoing analyses
[c] signifies an estimate documented in an unpublished report or draft manuscript
[d] signifies an estimate documented in a finalized report or published journal article (including in press)

2.2.3.2 Fish Length Derived Parameters

Description: The NMFS Commercial Fishery BioSampling Program started in 2009. This program has two components: First is the Field/Market Sampling Program and the second is the Life History Program, details of which are described in a separate section of this report. The goals of the Field/Market Sampling Program are:

- Broad scale look at commercial landings (by fisher/trip, gear & area fished)

- Length and weight frequencies of whole commercial landings per fisher-trip (with an effort to also sample landings not sold commercially)
- Accurate species identification
- Develop accurate local length-weight curves

In American Samoa, the BioSampling is focused on the commercial coral reef spear fishery with occasional sampling of the bottomfish fishery occurring locally and less frequently at the banks. Sampling is conducted in direct partnership with the spear fisherman. The Market Sampling information includes (but not limited to): 1) fish length; 2) fish weight; 3) species identification; and 4) basic effort information.

Category:

- ☐ Fishery independent
- ☐ Fishery dependent
- ✓ Biological

Timeframe: N/A

Jurisdiction:

- ☐ American Samoa
- ✓ Guam
- ☐ Commonwealth of Northern Mariana Islands
- ☐ Main Hawaiian Islands
- ☐ Northwest Hawaiian Islands
- ☐ Pacific Remote Island Areas

Spatial Scale:

- ☐ Regional
- ☐ Archipelagic
- ✓ Island
- ☐ Site

Data Source: NMFS BioSampling Program

Parameter definition:

***L_{max}* – maximum fish length** is the longest fish per species recorded in the BioSampling Program from the commercial spear fishery. This value is derived from measuring the fork length of individual samples for species occurring in the spear fishery.

***L_{bar}* – mean length** is the average value of all lengths recorded from the commercial spear fishery. This can be influenced by gear selectivity since the commercial spear fishery has a typical size target based on customer demand. This can also be influenced by size regulations.

***n* – sample size** is the total number of samples accumulated for each species recorded in the commercial spear fishery.

***$N_{L\text{-}W}$* – sample size for L-W regression** is the number of samples used to generate the a & b coefficients.

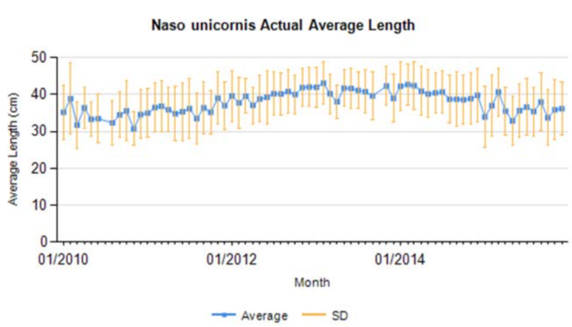
***a & b* – length-weight coefficients** are the coefficients derived from the regression line fitted to all length and weight measured per species in the commercial spear fishery. These values are used to convert length information to weight. Values are influenced by the life history characteristics of the species, geographic location, population status, and nature of the fisheries from which the species are harvested

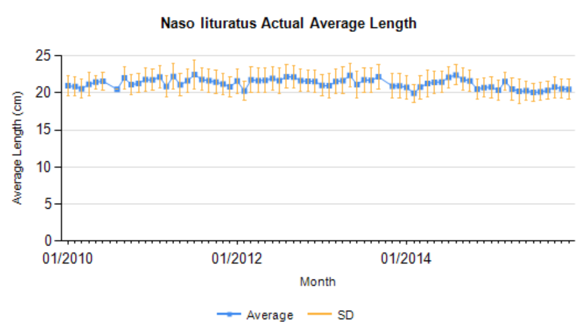
Rationale: Length-derived information is being used as an indicator of population status particularly for data-poor stocks like coral reef fish. Average length (L_{bar}) was used as a principal stock assessment indicator variable for exploited reef fish population (Nadon et al 2015). Average length was also shown to be correlated with population size (Kerr and Dickle 2001). Maximum length (L_{max}), typically coupled with maximum age, is typically used as a proxy for fish longevity which has implications on the productivity and susceptibility of a species to fishing pressure. The length-weight coefficients (a & b values) are used to convert length to weight for fishery dependent and fishery independent data collection where length are typically recorded but weight is the factor being used for management. This section of the report presents the best available information for the length-derived variables for the CNMI coral reef and bottomfish fisheries.

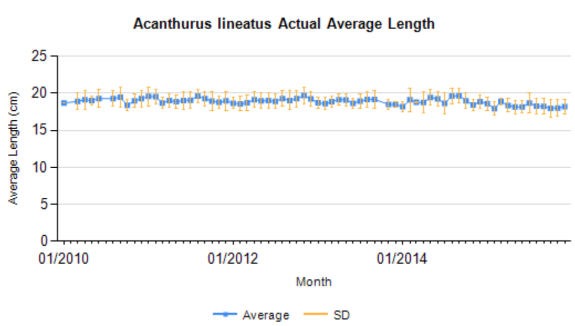
Table 54. Available length derived information for various coral reef species in Guam.

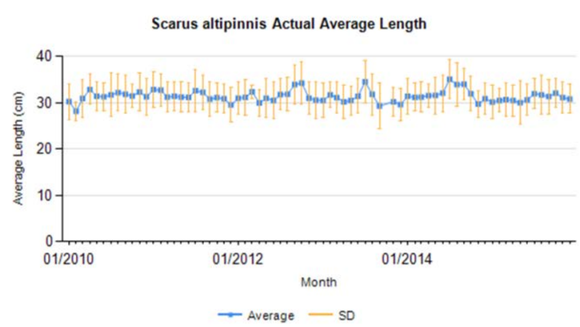
Species	*Length derived parameters*						Reference
	L_{max}	L_{bar}	*n*	*L-W*	*a*	*b*	
Naso unicornis	57.2	38.02	15461		0.0278	2.9135	2010-2015 Guam Biosampling Database
Naso lituratus	29.6	21.35	16702		0.0223	3.0264	
Acanthurus lineatus	28.9	19.04	4325		0.0473	2.8110	
Scarus altipinnis	46.4	31.16	3913		0.0207	3.0040	
Myripristis bendti	29.4	18.63	3903		0.0858	2.5911	
Siganus argenteus	34.5	21.71	3653		0.0163	3.0428	
Acanthurus nigricauda	29.1	21.40	3500		0.0511	2.7811	
Hipposcarus longiceps	51.4	37.30	3149		0.0172	3.0320	
Scarus schlegeli	36.2	25.19	2787		0.0205	3.0033	
Siganus punctatus	32.0	23.97	2619		0.0199	3.0690	

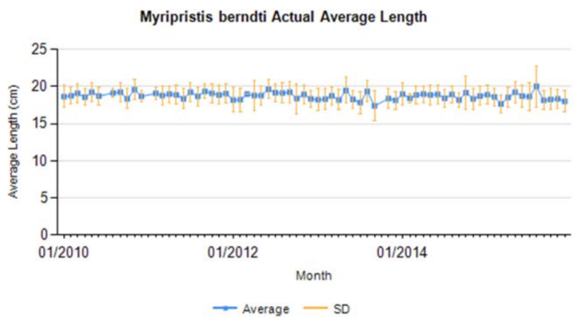
Monotaxis grandoculis	48.9	29.17	2388		0.0440	2.8384	
Scarus rubroviolaceus	47.8	31.91	2192		0.0114	3.1812	
Lethrinus obsoletus	34.7	22.15	2273		0.0169	3.0471	
Scarus forsteni	39.1	28.13	1801		0.0149	3.1169	
Lutjanus gibbus	43.5	29.99	1687		0.0195	3.0274	
Panulirus penicillatus							
Parupeneus insularis	28.5	21.89	1560		0.0178	3.0865	
Siganus spinus	27.5	16.53	1670		0.0353	2.7886	
Lethrinus atkinsoni	*33.7*	*21.93*	*1644*		*0.0215*	*3.0217*	
Chlorurus microrhinus	*50.5*	*32.54*	*1527*		*0.0187*	*3.0520*	
Chlorurus sordidus	*33.1*	*22.39*	*1234*		*0.0208*	*3.0293*	
Kyphosus cinerascens	*50.7*	*29.94*	*1146*		*0.0323*	*2.9267*	

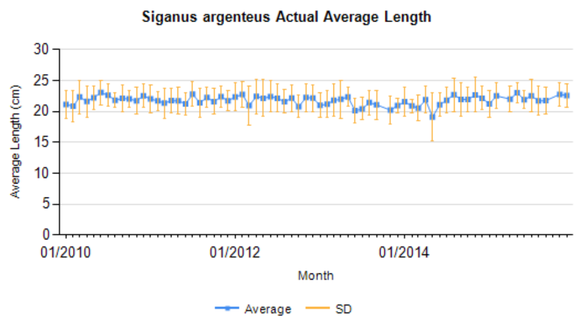


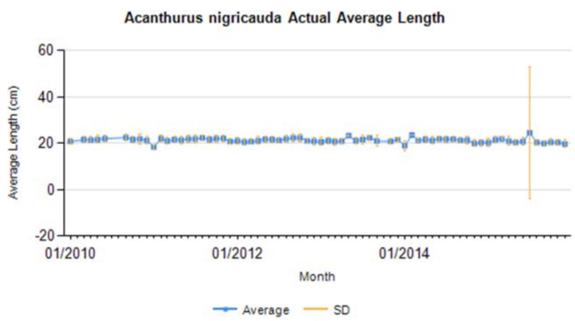


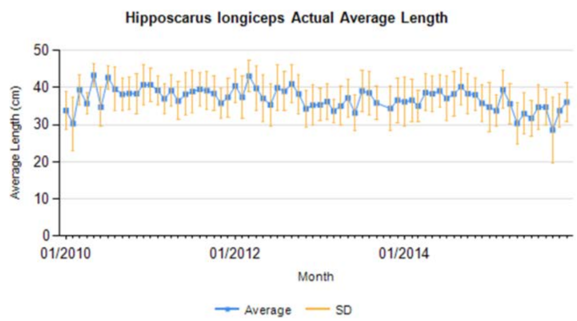


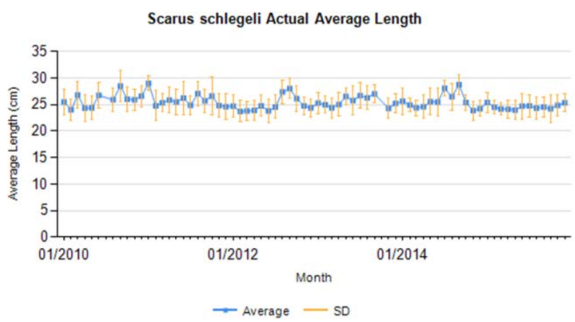


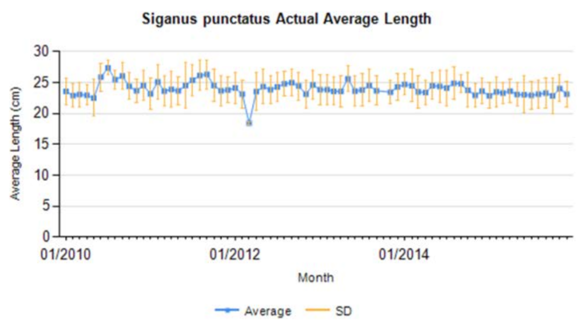

Myripristis berndti Actual Average Length
Average Length (cm)
01/2010
01/2012
01/2014
Month
Average
SD

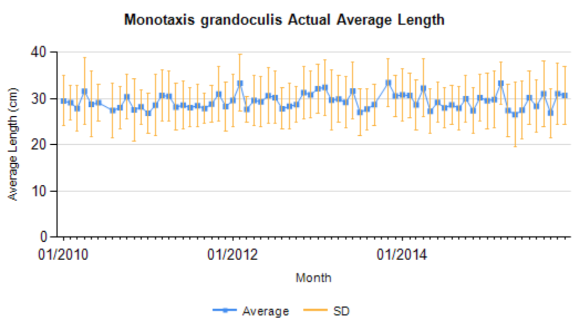

Siganus argenteus Actual Average Length
Average Length (cm)
01/2010
01/2012
01/2014
Month
Average
SD

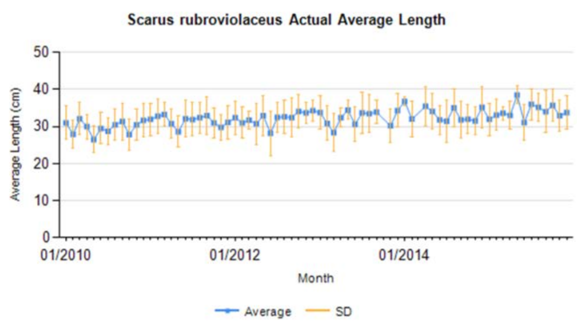

Acanthurus nigricauda Actual Average Length
Average Length (cm)
01/2010
01/2012
01/2014
Month
Average
SD

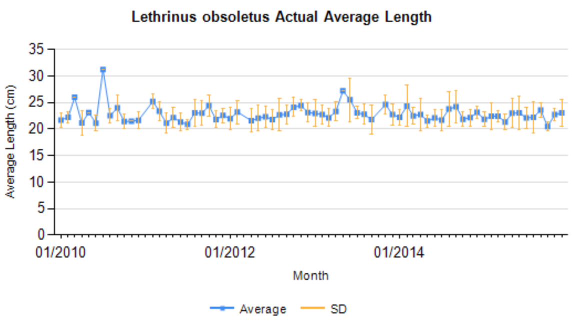

Hipposcarus longiceps Actual Average Length
Average Length (cm)
01/2010
01/2012
01/2014
Month
Average
SD

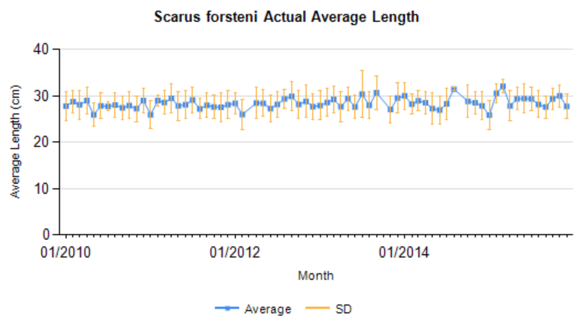

Scarus schlegeli Actual Average Length
Average Length (cm)
01/2010
01/2012
01/2014
Month
Average
SD

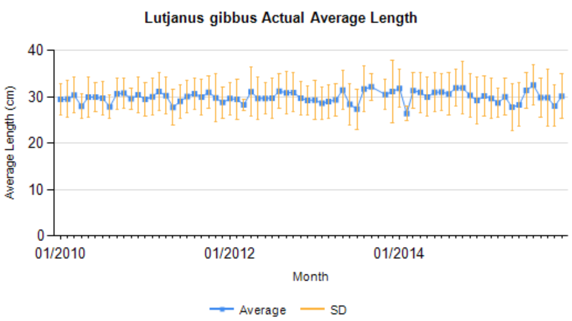

Siganus punctatus Actual Average Length
Average Length (cm)
01/2010
01/2012
01/2014
Month
Average
SD

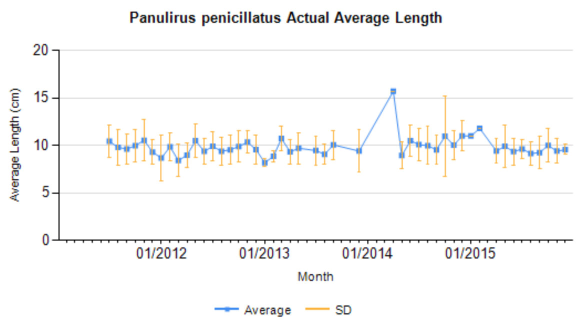

Monotaxis grandoculis Actual Average Length
Average Length (cm)
01/2010
01/2012
01/2014
Month
Average
SD

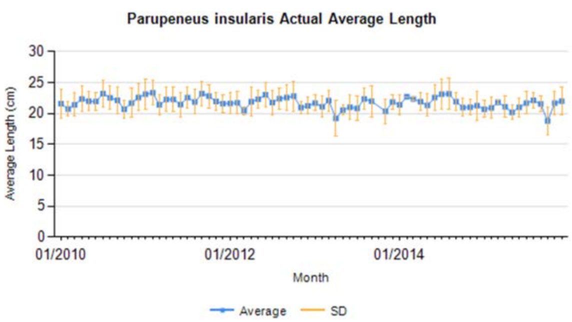

Scarus rubroviolaceus Actual Average Length
Average Length (cm)
01/2010
01/2012
01/2014
Month
Average
SD

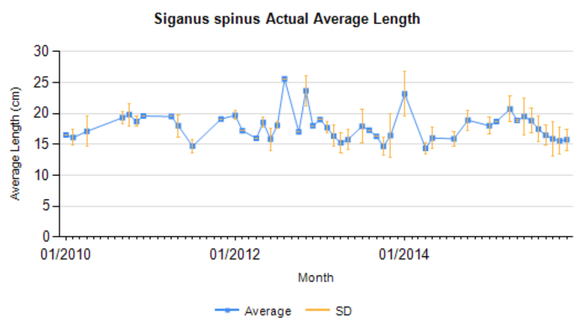

Lethrinus obsoletus Actual Average Length
Average Length (cm)
35
30
25
20
15
10
5
0
01/2010
01/2012
01/2014
Month
Average
SD

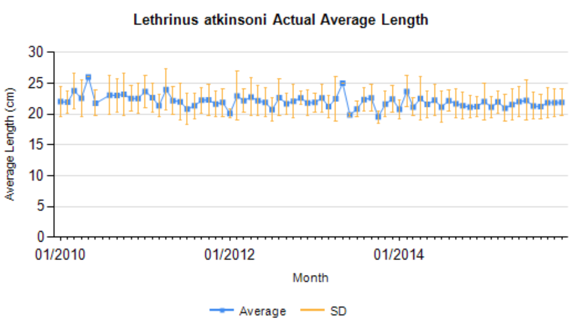

Scarus forsteni Actual Average Length
Average Length (cm)
40
30
20
10
0
01/2010
01/2012
01/2014
Month
Average
SD

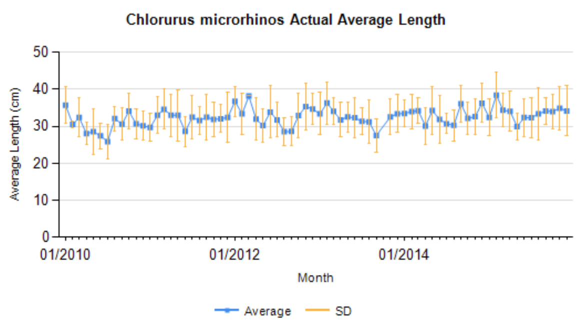

Lutjanus gibbus Actual Average Length
Average Length (cm)
40
30
20
10
0
01/2010
01/2012
01/2014
Month
Average
SD


Panulirus penicillatus Actual Average Length
Average Length (cm)
20
15
10
5
0
01/2012
01/2013
01/2014
01/2015
Month
Average
SD


Parupeneus insularis Actual Average Length
Average Length (cm)
30
25
20
15
10
5
0
01/2010
01/2012
01/2014
Month
Average
SD


Siganus spinus Actual Average Length
Average Length (cm)
30
25
20
15
10
5
0
01/2010
01/2012
01/2014
Month
Average
SD


Lethrinus atkinsoni Actual Average Length
Average Length (cm)
30
25
20
15
10
5
0
01/2010
01/2012
01/2014
Month
Average
SD


Chlorurus microrhinos Actual Average Length
Average Length (cm)
50
40
30
20
10
0
01/2010
01/2012
01/2014
Month
Average
SD

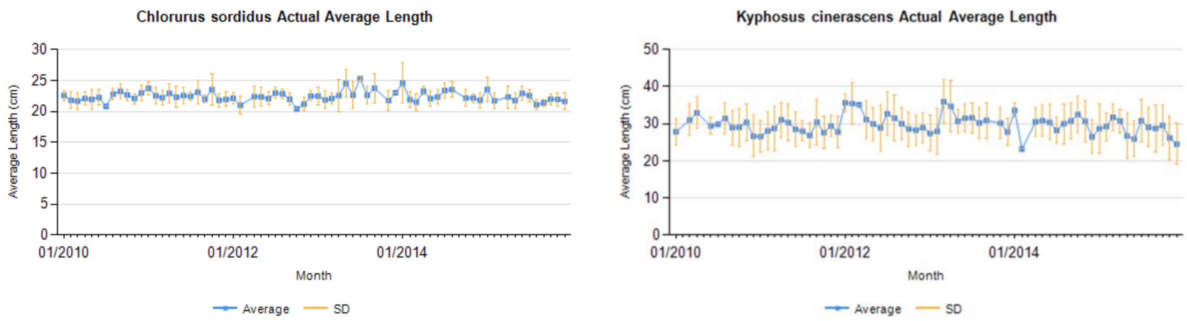


Figure 8. Average length over time of representative Guam coral reef fish management unit species derived from the BioSampling Program.

2.2.4 Guam Bottomfish Ecosystem – Bottomfish Life History

2.2.4.1 Age & Growth and Reproductive Maturity

Description: Age determination is based on counts of yearly growth marks (annuli) and/or daily growth increments (DGIs) internally visible within transversely-cut thin sections of sagittal otoliths. Validated age determination, particularly for long-lived (≥30 years) fish, is based on an environmental signal (bomb radiocarbon ^{14}C) produced during previous atmospheric thermonuclear testing in the Pacific and incorporated into the core regions of sagittal otolith and other aragonite-based calcified structures such as hermatypic corals. This technique relies on developing a regionally-based aged coral core reference series for which the rise, peak, and decline of ^{14}C values is available over the known age series of the coral core. Estimates of fish age are determined by projecting the ^{14}C otolith core values back in time from its capture date to where it intersects with the known age ^{14}C coral reference series. This technique provides age estimates independent of age estimates based on visual counts of annuli or DGIs. The relation between age and fish length is evaluated by fitting this data to a von Bertalanffy growth function based on statistical analyses. The resulting von Bertalanffy growth function predicts the pattern of growth over time for that particular species. This function typically uses three coefficients (L_∞, k, and t_0) which together characterize the shape of the length-at-age growth relationship. The ^{14}C derived ages typically provide more accurate estimates of older ages (≥30 years) and hence more realistic values of T_{max} compared to annuli or DGI-based counts of otolith sections.

Length at reproductive maturity is based on the histological analyses of small tissue samples of gonad material that are typically collected along with otoliths when a fish is processed for life history studies. The gonad tissue sample is preserved then subsequently cut into five micron sections, stained, and sealed onto a glass slide for subsequent examination. Based on standard cell structure features and developmental stages within ovaries and testes, the gender, developmental stage, and maturity status (immature or mature) is determined via microscopic evaluation. The percent of mature samples for a given length interval are assembled for each sex and these data are fitted to a three- or four-parameter logistic function to determine the best fit of these data based on statistical analyses. The mid-point of this fitted function provides an estimate of the length at which 50% of fish have achieved reproductive maturity (L_{50}). For species that undergo sex reversal (primarily female to male in the tropical Pacific region), such as groupers and deeper-water emperors among the bottomfishes, and for parrotfish, shallow-water emperors, and wrasses among the coral reef fishes, standard histological criteria are used to determine gender and reproductive developmental stages that indicate the transitioning or completed transition from one sex to another. These data are similarly analyzed using a three- or four-parameter logistic function to determine the best fit of the data based on statistical analyses. The mid-point of this fitted function provides an estimate of the length at which 50% of fish of a particular species have or are undergoing sex reversal ($L\Delta_{50}$).

Age at 50% maturity (A_{50}) and 50% sex reversal ($A\Delta_{50}$) is typically derived by referencing the von Bertalanffy growth function for that species and using the corresponding L_{50} and $L\Delta_{50}$ values to obtain the corresponding age value from this growth function. In studies where both age & growth and reproductive maturity are concurrently determined, estimates of A_{50} and $A\Delta_{50}$ are derived directly by fitting the percent of mature samples for each age (one-year) interval to a three- or four-parameter logistic function using statistical analyses. The mid-point of this fitted logistic function provides a direct estimate of the age at which 50% of fish of a particular species have achieved reproductive maturity (A_{50}) and sex reversal ($A\Delta_{50}$).

Category:

- ☐ Fishery independent
- ☐ Fishery dependent
- ✓ Biological

Timeframe: N/A

Jurisdiction:

- ☐ American Samoa
- ✓ Guam
- ☐ Commonwealth of Northern Mariana Islands
- ☐ Main Hawaiian Islands
- ☐ Northwest Hawaiian Islands:
- ☐ Pacific Remote Island Areas

Spatial Scale:

- ☐ Regional
- ☐ Archipelagic
- ✓ Island
- ☐ Site

Data Source: Sources of data are directly derived from field samples collected at sea on NOAA research vessels and from the Guam contracted bio-sampling team which samples the catch of fishermen and local fish vendors. Laboratory analyses and data generated from these analyses reside with the PIFSC Life History Program. Refer to the “Reference” column in Table 55 for specific details on data sources by species.

Parameter definitions:

***T_{max}* (maximum age) –** The maximum observed age revealed from an otolith-based age determination study. T_{max} values can be derived from ages determined by annuli counts of sagittal otolith sections and/or bomb radiocarbon (^{14}C) analysis of otolith core material.

***L_∞* (asymptotic length)** – One of three coefficients of the von Bertalanffy growth function (VBGF) that measures the mean maximum length at which the growth curve plateaus and no longer increases in length with increasing age. This coefficient reflects the mean maximum length and not the observed maximum length.

***k* (growth coefficient)** – One of three coefficients of the VBGF that measures the shape and steepness by which the initial portion of the growth function approaches its mean maximum length (L_∞).

***t_0* (hypothetical age at length zero)** – One of three coefficients of the VBGF whose measure is highly influenced by the other two VBGF coefficients (*k* and L_∞) and typically assumes a negative value when specimens representing early growth phases (0+ to 1+ ages) are not available for age determination.

***M* (natural mortality)** – This is a measure of mortality rate for a fish stock not under the influence of fishing pressure and is considered to be directly related to stock productivity (i.e., high *M* indicates high productivity and low *M* indicates low stock productivity). *M* can be derived through use of various equations that link *M* to T_{max} and *k*, or in some instances, by calculating the value of the slope from a regression fit to a declining catch curve (regression of the natural logarithm of abundance versus age class) derived from fishing an unfished or lightly-fished population.

***A_{50}* (age at 50% maturity)** – Age at which 50% of the sampled stock under study has attained reproductive maturity. This parameter is best determined based on studies that concurrently determine both age (otolith-based age data) and reproductive maturity status (logistic function fitted to percent mature by age class with maturity determined via microscopic analyses of gonad histology preparations). A more approximate means of estimating A_{50} is to use an existing L_{50} estimate to find the corresponding age (A_{50}) from an existing VBGF curve.

***$A\Delta_{50}$* (age of sex switching)** – Age at which 50% of the immature and adult females of the sampled stock under study is undergoing or has attained sex reversal. This parameter is best determined based on studies that concurrently determines both age (otolith-based age data) and reproductive sex reversal status (logistic function fitted to percent sex reversal by age class with sex reversal determined via microscopic analyses of gonad histology preparations). A more approximate means of estimating $A\Delta_{50}$ is to use an existing $L\Delta_{50}$ estimate to find the corresponding age ($A\Delta_{50}$) from the VBGF curve.

***L_{50}* (length at which 50% of a fish species are capable of spawning)** – Length (usually in terms of fork length) at which 50% of the females of a sampled stock under study has attained reproductive maturity; this is the length associated with A_{50} estimates. This parameter is derived using a logistic function to fit the percent mature data by length class with maturity status best determined via microscopic analyses of gonad histology preparations). L_{50} information is typically more available than A_{50} since L_{50} estimates do not require knowledge of age & growth.

***$L\Delta_{50}$* (length of sex switching)** – Length (usually in terms of fork length) at which 50% of the immature and adult females of the sampled stock under study is undergoing or has attained sex reversal; this is the length associated with $A\Delta_{50}$ estimates. This parameter is derived using a logistic function to fit the percent sex reversal data by length class with sex reversal status best determined via microscopic analyses of gonad histology preparations). $L\Delta_{50}$ information is typically more available than $A\Delta_{50}$ since $L\Delta_{50}$ estimates do not require knowledge of age & growth.

Rationale: These nine life history parameters provide basic biological information at the species level to evaluate the productivity of a stock - an indication of the capacity of a stock to recover once it has been depleted. Currently, the assessment of coral reef fish resources in American Samoa is data-limited. Knowledge of these life history parameters support current efforts to characterize the resilience of these resources and also provide important biological inputs for future stock assessment efforts and enhance our understanding of the species-likely role and status as a component of the overall ecosystem. Furthermore, knowledge of life histories across species at the taxonomic level of families or among different species that are ecologically or functionally similar can provide important information on the diversity of life histories and the extent to which species can be grouped (based on similar life histories) for future multi-species assessments.

Table 55. Available age, growth, and reproductive maturity information for bottomfish species targeted for life history sampling (otoliths and gonads) in Guam. Parameter estimates are for females unless otherwise noted (F=females, M=males). Parameters T_{max}, t_0, A_{50}, and $A\Delta_{50}$ are in units of years; L_∞, L_{50}, and $L\Delta_{50}$ are in units of mm fork length (FL); k in units of year^{-1}; X=parameter estimate too preliminary or Y=published age and growth parameter estimates based on DGI numerical integration technique and likely to be inaccurate; NA=not applicable. Superscript letters indicate status of parameter estimate (see footnotes below table). Published or in press publications ([d]) are denoted in "Reference" column.

Species	Age, growth, and reproductive maturity parameters									Reference
	T_{max}	L_∞	k	t_0	M	A_{50}	$A\Delta_{50}$	L_{50}	$L\Delta_{50}$	
Aphareus rutilans							NA		NA	
Aprion virescens							NA		NA	
Etelis carbunculus							NA		NA	
Etelis coruscans							NA		NA	
Monotaxis grandoculis								228[b]	X[a]	
Pristipomoides auricilla							NA		NA	
Pristipomoides filamentosus							NA		NA	
Pristipomoides flavipinnis							NA		NA	
Pristipomoides sieboldii							NA		NA	
Pristpomoides zonatus							NA		NA	
Variola louti								220[b]	X[a]	

[a] signifies estimate pending further evaluation in an initiated and ongoing study
[b] signifies a preliminary estimate taken from ongoing analyses
[c] signifies an estimate documented in an unpublished report or draft manuscript
[d] signifies an estimate documented in a finalized report or published journal article (including in press)

2.2.4.2 Fish Length Derived Parameters

Description: The NMFS Commercial Fishery BioSampling Program started in 2009. This program has two components: First is the Field/Market Sampling Program and the second is the

Life History Program, details of which are described in a separate section of this report. The goals of the Field/Market Sampling Program are:

- Broad scale look at commercial landings (by fisher/trip, gear & area fished)
- Length and weight frequencies of whole commercial landings per fisher-trip (with an effort to also sample landings not sold commercially)
- Accurate species identification
- Develop accurate local length-weight curves

In Guam, the BioSampling is focused on the commercial fishery. Sampling is conducted in partnership with the Guam Fisherman's Cooperative Association (GFCA). The Market Sampling information includes (but not limited to): 1) fish length; 2) fish weight; 3) species identification; and 4) basic effort information. More specific fishery information such as gear information, species composition and total catch information is recorded through the log book system implemented by GFCA and transcribed into the database maintained by the Western Pacific Fishery Information Network.

Category:

- ☐ Fishery independent
- ☐ Fishery dependent
- ✓ Biological

Timeframe: N/A

Jurisdiction:

- ☐ American Samoa
- ✓ Guam
- ☐ Commonwealth of Northern Mariana Islands
- ☐ Main Hawaiian Islands
- ☐ Northwest Hawaiian Islands
- ☐ Pacific Remote Island Areas

Spatial Scale:

- ☐ Regional
- ☐ Archipelagic
- ✓ Island
- ☐ Site

Data Source: NMFS BioSampling Program

Parameter definition:

***L_{max}* – maximum fish length** is the longest fish per species recorded in the BioSampling Program from the commercial spear fishery. This value is derived from measuring the fork length of individual samples for species occurring in the spear fishery.

***L_{bar}* – mean length** is the average value of all lengths recorded from the commercial spear fishery. This can be influenced by gear selectivity since the commercial spear fishery has a typical size target based on customer demand. This can also be influenced by size regulations.

n* – *sample size is the total number of samples accumulated for each species recorded in the commercial spear fishery.

$N_{L\text{-}W}$* – *sample size for L-W regression is the number of samples used to generate the a & b coefficients

a & b* – *length-weight coefficients are the coefficients derived from the regression line fitted to all length and weight measured per species in the commercial spear fishery. These values are used to convert length information to weight. Values are influenced by the life history characteristics of the species, geographic location, population status, and nature of the fisheries from which the species are harvested from.

Rationale: Length-derived information is being used as an indicator of population status particularly for data-poor stocks like coral reef fish. Average length (L_{bar}) was used as a principal stock assessment indicator variable for exploited reef fish population (Nadon et al 2015). Average length was also shown to be correlated with population size (Kerr and Dickle 2001). Maximum length (L_{max}), typically coupled with maximum age, is typically used as a proxy for fish longevity which has implications on the productivity and susceptibility of a species to fishing pressure. The length-weight coefficients (a & b values) are used to convert length to weight for fishery dependent and fishery independent data collection where length are typically recorded but weight is the factor being used for management. This section of the report presents the best available information for the length-derived variables for the CNMI coral reef and bottomfish fisheries.

Table 56. Available length derived information for various bottomfish species in Guam.

Species	***Length derived parameters***						**Reference**
	L_{max}	***L_{bar}***	***n***	***L-W***	***a***	***b***	
Lethrinus rubrioperculatus	46.6	27.10	3374		0.0248	2.9158	2010-2015 Guam Biosampling Database
Epinephelus fasciatus	35.8	24.01	3033		0.0141	3.0303	
Pristipomoides auricilla	39.0	28.18	1732		0.0152	3.0742	

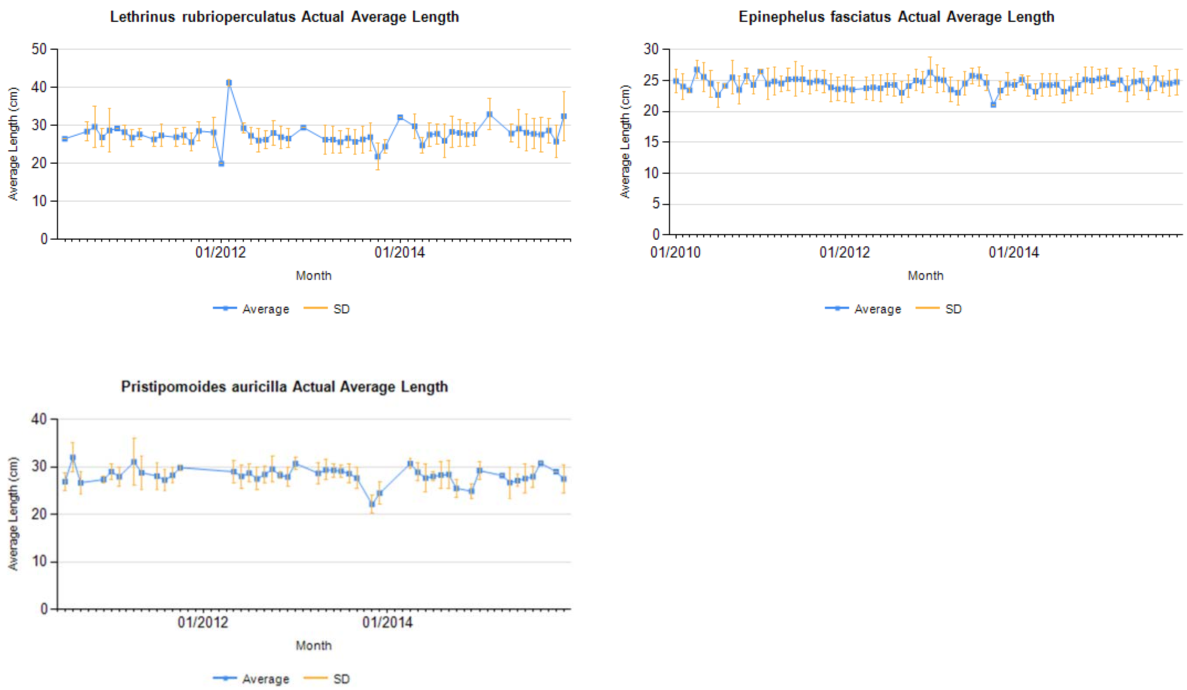


Figure 9. Average length over time of representative Guam bottomfish management unit species derived from the BioSampling Program

2.3 Human Dimensions

Human dimensions data will be made available in subsequent reports as resources allow.

2.4 Protected Species

This section of the report summarizes information on protected species interactions in fisheries managed under the Mariana FEP. Protected species covered in this report include sea turtles, seabirds, marine mammals, sharks and corals.

Lists of species protected under the Endangered Species Act and the Marine Mammal Protection Act that occur around the Mariana Archipelago and their listing status can be found online at: http://www.fpir.noaa.gov/Library/PRD/ESA%20Consultation/Marianas_Species_List_Jan_2015.pdf

2.4.1 Indicators for Monitoring Protected Species Interactions in the Marianas FEP Fisheries

In this report, the Council monitors protected species interactions in the Marianas FEP fisheries using proxy indicators such as fishing effort and changes in gear types as these fisheries do not have observer coverage. Discussion of protected species interactions is focused on fishing operations in federal waters and associated transit through Territorial waters.

2.4.1.1 FEP Conservation Measures

Bottomfish, precious coral, coral reef and crustacean fisheries managed under this FEP have not had reported interactions with protected species, and no specific regulations are in place to mitigate protected species interactions. Destructive gear such as bottom trawls, bottom gillnets, explosives and poisons are prohibited under this FEP, and these provide benefit to protected species by preventing potential interactions with non-selective fishing gear.

2.4.1.2 ESA Consultations

ESA consultations were conducted by NMFS and the U.S. Fish and Wildlife Service (for species under their jurisdiction) to ensure ongoing fisheries operations managed under the Marianas FEP 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.

Bottomfish Fishery

In a Biological Opinion issued on March 8, 2002, NMFS concluded that the ongoing operation of the Western Pacific Region's bottomfish and seamount fisheries 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. An informal consultation completed by NMFS on June 3, 2008 concluded that Mariana Archipelago bottomfish fisheries are not likely to adversely affects four sea turtle species (leatherback, olive ridley, green and hawksbill turtles) and five marine mammal species (humpback, blue, fin, sei and sperm whales). NMFS also concluded in an informal consultation dated April 29, 2015 that fisheries managed under the Mariana Archipelago FEP are not likely to adversely affect the Indo-West Pacific DPS of scalloped hammerhead shark and ESA-listed reef-building corals.

Crustacean Fishery

An informal consultation completed by NMFS on September 28, 2007 concluded that Mariana Archipelago crustacean fisheries are not likely to adversely affect five sea turtle species (loggerhead, leatherback, olive ridley, green and hawksbill turtles) and five marine mammal species (humpback, blue, fin, sei and sperm whales). NMFS also concluded in an informal consultation dated April 29, 2015 that fisheries managed under the Mariana Archipelago FEP are not likely to adversely affect the Indo-West Pacific DPS of scalloped hammerhead shark and ESA-listed reef-building corals.

Coral Reef Fishery
An informal consultation completed by NMFS on March 7, 2002 concluded 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.

An informal consultation completed by NMFS in June 3, 2008 concluded that Mariana Archipelago coral reef fisheries are not likely to adversely affect adversely affects four sea turtle species (leatherback, olive ridley, green and hawksbill turtles) and five marine mammal species (humpback, blue, fin, sei and sperm whales). NMFS also concluded in an informal consultation dated April 29, 2015 that fisheries managed under the Mariana Archipelago FEP are not likely to adversely affect the Indo-West Pacific DPS of scalloped hammerhead shark and ESA-listed reef-building corals.

Precious Coral Fishery
In a Biological Opinion issued on October 4, 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. An informal consultation completed by NMFS on December 20, 2000 concluded that Mariana Archipelago precious coral fisheries are not likely to adversely affect humpback whales, green turtles or hawksbill turtles. NMFS also concluded in an informal consultation dated April 29, 2015 that fisheries managed under the Mariana Archipelago FEP are not likely to adversely affect the Indo-West Pacific DPS of scalloped hammerhead shark and ESA-listed reef-building corals.

2.4.1.3 Non-ESA Marine Mammals

The MMPA requires NMFS to annually publish a List of Fisheries (LOF) that classifies commercial fisheries in one of three categories based on the level of mortality and serious injury of marine mammals associated with that fishery. According to the 2016 LOF (81 FR 20550, April 8, 2016), the Guam and CNMI bottomfish fisheries operating under the Marianas FEP are classified as Category III fisheries (i.e. a remote likelihood of or no known incidental mortality and serious injury of marine mammals).

2.4.2 Status of Protected Species Interactions in the Marianas FEP Fisheries

Bottomfish Fishery
There are no observer data available for the Guam and CNMI bottomfish fisheries. However based on current ESA consultations, these fisheries are not expected to interact with any ESA-listed species in Federal waters around Guam or CNMI. 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.

Based on fishing effort and other characteristics described in Section 1, no notable changes have been observed in the fishery. There is no other information to indicate that impacts to protected species from this fishery have changed in recent years.

Crustacean Fishery
There are no observer data available for the Guam and CNMI crustacean fisheries. However based on current ESA consultations, these fisheries are not expected to interact with any ESA-listed species in Federal waters around Guam or CNMI. NMFS has also concluded that the Mariana Archipelago crustacean commercial fisheries will not affect marine mammals in any manner not considered or authorized under the Marine Mammal Protection Act.

Based on fishing effort and other characteristics described in Section 1, no notable changes have been observed in the fishery. There is no other information to indicate that impacts to protected species from this fishery have changed in recent years.

Coral Reef Fishery
There are no observer data available for the Guam and CNMI coral reef fisheries. However based on current ESA consultations, these fisheries are not expected to interact with any ESA-listed species in Federal waters around Guam or CNMI. NMFS has also concluded that the Mariana Archipelago coral reef commercial fisheries will not affect marine mammals in any manner not considered or authorized under the Marine Mammal Protection Act.

Based on fishing effort and other characteristics described in Section 1, no notable changes have been observed in the fishery. There is no other information to indicate that impacts to protected species from this fishery have changed in recent years.

Precious Coral Fishery
There are no observer data available for the Guam and CNMI precious coral fisheries. However based on current ESA consultations, these fisheries are not expected to interact with any ESA-listed species in Federal waters around Guam or CNMI. NMFS has also concluded that the Mariana Archipelago precious coral commercial fisheries will not affect marine mammals in any manner not considered or authorized under the Marine Mammal Protection Act.

Based on fishing effort and other characteristics described in Section 1, no notable changes have been observed in the fishery. There is no other information to indicate that impacts to protected species from this fishery have changed in recent years.

2.4.3 Identification of research, data and assessment needs

The following research, data and assessment needs for insular fisheries were identified by the Council's Protected Species Advisory Committee and Plan Team:

- Improve the precision of non-commercial fisheries data to improve understanding of potential protected species impacts.
- Develop innovative approaches to derive robust estimates of protected species interactions in insular fisheries.
- Update analysis of fishing-gear related strandings of Hawaii green turtles.

2.5 Climate and Oceanic Indicators

2.5.1 Introduction

The 2015 Annual Report includes an inaugural chapter on indicators of current and changing climate and related oceanic conditions in the geographic areas for which the Western Pacific Regional Fishery Management Council has responsibility. There are a number of reasons for the Council's decision to provide and maintain an evolving discussion of climate conditions as an integral and continuous consideration in their deliberations, decisions and reports:

- Emerging scientific and community understanding of the impacts of changing climate conditions on fishery resources, the ecosystems that sustain those resources and the communities that depend upon them;
- Recent Federal Directives including the 2010 implementation of a National Ocean Policy that identified Resiliency and Adaptation to Climate Change and Ocean Acidification as one of nine National priorities; the development of a Climate Science Strategy by the National Marine Fisheries Service (NMFS) in 2015 and the ongoing development of Pacific Regional Climate Science program
- The Council's own engagement with the National Oceanic and Atmospheric Administration (NOAA) as well as jurisdictional fishery management agencies in American Samoa, the Commonwealth of the Northern Mariana Islands, Guam, Hawaii as well as fishing industry representatives and local communities in those jurisdictions; and
- Deliberations of the Council's Marine Planning and Climate Change Committee.

Beginning with the 2015 Report, the Council and its partners will provide continuing descriptions of changes in a series of climate and oceanic indicators that will grow and evolve over time as they become available and their relevance to Western Pacific fishery resources becomes clear.

2.5.2 Conceptual Model

In developing this chapter, the Council relied on a number of recent reports conducted in the context of the U.S. National Climate Assessment including, most notably, the 2012 Pacific Islands Regional Climate Assessment (PIRCA) and the Ocean and Coasts chapter of the 2014 report on a Pilot Indicator System prepared by the National Climate Assessment and Development Advisory Committee (NCADAC).

The Advisory Committee Report presented a possible conceptual framework designed to illustrate how climate factors can connect to and interact with other ecosystem components to ocean and coastal ecosystems and human communities. The Council adapted this model with considerations relevant to the fishery resources of the Western Pacific Region:

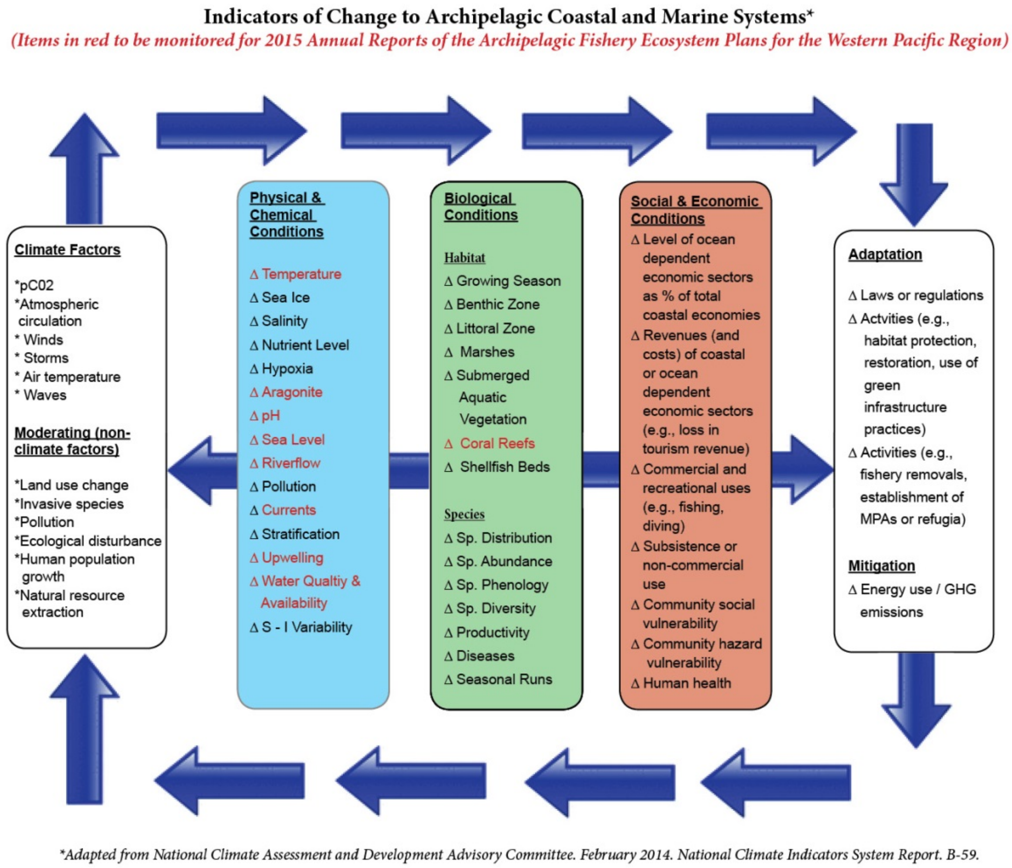


Figure 10. Indicators of Change to Archipelagic and Coastal Marine Systems.

As described in the 2014 NCADAC report, the conceptual model represents a "simplified representation of climate and non-climate stressors in coastal and marine ecosystems." For the purposes of this Annual Report, the modified Conceptual Model allows the Council and its partners to identify indicators of interest to be monitored on a continuing basis in coming years. The indicators shown in red are discussed are included in this 2015 Annual Report. Other indicators will be added over time as datasets become available and understanding of the nature of the causal chain from stressors to impacts emerges.

The Council also hopes that this Conceptual Model can provide a guide for future monitoring and research that will enable the Council and its partners to move from observations and correlations to understanding the specific nature of interactions and developing capabilities to predict future changes of importance in developing, evaluating and adapting ecosystem-fishery plans in the Western Pacific Region.

2.5.3 Selected Indicators

The primary goal for selecting the Indicators used in this (and future reports) is to provide fisheries-related communities, resource managers and businesses with climate-related situational awareness. In this context, Indicators were selected to:

- Be fisheries relevant and informative
- Build intuition about current conditions in light of changing climate

- Provide historical context and
- Recognize patterns and trends.

For the 2015 report on Western Pacific Pelagic resources, the Council has included the following climate and oceanic indicators:

Atmospheric Carbon Dioxide (at Mauna Loa Observatory) -- Increasing atmospheric CO_2 is a primary measure of anthropogenic climate change.

Ocean pH (at Station ALOHA) **–** Ocean pH provides a measure of ocean acidification. Increasing ocean acidification limits the ability of marine organisms to build shells and other hard structures.

Oceanic Niño Index (ONI) -- Sea surface temperature anomaly from Niño 3.4 region (5°N - 5°S, 120° - 170°W). This index is used to determine the phase of the El Niño – Southern Oscillation (ENSO), which has implications across the region affecting migratory patterns of key commercial fish stocks which, in turn, affect the location, safety and costs of commercial fishing.

Sea Surface Temperature -- Monthly sea surface temperature anomaly from 2003-2015 from the AVHRR instrument aboard the NOAA Polar Operational Environmental Satellite (POES). Sea surface temperature is one of the most directly observable measures we have for tracking increasing ocean temperature.

Sea Surface Temperature Anomaly -- Sea surface temperature Anomaly highlights long term trends, filtering out seasonal cycle is one of the most directly observable measures we have for tracking increasing ocean temperature.

Sea Level (Sea Surface Height) and Anomaly – Rising sea levels can result in a number of coastal impacts, including inundation of infrastructure, increased damage resulting from storm-driven waves and flooding, and saltwater intrusion into freshwater supplies.

Heavy Weather (Tropical Cyclones) -- Measures of tropical cyclone occurrence, strength and energy. Tropical cyclones have the potential to significantly impact fishing operations.

Wave Data -- To describe patterns in wave forcing, we present data from the Wave Watch 3 global wave model run by the Department of Ocean and Resources Engineering at the University of Hawaiʻi in collaboration with. NOAA/NCEP and NWS Honolulu. Wave forcing can have major implications for both coastal ecosystems and pelagic fishing operations

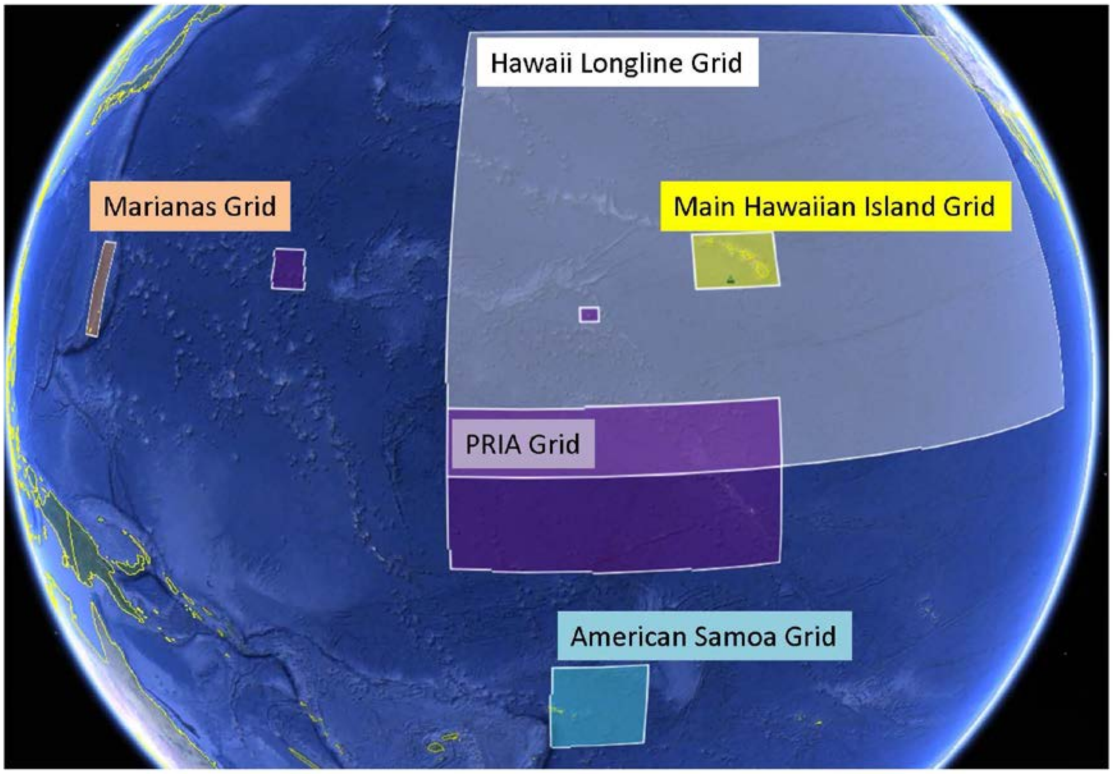


Figure 11. Regional spatial grids.

Table 57. Climate and Ocean Indicator Summary - Marianas.

Indicator	Definition and Rationale	Indicator Status
Atmospheric Concentration of Carbon Dioxide (CO_2)	Atmospheric concentration CO_2 at Mauna Loa Observatory. Increasing atmospheric CO_2 is a primary measure of anthropogenic climate change.	Trend: increasing exponentially 2015: time series maximum 400.83 ppm
Oceanic pH	Ocean surface pH at Station ALOHA. Ocean pH provides a measure of ocean acidification. Increasing ocean acidification limits the ability of marine organisms to build shells and other hard structures.	Trend: pH is decreasing at a rate of 0.039 pH units per year, equivalent to 0.4% increase in acidity per year
Oceanic Niño Index (ONI)	Sea surface temperature anomaly from Niño 3.4 region (5°N - 5°S, 120° - 170°W). This index is used to determine the phase of the El Niño – Southern Oscillation (ENSO), which has implications across the region, affecting migratory patterns of key commercial fish stocks which in turn affect the location, safety, and costs of commercial fishing.	2015: Strong El Niño

Sea Surface Temperature[1] (SST)	Satellite remotely-sensed sea surface temperature. SST is projected to rise, and impacts phenomena ranging from winds to fish distribution.	SST in waters throughout the entire Mariana Archipelago ranged between 29-30º C reflecting a warm anomaly of approx. 0.5° C
Tropical Cyclones	Measures of tropical cyclone occurrence, strength, and energy. Tropical cyclones have the potential to significantly impact fishing operations.	Eastern Pacific, 2015: 18 named storms, time series maximum 9 major hurricanes
		Central Pacific, 2015: 14 named storms, time series maximum 5 major hurricanes
		Western Pacific, 2015: 27 named storms
Sea Level/Sea Surface Height	Monthly mean sea level time series, including extremes. Data from satellite altimetry & in situ tide gauges. Rising sea levels can result in a number of coastal impacts, including inundation of infrastructure, increased damage resulting from storm-driven waves and flooding, and saltwater intrusion into freshwater supplies.	As measured by tide gauges in Apra Harbor, Guam, sea level showed a decline for most of 2015 reaching approximately 0.15 below average at its lowest point.
Wave Energy	WaveWatch III (WW3) Global Wave Model" run by UH Department of Ocean Resources & Engineering in collaboration with NOAA/NCEP & NOAA/NWS-Pacific Wave forcing can have major implications for both coastal ecosystems and pelagic fishing operations.	Significant wave heights varied throughout the Mariana Archipelago from between 1.0-1.5m for Guam and Saipan to between 2.0-2.5m in Pagan & Maug.

2.5.3.1 Atmospheric Concentration of Carbon Dioxide (CO_2) at Mauna Loa

Description: Monthly mean atmospheric carbon dioxide at Mauna Loa Observatory, Hawaii in ppm from March 1958 to present. The carbon dioxide data is measured as the mole fraction in dry air, on Mauna Loa. A dry mole fraction is defined as the number of molecules of carbon dioxide divided by the number of molecules of dry air multiplied by one million (ppm). This constitutes the longest record of direct measurements of CO_2 in the atmosphere. The measurements were started by C. David Keeling of the Scripps Institution of Oceanography in March of 1958 at a facility of the National Oceanic and Atmospheric Administration [Keeling, 1976]. NOAA started its own CO_2 measurements in May of 1974, and they have run in parallel with those made by Scripps since then [Thoning, 1989].

The observed increase in monthly average carbon dioxide data is due primarily to CO_2

[1] 2015 data are incomplete.

emissions from fossil fuel burning. Carbon dioxide remains in the atmosphere for a very long time, and emissions from any location mix throughout the atmosphere in about one year. The annual oscillations at Mauna Loa, Hawaii are due to the seasonal imbalance between the photosynthesis and respiration of plants on land. During the summer photosynthesis exceeds respiration and CO_2 is removed from the atmosphere, whereas outside the growing season respiration exceeds photosynthesis and CO_2 is returned to the atmosphere. The seasonal cycle is strongest in the northern hemisphere because of the presence of the continents. The difference between Mauna Loa and the South Pole has increased over time as the global rate of fossil fuel burning, most of which takes place in the northern hemisphere, has accelerated.

Timeframe: Yearly (by month)

Region/Location: Hawaii but representative of global concentration of carbon dioxide.

Data Source: "Full Mauna Loa CO_2 record" at http://www.esrl.noaa.gov/gmd/ccgg/trends/ , NOAA ESRL Global Monitoring Division. The National Oceanic and Atmospheric Administration (NOAA) Global Monitoring Division provides high-precision measurements of the abundance and distribution of long-lived greenhouse gases that are used to calculate global average concentrations.

Measurement Platform: In-situ Station

Rationale: Atmospheric carbon dioxide is a measure of what human activity has already done to affect the climate system through greenhouse gas emissions. It provides quantitative information in a simplified, standardized format that decision makers can easily understand. This indicator demonstrates that the concentration (and, in turn, the warming influence) of greenhouse gases in the atmosphere has increased substantially over the last several decades. In 2015, the annual mean concentration of C02 was 400.83 ppm. In 1959, the onset year it was 315.97ppm. It passed 350ppm in 1988.

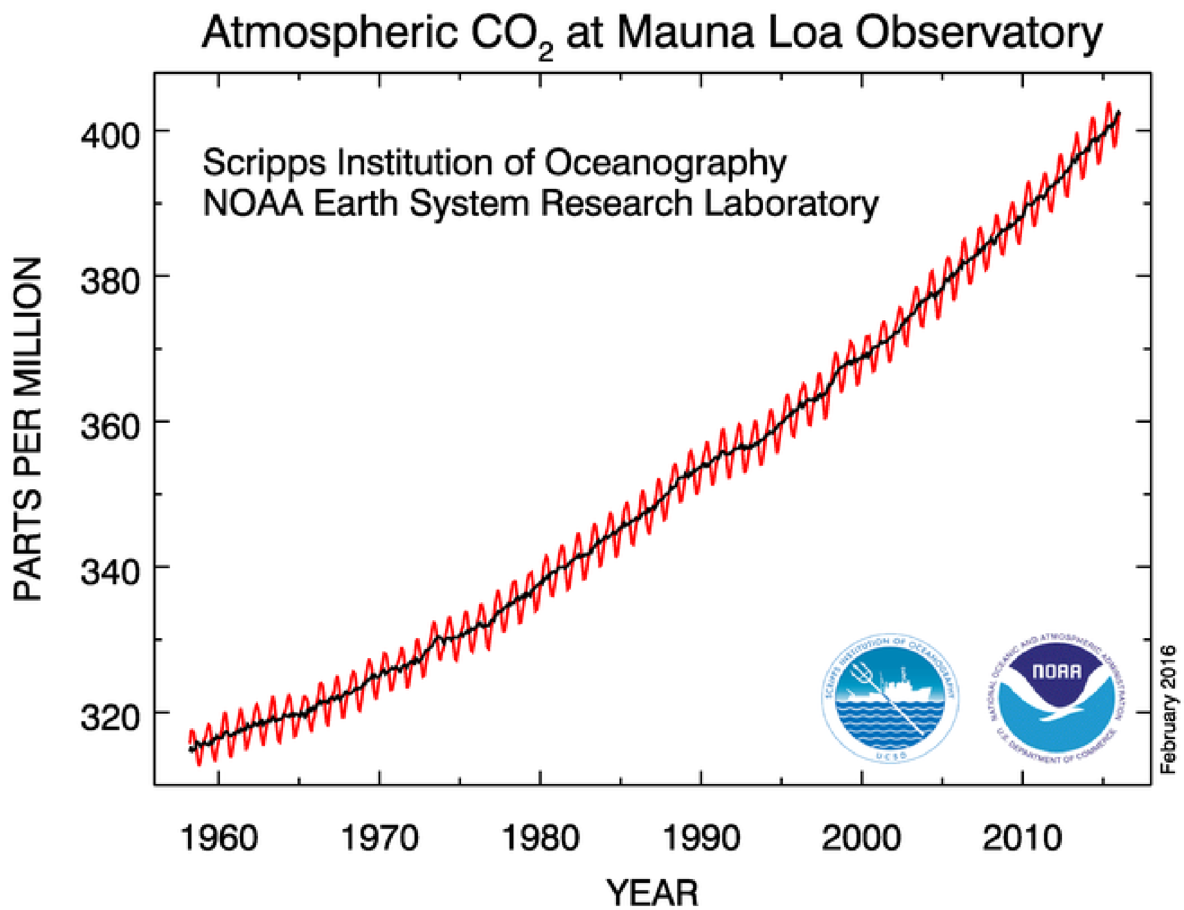


Figure 12. Monthly mean atmospheric carbon dioxide at Mauna Loa Observatory, Hawaii. The carbon dioxide data (red curve), measured as the mole fraction (ppm), in dry air, on Mauna Loa. The black curve represents the seasonally corrected data.

2.5.3.2 Ocean pH

Description: Trends in surface (0-10m) pH and pCO2 at Station ALOHA, North of Oahu (22° 45' N, 158° W), collected by the Hawai'i Ocean Time-series (HOT). Green dots represent directly measured pH, blue dots represent pH calculated from TA and DIC.

The 25+ year time-series at Station ALOHA represents the best available documentation of the significant downward trend of ocean pH since 1989. Actual ocean pH varies in both time and space, but over last 25 years, the HOTS Station ALOHA time series has shown a significant linear decrease of -0.0386 pH units, or roughly a 9% increase in acidity ([H+]) over that period.

Timeframe: Updated Monthly

Region/Location: North Oahu.

Data Source/Responsible Party: Hawai'i Ocean Time Series. (http://hahana.soest.hawaii.edu/hot/)

Measurement Platform: Oceanographic research station, shipboard collection.

<u>Rationale:</u> Increasing ocean acidification affects coral reef growth and health which in turn affects the health of coral reef ecosystems and the ecosystems and resources that they sustain. Monitoring pH on a continuous provides a foundational basis for documenting, understanding and, ultimately, predicting the effects of ocean acidification.

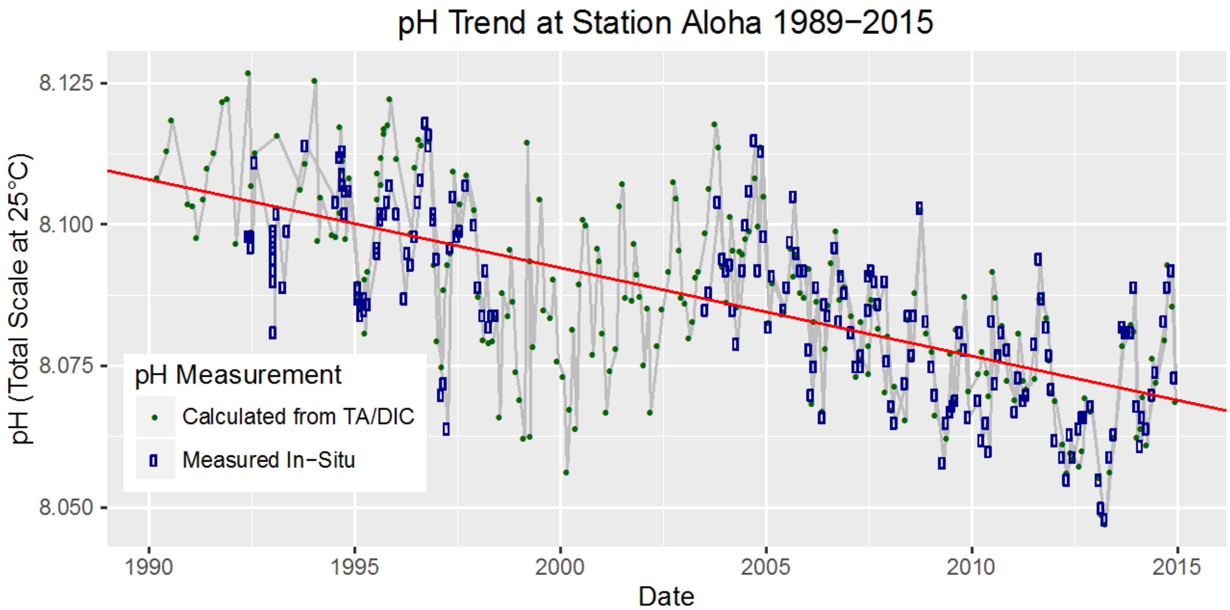


Figure 13. pH trend at Station Aloha 1989-2015.

2.5.3.3 Oceanic Niño Index (ONI)

Description: Warm (red) and cold (blue) periods based on a threshold of +/- 0.5°C for the Oceanic Niño Index (ONI) [3 month running mean of ERSST.v4 SST anomalies in the Niño 3.4 region (5°N-5°S, 120°-170°W)], based on centered 30-year base periods updated every 5 years.

For historical purposes, periods of below and above normal sea surface temperatures (SSTs) are colored in blue and red when the threshold is met for a minimum of 5 consecutive overlapping seasons. The ONI is one measure of the El Niño-Southern Oscillation, and other indices can confirm whether features consistent with a coupled ocean-atmosphere phenomenon accompanied these periods.

Description was inserted from:
http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml

Timeframe: Every 3 months.

Region/Location: Niño3.4 Region: 5°S - 5°N, 120°-170°W

Data Source/Responsible Party: NOAA NCEI Equatorial Pacific Sea Surface Temperatures (www.ncdc.noaa.gov/teleconnections/enso/indicators/sst.php)

Measurement Platform: In-situ Station, Satellite, Model, Other…

Rationale: The ONI focuses on ocean temperature which has the most direct effect on those fisheries. The atmospheric half of this Pacific basin oscillation is measured using the Southern Oscillation Index.

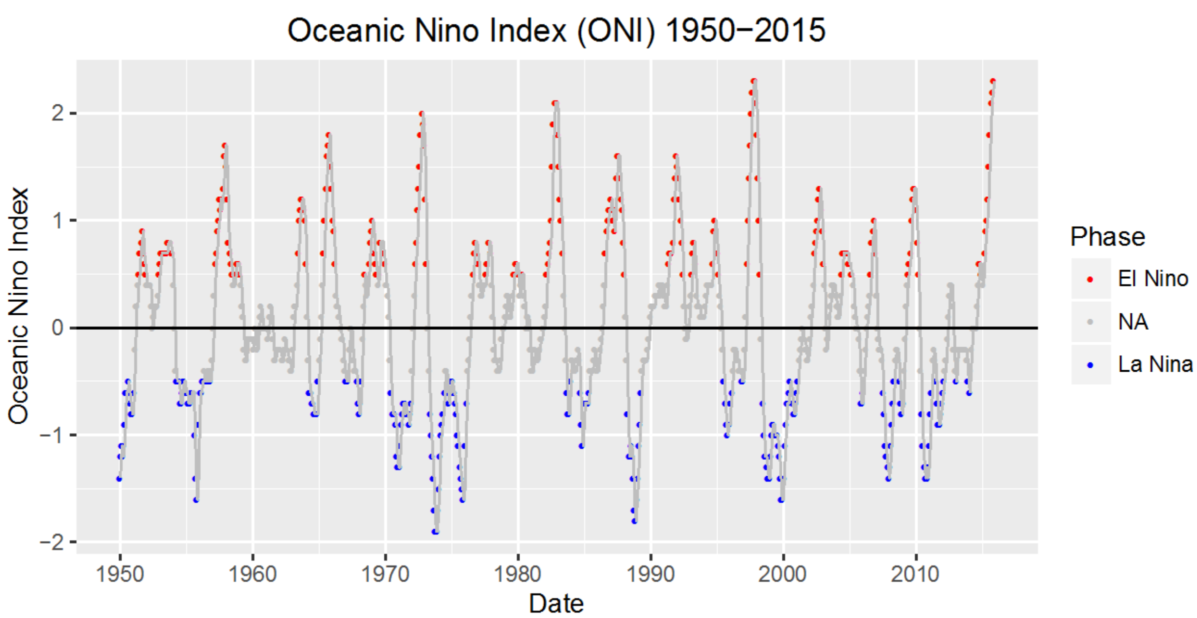


Figure 14. Oceanic Niño Index (ONI) 1950-2015.

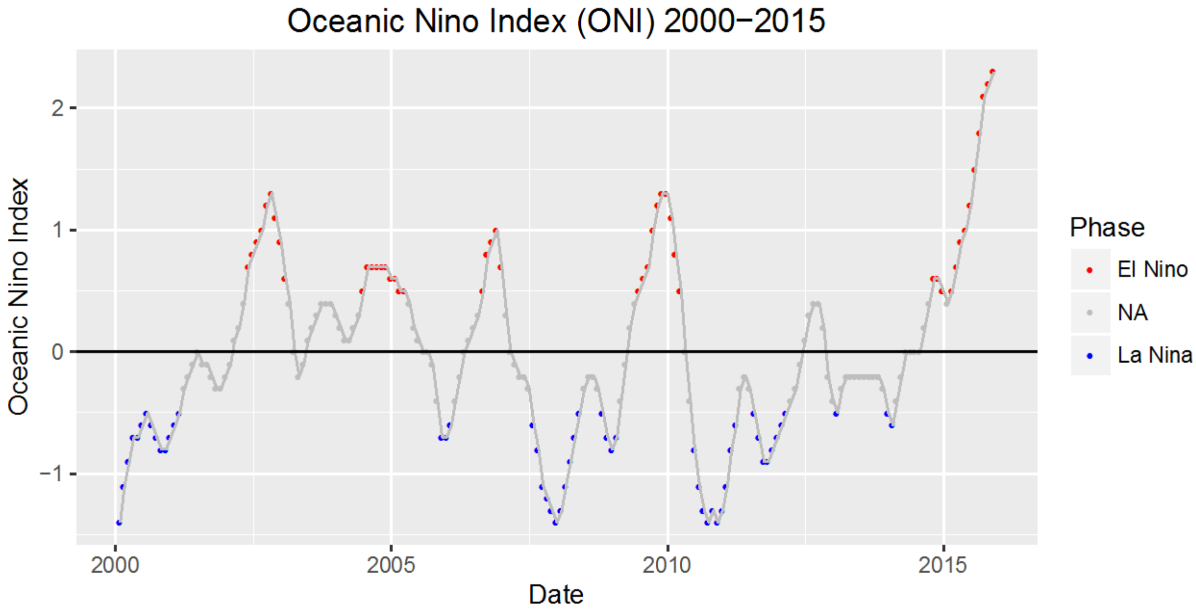
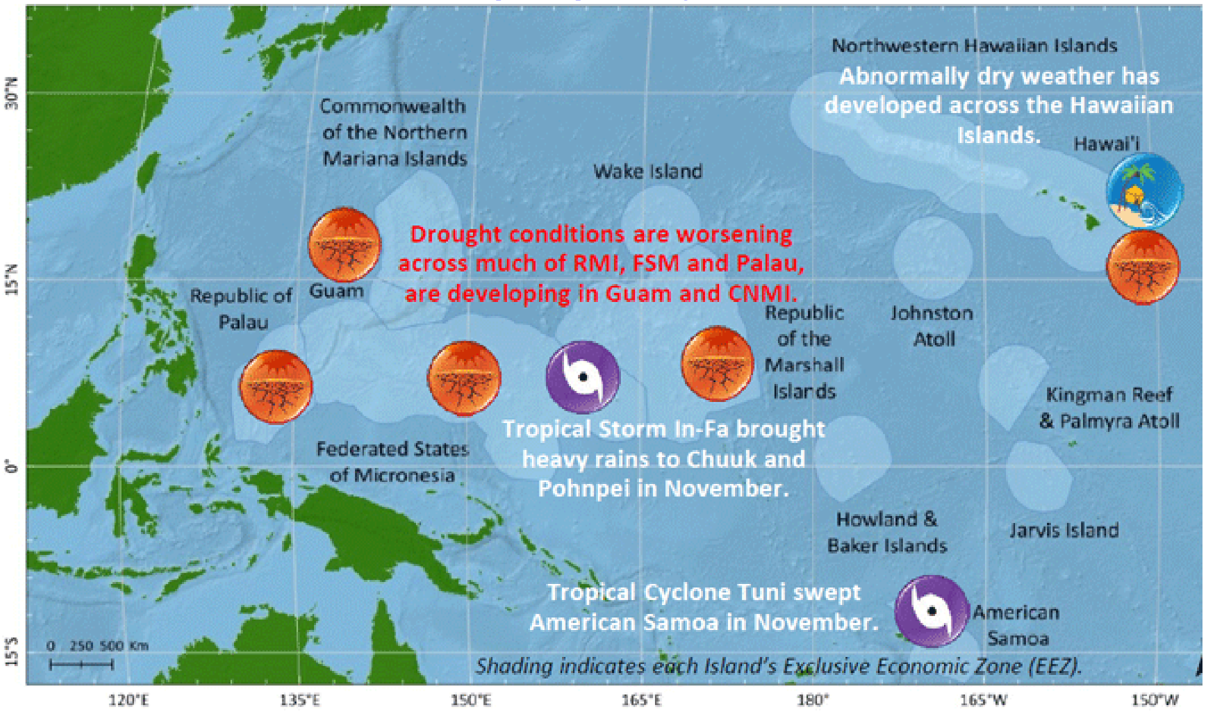


Figure 15. Oceanic Niño Index (ONI) 2000-2015.

The 2015-2016 El Niño

From: http://www.pacificcis.org/dashboard



Significant Events and Archipelagic Impacts

Facilities and Infrastructure – Significant surf-induced coastal flooding occurred on the north shore of Oahu in late January from 40' waves. The swell was enough to wash over Kam Highway, sending onlookers into the sea. In American Samoa, tropical cyclone Tuni resulted in flooding which closed much of the main road around the Independent Samoa island of Upolu.

Water Resources – The water storage reservoir on Majuro, RMI was 60% full as of 1 February, but household water tanks were critically low and some have gone dry. As a result, the RMI Government has declared a State of Emergency, activating the emergency operations center and mobilizing additional resources. Meanwhile, CNMI and Guam are being advised to begin water conservation measures as drought sets in. Residents on the islands of Palau, Yap, Chuuk, and the Marshalls are encouraged to check their water wells for excessive salinity as drought intensifies across the region.

Agriculture – Significant yellowing of food crops and vegetation have been observed in Guam, CNMI, Palau, and Yap, along with an increase in grass fires due to severe drought conditions. Yellowing of breadfruit tree leaves and pandanus fronds have been observed in Majuro.

Natural Resources – Coral bleaching HotSpots are concentrated on the central equatorial Pacific Ocean but have diminished throughout most of the northeastern Pacific Ocean. Taimasa (low stands) conditions have been reported in American Samoa.

Public Health – Drought is causing school attendance rates to drop across the Pacific Islands as hungry and dehydrated children face a high risk of malnutrition due to crop failure, water shortages, and poor sanitation.

The current El Niño has reached its peak and a slow decline towards neutral conditions is expected to begin in the 1st quarter 2016. However, many islands will continue to feel the effects of El Niño throughout much of 2016. The SST anomaly outlook for the 1st quarter indicates near-normal values in American Samoa, with slightly below normal values across CNMI, FSM, and Palau. Above-normal SST anomalies are forecast to continue across the Hawaiian Islands. The 4-month coral bleaching outlook projects continued thermal stress to last through at least the end of May across the central equatorial Pacific. Alert Level 2 is expected to be widespread in the Eastern Pacific while the southwestern Pacific around the Great Barrier Reef, Vanuatu, and Fiji, reaches Alert Level 1.

The forecast values for sea level in the 1st quarter indicate that most of the USAPI stations are likely to be much closer to normal. American Samoa is expected to be marginally below normal, with further falls expected as the year continues. In Hawaii, both Honolulu and Hilo are likely to be slightly elevated. Severe drought is expected to develop and/or continue across nearly all of the USAPI, including Palau, Yap, Chuuk, Pohnpei, and Kosrae, as well as all islands in the RMI, Guam and CNMI, and the Hawaiian Islands. Below-normal rainfall is projected for American Samoa. Tropical cyclone (TC) activity in the western north Pacific is expected to be quiet in the 1st quarter. During the last major El Niño event in 1998, Feb-Apr saw zero typhoons or tropical storms. In the southwest Pacific, due to strong El Niño conditions, the chances for TC activity remains elevated for a majority of the Pacific Island countries, and particularly in the eastern portion of the basin, including American Samoa.

Figure 16. 2015-2016 El Niño Event Infographic.

2.5.3.4 Sea Surface Temperature

Description: Monthly sea surface temperature from 2003-2015 from the Advanced Very High Resolution Radiometer (AVHRR) instrument aboard the NOAA Polar Operational Environmental Satellite (POES). These data take us back to 2003, if we were to blend this record with Pathfinder, we could reach back to 1981.

*Background Below Provided By **CoastWatch West Coast Node.*** We would like to acknowledge the NOAA CoastWatch Program and the NOAA NWS Monterey Regional Forecast Office.

Short Description: The global area coverage (GAC) data stream from NOAA | NESDIS | OSDPD provides a high-quality sea surface temperature product with very little cloud contamination. This data is used for a variety of fisheries management projects, including the El Niño Watch Report, which stress data quality over high spatial resolution.

Technical Summary: CoastWatch offers global sea surface temperature (SST) data from the Advanced Very High Resolution Radiometer (AVHRR) instrument aboard NOAA's Polar Operational Environmental Satellites (POES). Two satellites are currently in use, NOAA-17 and NOAA-18. The AVHRR sensor is a five channel sensor comprised of two visible radiance channels and three infrared radiance channels. During daytime satellite passes, all five radiance channels are used. During nighttime passes, only the infrared radiance channels are used.

The POES satellite stores a sub-sample of the AVHRR radiance measurements onboard, generating a global data set. The satellite downloads this dataset once it is within range of a receiving station. The sub-sampling reduces the resolution of the original data from 1.47km for the HRPT SST product to 11km for the global data product.

AVHRR radiance measurements are processed to SST by NOAA's National Environmental Satellite, Data, and Information Service (NESDIS), Office of Satellite Data Processing and Distribution (OSDPD) using the non-linear sea surface temperature (NLSST) algorithm detailed in *Walton et al., 1998*. SST values are accurate to within 0.5 degrees Celsius. Ongoing calibration and validation efforts by NOAA satellites and information provide for continuity of quality assessment and algorithm integrity (e.g., *Li et al., 2001a and Li et al., 2001b*). In addition, the CoastWatch West Coast Regional Node (WCRN) runs monthly validation tests for all SST data streams using data from the NOAA National Weather Service and National Data Buoy Center (NDBC).

The data are cloud screened using the CLAVR-x method developed and maintained by NOAA Satellites and Information (e.g., *Stowe et al., 1999*). The data are mapped to an equal angle grid (0.1 degrees latitude by 0.1 degrees longitude) using a simple arithmetic mean to produce individual and composite images of various durations (e.g., 1, 3, 8, 14-day).

Timeframe: 2003-2015, Daily data available, Monthly means shown.

Region/Location: Global.

Data Source: "SST, POES AVHRR, GAC, Global, Day and Night (Monthly Composite)" http://coastwatch.pfeg.noaa.gov/erddap/griddap/erdAGsstamday.html.

Measurement Platform: *AVHRR, POES Satellite*

Rationale: Sea surface temperature is one of the most directly observable measures we have for tracking increasing ocean temperature.

References: Li, X., W. Pichel, E. Maturi, P. Clemente-Colón, and J. Sapper, 2001a. Deriving the operational nonlinear multi-channel sea surface temperature algorithm coefficients for NOAA-15 AVHRR/3, Int. J. Remote Sens., Volume 22, No. 4, 699 - 704.

Li, X, W. Pichel, P. Clemente-Colón, V. Krasnopolsky, and J. Sapper, 2001b. Validation of
coastal sea and lake surface temperature measurements derived from NOAA/AVHRR Data, Int. J. Remote Sens., Vol. 22, No. 7, 1285-1303.

Stowe, L. L., P. A. Davis, and E. P. McClain, 1999. Scientific basis and initial evaluation of the
CLAVR-1 global clear/cloud classification algorithm for the advanced very high resolution radiometer. J. Atmos. Oceanic Technol., 16, 656-681.

Walton C. C., W. G. Pichel, J. F. Sapper, D. A. May, 1998. The development and operational
application of nonlinear algorithms for the measurement of sea surface temperatures with the NOAA polar-orbiting environmental satellites, J. Geophys. Res., 103: (C12) 27999-28012.

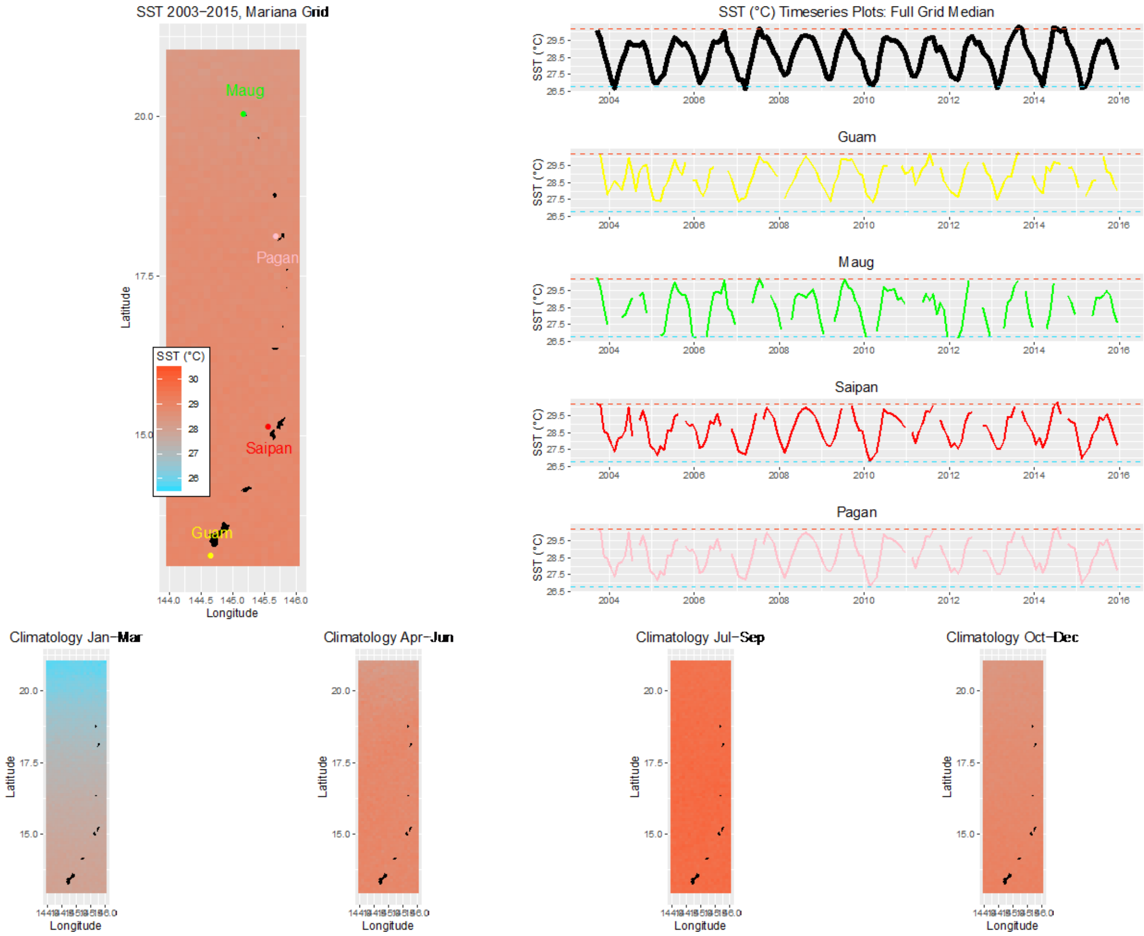


Figure 17. Sea surface temperature plots for the Mariana Regional Grid.

2.5.3.5 Sea Surface Temperature Anomaly

Description: Monthly sea surface temperature anomaly from 2003-2015 from the AVHRR instrument aboard the NOAA Polar Operational Environmental Satellite (POES), compared against the Casey and Cornillon Climatology (Casey and Cornillion 1999). These data take us back to 2003, if we were to blend this record with Pathfinder, we could reach back to 1981.

Background Below Inserted From Coastwatch West Coast Node: [http://coastwatch.pfeg.noaa.gov/infog/AG_tanm_las.html]. We would like to acknowledge the NOAA CoastWatch Program and the NOAA NESDIS Office of Satellite Data Processing and Distribution.

Short Description: The SST anomaly product is used to show the difference between the surface temperature at a given time and the temperature that is normal for that time of year. This effectively filters out seasonal cycles and allows one to view intra-seasonal and inter-annual signals in the data. The global SST anomaly product is produced by comparing the AVHRR GAC SST with a climatology by *Casey and Cornillon*, *1999*, for the region and time period specified. The AVHRR GAC SST is a high quality data set provided by NOAA | NESDIS | OSDPD.

Technical Summary: SST anomaly data are distributed at 11km resolution. AVHRR GAC SST values are accurate to within plus or minus 0.5 degrees Celsius. The time-averaged SST from AVHRR GAC is compared to the climatological SST from *Casey and Cornillon, 1999*, for the specific time period and region. The data are mapped to an equal angle grid of 0.1 degrees latitude by 0.1 degrees longitude using a simple arithmetic mean to produce composite images of various duration (e.g., 1, 3, 8, 14-day).

Reference: Casey, K.S. and P. Cornillon. 1999. A comparison of satellite and in situ based sea surface temperature climatologies. J. Climate. Vol. 12, no. 6, 1848-1863.

Timeframe: 2003-2015, Daily data available, Monthly means shown.

Region/Location: Global.

Data Source: "SST Anomaly, POES AVHRR, Casey and Cornillon Climatology, Global (Monthly Composite)"
http://coastwatch.pfeg.noaa.gov/erddap/griddap/erdAGtanmmday_LonPM180.html

Measurement Platform: *POES, AVHRR Satellite*

Rationale: Sea surface temperature Anomaly highlights long term trends, filtering out seasonal cycle is one of the most directly observable measures we have for tracking increasing ocean temperature.

References: Casey, K.S. and P. Cornillon. 1999. A comparison of satellite and in situ based sea surface temperature climatologies. J. Climate. Vol. 12, no. 6, 1848-1863.

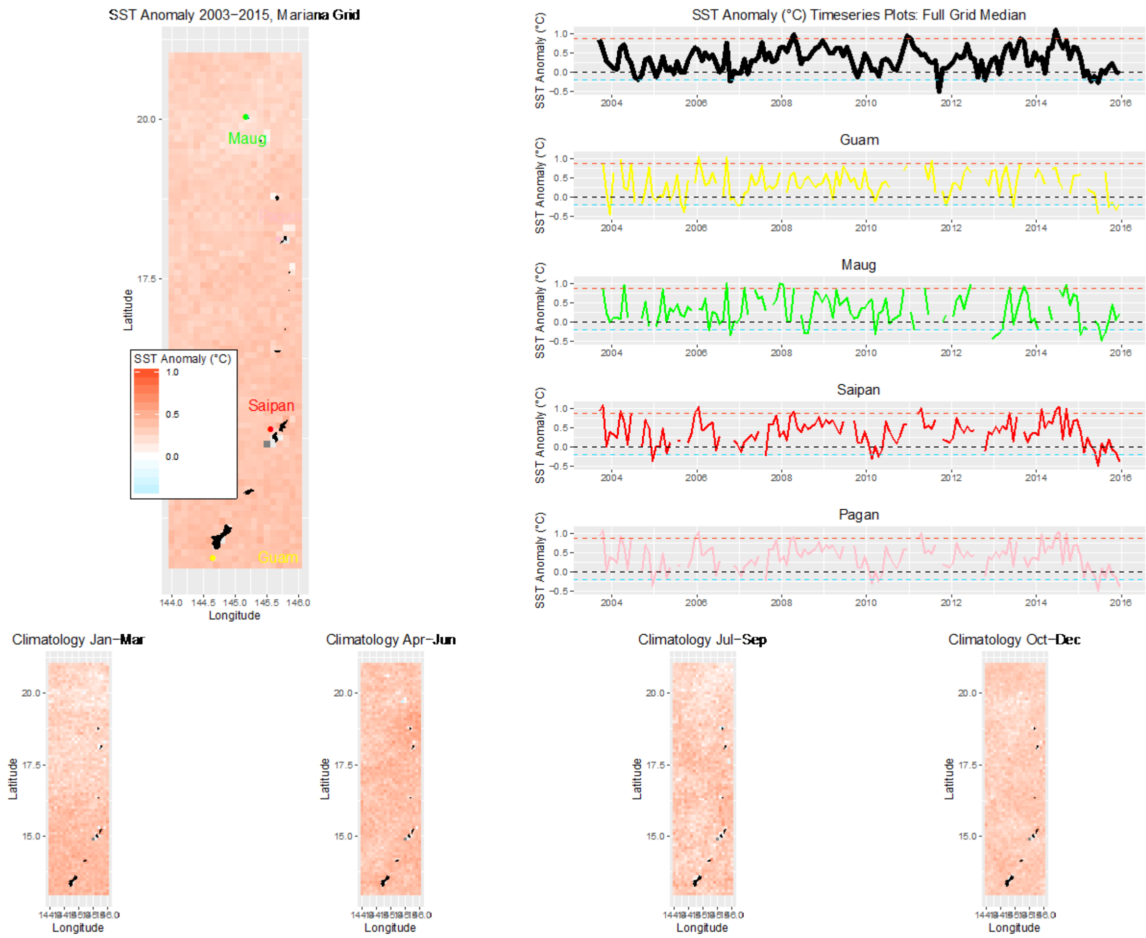


Figure 18. Sea surface temperature anomaly for the Mariana Regional Grid.

2.5.3.6 Heavy Weather (Tropical Cyclones)

Description: This indicator uses historical data from the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC) International Best Track Archive for Climate Stewardship (IBTrACS) to track the number of tropical cyclones in the western, central, and south Pacific basins. This indicator also monitors the Accumulated Cyclone Energy (ACE) Index and the Power Dissipation Index (PDI) which are two ways of monitoring the frequency, strength, and duration of tropical cyclones based on wind speed measurements.

The annual frequency of storms passing through the western North Pacific basin is tracked and a stacked time series plot will show the representative breakdown of the Saffir-Simpson hurricane categories. Three solid lines across the graph will also be plotted representing a) the annual long-term average number of named storms, b) the annual average number of typhoons, and c) the annual average number of major typhoons (Cat 3 and above). Three more lines will also be shown (in light gray) representing the annual average number of named-storms for ENSO a) neutral, b) warm, and c) cool.

Every cyclone has an ACE Index value, which is a number based on the maximum wind speed measured at six-hourly intervals over the entire time that the cyclone is classified as at least a tropical storm (wind speed of at least 34 knot; 39 mph). Therefore, a storm's ACE Index value accounts for both strength and duration. This plot will show the historical ACE values for each typhoon season and will have a solid line representing the annual average ACE value. Three more lines will also be shown (in light gray) representing the annual average ACE values for ENSO a) neutral, b) warm, and c) cool.

Timeframe: Yearly

Region/Location: Hawaii and U.S. Affiliated Pacific Islands

Data Source/Responsible Party: NCDC's International Best Track Archive for Climate Stewardship (IBTrACS).

Measurement Platform: Satellite

Rationale: The effects of tropical cyclones are numerous and well-known. At sea, storms disrupt and endanger shipping traffic as well as fishing effort and safety. The Hawaii longline fishery, for example, had serious problems between August and November 2015 with vessels dodging storms at sea, delayed departures and inability to make it safely back to Honolulu because of bad weather. When cyclones encounter land, their intense rains and high winds can cause severe property damage, loss of life, soil erosion, and flooding. The associated storm surge, the large volume of ocean water pushed toward shore by the cyclone's strong winds, can cause severe flooding and destruction.

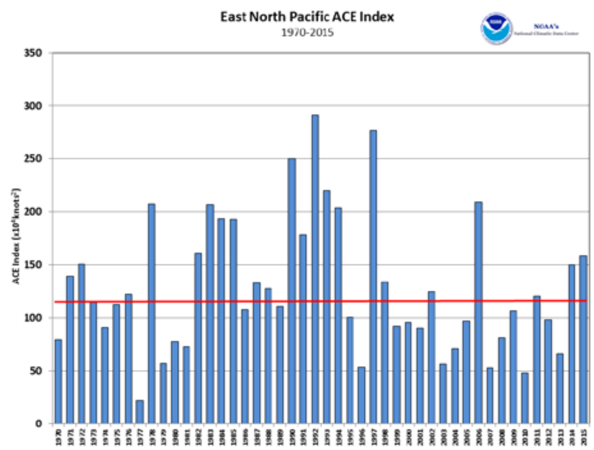


Figure 19. East Pacific Basin ACE Index. Source: NOAA's National Hurricane Center.

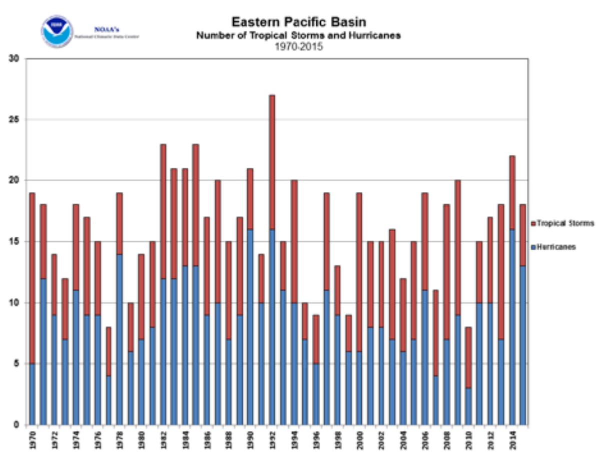


Figure 20. 2015 East Pacific Tropical Cyclone Count 1970-2015. Source: NOAA's National Hurricane Center.

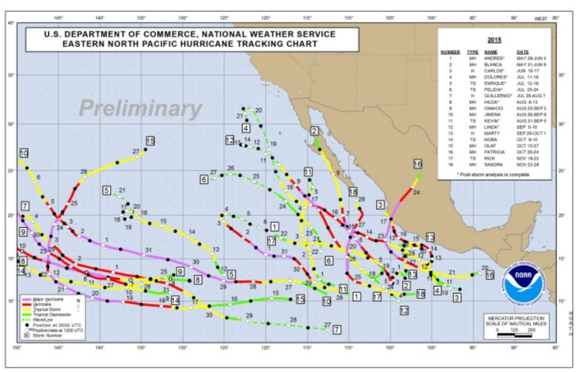


Figure 21. East Pacific Cyclone Tracks. Source: NOAA's National Hurricane Center.

The NOAA National Centers for Environmental Information, State of the Climate: Hurricanes and Tropical Storms for Annual 2015, published online January 2016, notes that "the 2015 East Pacific hurricane season had 18 named storms, including 13 hurricanes, nine of which became major. The 1981-2010 average number of named storms in the East Pacific is 16.5, with 8.9 hurricanes, and 4.3 major hurricanes. This is the first year since reliable record keeping began in 1971 that the eastern Pacific saw nine major hurricanes. The Central Pacific also saw an above-average tropical cyclone season, with 14 named storms, eight hurricanes, and five major hurricanes, the most active season since reliable record-keeping began in 1971. Three major hurricanes (Ignacio, Kilo and Jimena) were active across the two adjacent basins at the same time, the first time this occurrence has been observed. The ACE index for the East Pacific basin during 2015 was 158 ($x10^4$ $knots^2$), which is above the 1981-2010 average of 132 ($x10^4$ $knots^2$) and the highest since 2006. The Central Pacific basin ACE during 2015 was 124 ($x10^4$ $knots^2$)."

Inserted from: http://www.ncdc.noaa.gov/sotc/tropical-cyclones/201513

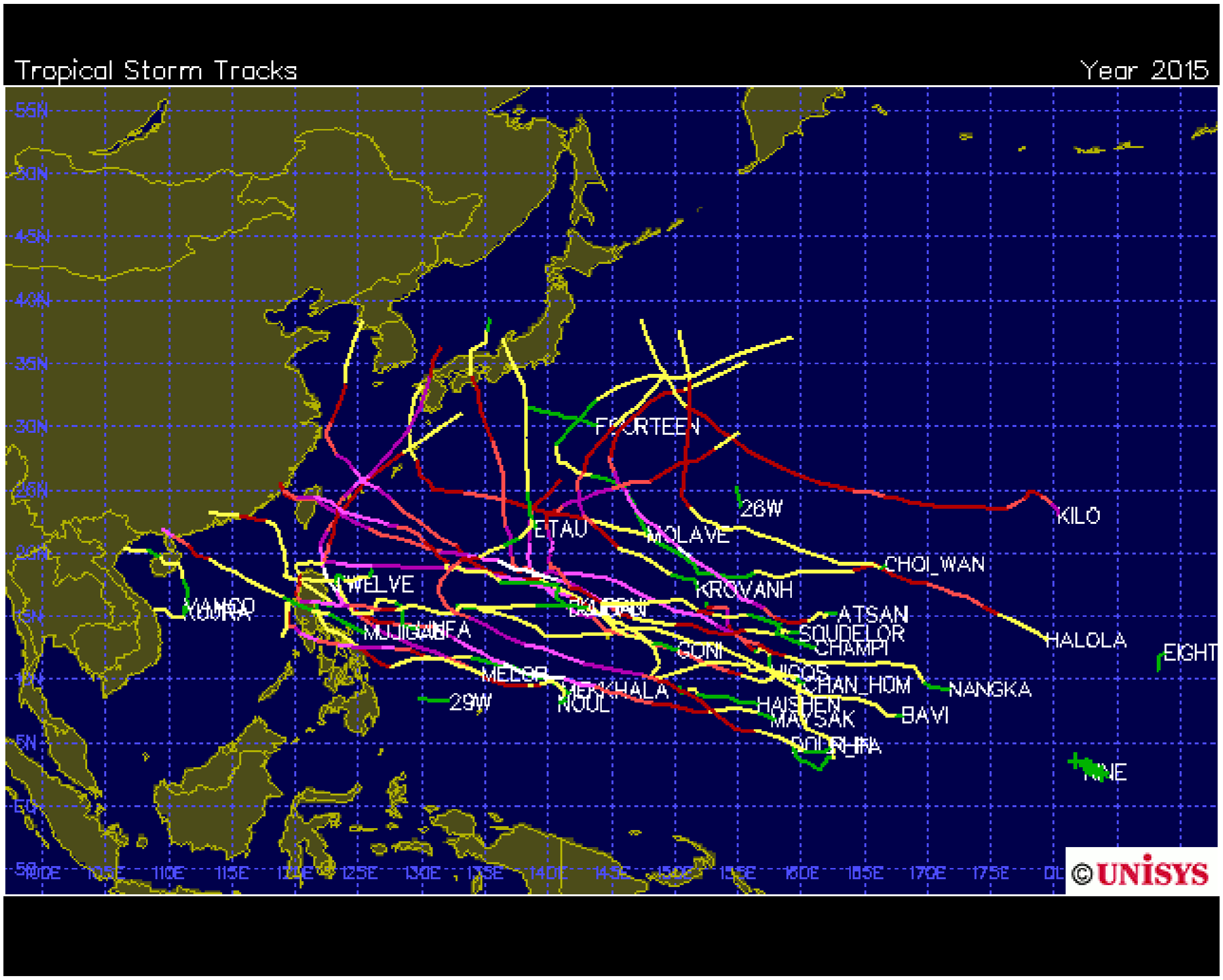


Figure 22. Western Pacific Cyclone Tracks 2015. Source: http://weather.unisys.com/hurricane/w_pacific/2015

References: NOAA National Centers for Environmental Information, State of the Climate: Hurricanes and Tropical Storms for Annual 2015, published online January 2016, retrieved on August 5, 2016 from http://www.ncdc.noaa.gov/sotc/tropical-cyclones/201513.

2.5.3.7 Sea Level (Sea Surface Height and Anomaly)

Description: Monthly mean sea level time series, including extremes

Timeframe: Monthly

Region/Location: Basinwide and observations from selected sites within the Mariana Archipelago

Data Source/Responsible Party: Basin-wide context from satellite altimetry: http://www.aviso.altimetry.fr/en/data/products/ocean-indicators-products/el-nino-bulletin.html

Quarterly time series of mean sea level anomalies from satellite altimetry: http://sealevel.jpl.nasa.gov/science/elninopdo/latestdata/archive/index.cfm?y=2015

Sea Surface Height and Anomaly from NOAA Ocean Service, Tides and Currents, Sea Level Trends: http://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=1630000.

Measurement Platform: Satellite and *in situ* tide gauges

Rationale: Rising sea levels can result in a number of coastal impacts, including inundation of infrastructure, increased damage resulting from storm-driven waves and flooding, and saltwater intrusion into freshwater supplies.

2.5.3.7.1 Basin-Wide Perspective

This image of the mean sea level anomaly for February 2016 compared to 1993-2013 climatology from satellite altimetry provides a glimpse into how the 2015-2016 El Niño continues to affect sea level across the Pacific Basin. The image captures the fact that sea level continues to be lower in the Western Pacific and higher in the Central and Eastern Pacific - a standard pattern during El Niño events. This basin-wide perspective provides a context for the location-specific sea level/sea surface height images that follow.

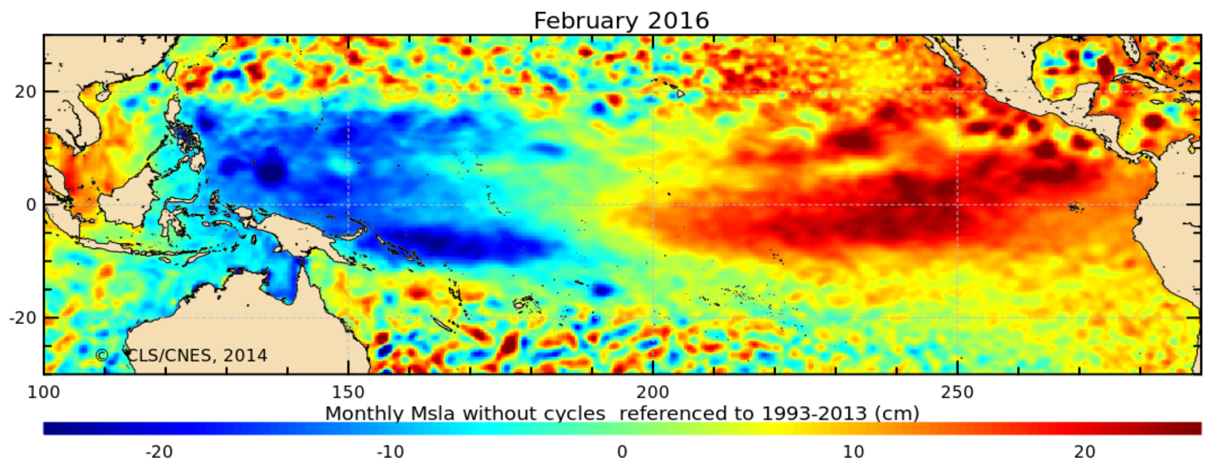
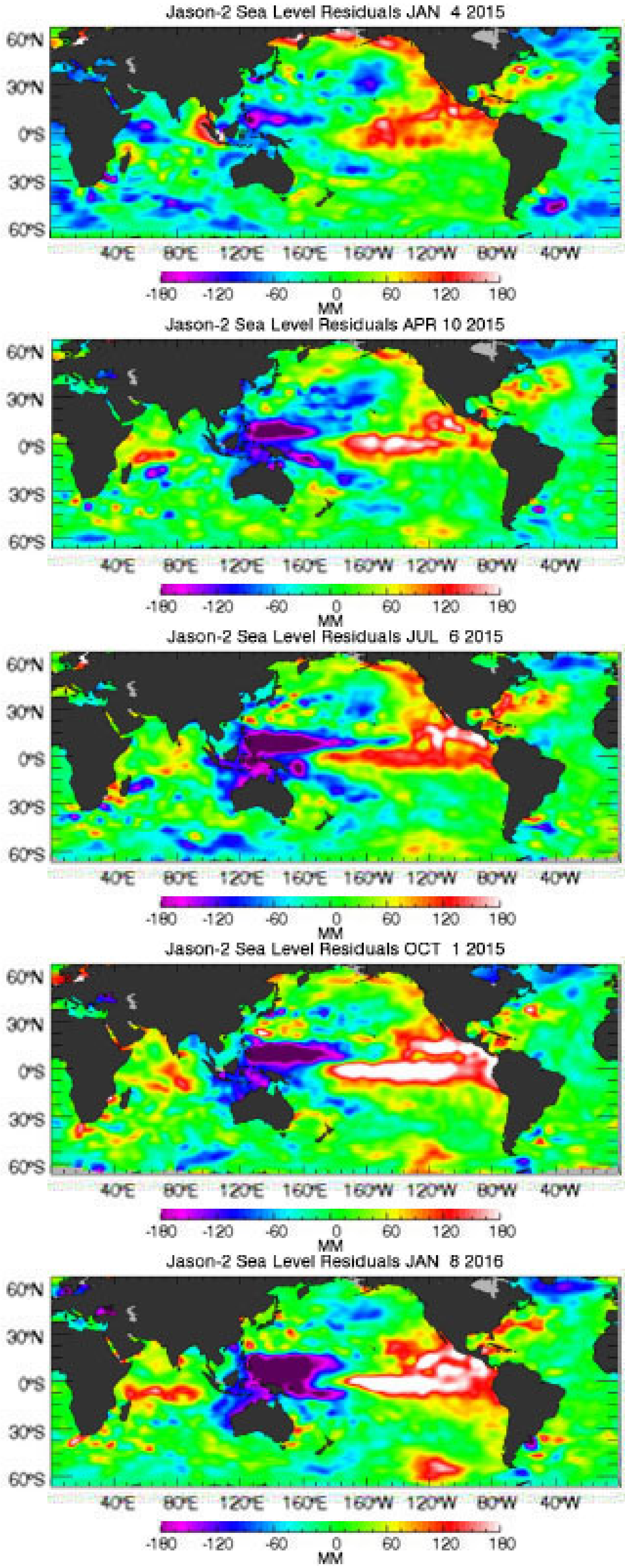
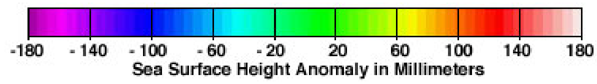


Figure 23. Mean sea level anomaly for February 2016 compared to 1993-2013 climatology from satellite altimetry.



Quarterly time series of mean sea level anomalies during 2015 provide a glimpse into the evolution of the 2015-2016 El Niño throughout the year using satellite altimetry measurements of sea level height (http://sealevel.jpl.nasa.gov/science/elninopdo/lateststdata/archive/index.cfm?y=2015)



2.5.3.7.2 Local Sea Level

These time-series from *in situ* tide gauges provide a perspective on sea level trends within each Archipelago (Tide Station Time Series from NOAA/COOPS).

The following figures and descriptive paragraphs were inserted from https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=1630000.

Figure 24 shows the monthly mean sea level without the regular seasonal fluctuations due to coastal ocean temperatures, salinities, winds, atmospheric pressures, and ocean currents. The long-term linear trend is also shown, including its 95% confidence interval. The plotted values are relative to the most recent Mean Sea Level datum established by CO-OPS. The calculated trends for all stations are available as a table in millimeters/year and in feet/century (0.3 meters = 1 foot). If present, solid vertical lines indicate times of any major earthquakes in the vicinity of the station and dashed vertical lines bracket any periods of questionable data or datum shift.

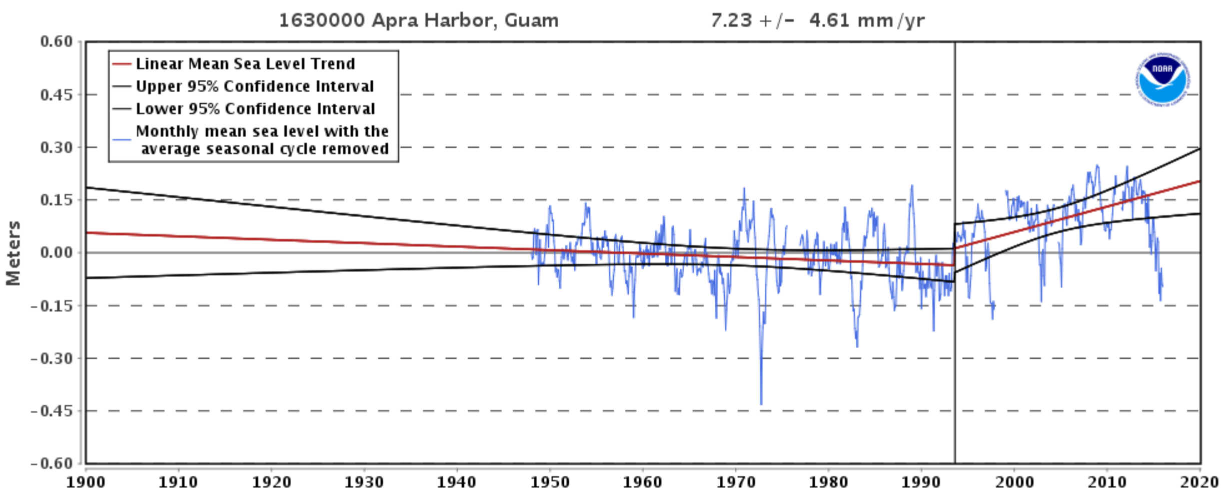


Figure 24. Local sea level at Apra Harbor, Guam, 1900-2015.

The monthly extreme water levels include a Mean Sea Level (MSL) trend of 8.45 millimeters/year with a 95% confidence interval of +/- 8.88 millimeters/year based on monthly MSL data from 1993 to 2006 which is equivalent to a change of 2.77 feet in 100 years. Figure 25 shows the monthly highest and lowest water levels with the 1%, 10%, 50%, and 99% annual exceedance probability levels in red, orange, green, and blue. The plotted values are in meters relative to the Mean Higher High Water (MHHW) or Mean Lower Low Water (MLLW) datums established by CO-OPS (1 foot = 0.3 meters). On average, the 1% level (red) will be exceeded in only one year per century, the 10% level (orange) will be exceeded in ten years per century, and the 50% level (green) will be exceeded in fifty years per century. The 99% level (blue) will be exceeded in all but one year per century, although it could be exceeded more than once in other years.

1630000 Apra Harbor, Guam,

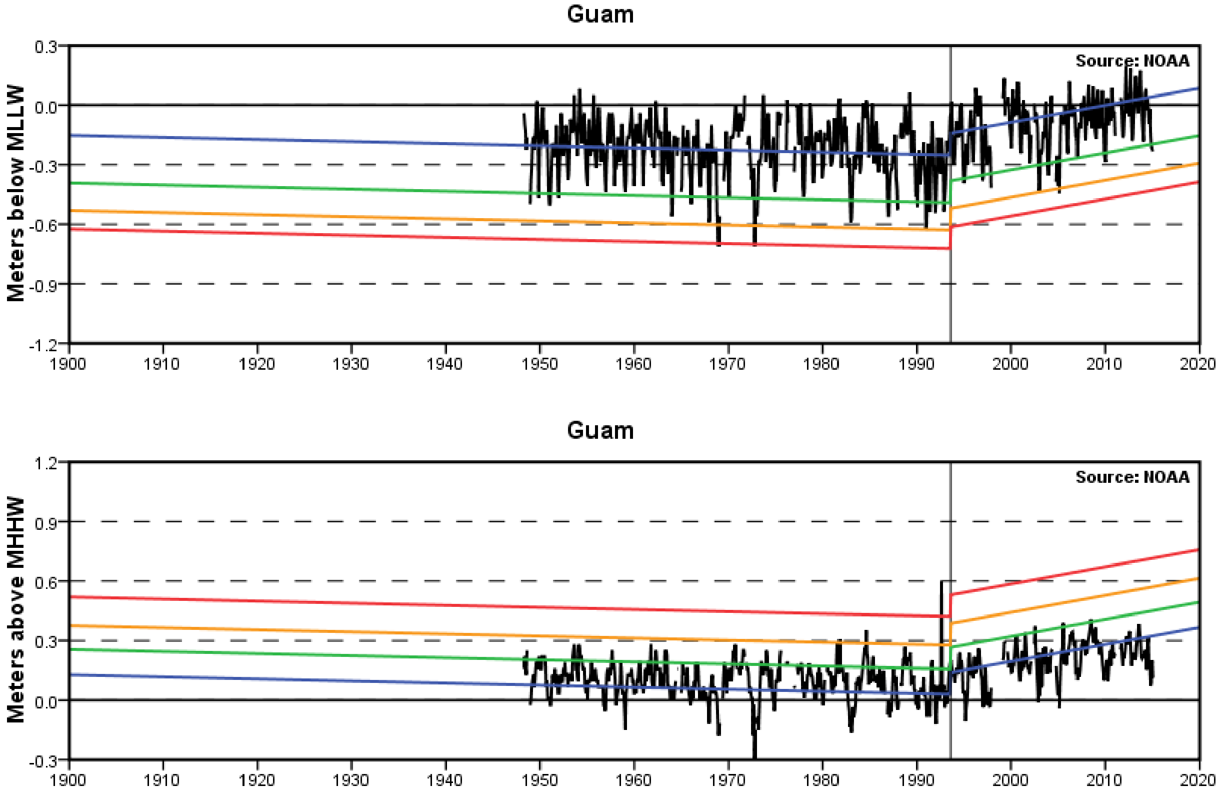


Figure 25. Monthly extreme water levels below and above MLLW and MHHW in Guam, 1900-2015.

2.5.3.8 Wave Watch 3 Global Wave Model

Description: To describe patterns in wave forcing, we present data from the Wave Watch 3 global wave model run by the Department of Ocean and Resources Engineering at the University of Hawai‘i in collaboration with NOAA/NCEP and NWS Honolulu. PacIOOS describes the model at http://oos.soest.hawaii.edu/pacioos/focus/modeling/wave_models.php: “The global model is initialized daily and is forced with NOAA/NCEP's global forecast system (GFS) winds. This model is designed to capture the large-scale ocean waves, provide spectral boundary conditions for the Hawai‘i and Mariana Islands regional WW3 model, and most importantly, the 7 day model outputs a 5 day forecast.”

Data presented here come from the global model, but regional WW3 models with higher resolution exist for Hawaii, Marianas and Samoa, and in some cases, very high resolution SWAN models exist for islands within those groups.

Timeframe: 2010-2016, Daily data.

Region/Location: Global.

Data Source: “WaveWatch III (WW3) Global Wave Model”: http://oos.soest.hawaii.edu/erddap/griddap/NWW3_Global_Best.html

Measurement Platform: *Global Forecast System Winds, WW3 model*

Rationale: Wave forcing can have major implications for both coastal ecosystems and pelagic fishing operations.

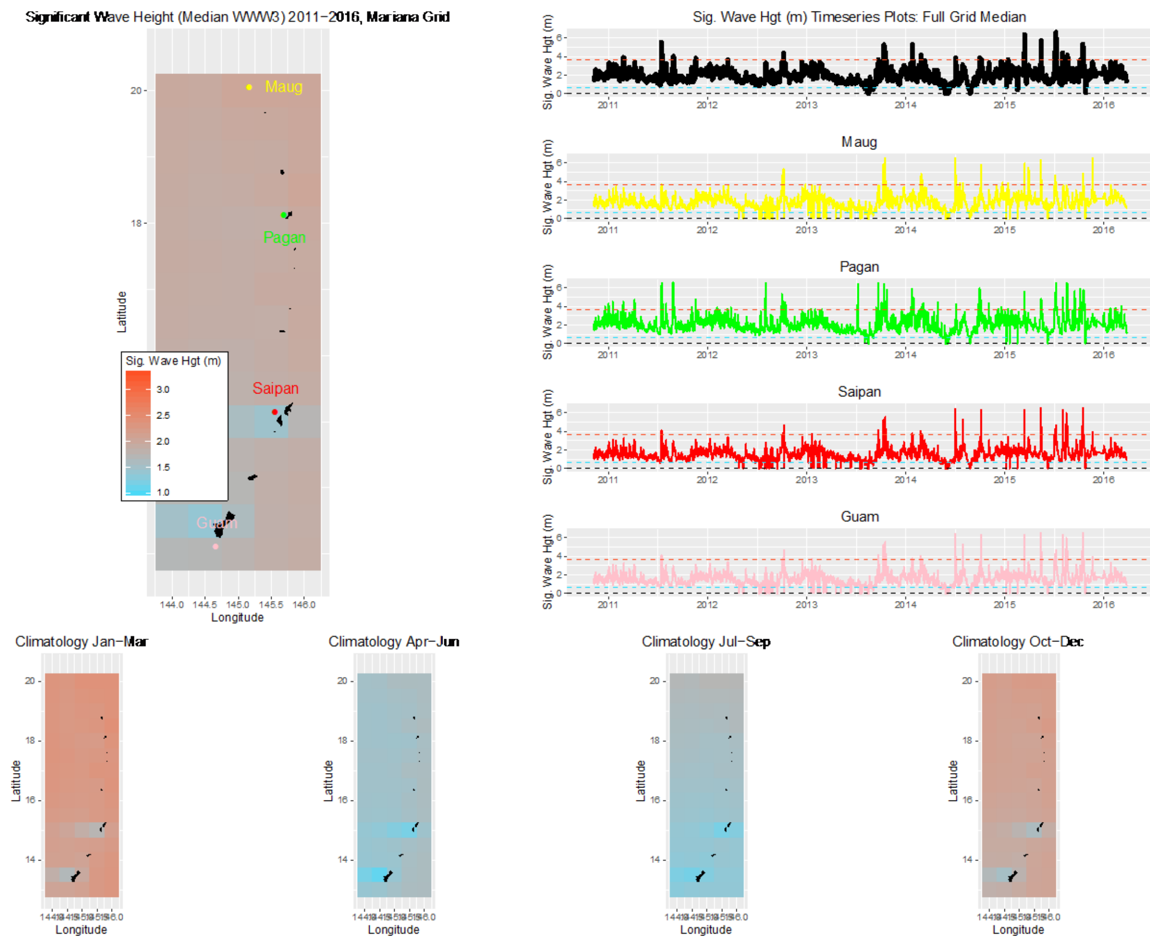


Figure 26. Wave watch summary for Mariana regional grid.

2.5.4 Observational and Research Needs

Through preparation of the 2015 Archipelagic Annual Reports, the Council has identified a number of observational and research needs that, if addressed, would improve the information content of future Climate and Ocean Indicators chapters. This information would provide fishery managers, fishing industry and community stakeholders with better understanding and predictive capacity vital to sustaining resilient and vibrant fishery systems in the Western Pacific.

- Emphasize the importance of continuing the climate and ocean indicators used in this report so that a consistent, long-term record can be maintained;
- Develop agreements among stakeholders and research partners to ensure the sustainability, availability and accessibility of climate and ocean indicators, their associated datasets and analytical methods used in this and future reports;
- Improve monitoring and understanding of the impacts of changes in ocean temperature, pH and ocean acidity, ocean oxygen content and hypoxia, and sea level rise through active collaboration by all fishery stakeholders and research partners;
- Explore connections among sea surface conditions, stratification and mixing;
- Improve understanding of mahi and swordfish size in relation to the orientation of the TZCF;
- Explore the biological implications of tropical cyclones;

- Standardize fish community size structure data for gear type;
- Develop, test and provide access to additional climate and ocean indicators that can improve the Archipelagic Conceptual Model;
- Investigate the connections between climate variables and other indicators in the Archipelagic Conceptual Model to improve understanding of changes in physical, biochemical, biologic and socio-economic processes and their interactions in the regional ecosystem;
- Develop predictive models that can be used for scenario planning to account for unexpected changes and uncertainties in the regional ecosystem and fisheries;
- Foster applied research in ecosystem modeling to better describe current conditions and to better anticipate the future under alternative models of climate and ocean change including changes in expected human benefits and their variability;
- Clarify and elucidate the interactions among (1) changes in climate, (2) ecosystems and (3) social, economic and cultural impacts on fishing communities;
- Explore the implications and effectiveness of large marine protected areas including intergenerational losses of knowledge due to lack of access to traditional fishing areas;
- Cultural knowledge and practices for adapting to changing climate in the past and how they might contribute to future climate adaptation.
- Enhanced information on social, economic and cultural impacts of a changing climate and increased pressure on the ocean and its resources.
- Analysis of potential relationship(s) between traditional runs of fish and climate change indicators.
- Explore the use of electronic monitoring and autonomous vehicles including small vessel prototypes.
- Cultural knowledge and practices for adapting to changing climate in the past and how they might contribute to future climate adaptation.
- Explore additional and/or alternative climate and ocean indicators that may have important effects on archipelagic fisheries systems including:
    - Ocean currents and anomalies;
    - Near-surface wind velocities and anomalies;
    - Wave forcing anomalies and wave power;
    - Storm frequency;
    - Estimates of phytoplankton abundance and size from satellite remotely-sensed SST and chlorophyll measurements;
    - Nutrients;
    - Eddy kinetic energy (EKE) which can be derived from satellite and remotely-sensed sea surface height data and can be indicative of productivity-enhancing eddies;
    - Degree Heating Weeks for coral reef ecosystems;
    - Time series of species richness and diversity from catch data which could potentially provide insight into how the ecosystem is responding to physical climate influences;
    - Identifying and monitoring key socio-economic and cultural indicators of the impacts of changing climate on resources, fishing communities, operations and resilience.

2.5.5 A Look to the Future

Future Annual Reports will include additional indicators as they become available and their relevance to the development, evaluation and revision of ecosystem-fishery plans becomes clear. Working with national and jurisdictional partners, the Council will make all datasets used in the preparation of this and future reports available and easily accessible.

2.6 Essential Fish Habitat

2.6.1 Introduction

The Magnuson-Stevens Fishery Conservation and Management Act includes provisions concerning the identification and conservation of essential fish habitat (EFH), and under the EFH final rule, habitat areas of particular concern (HAPC) (50 Code of Federal Regulations [CFR] 600.815). The Magnuson-Stevens Act defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." HAPC are those areas of EFH identified pursuant to 50 CFR 600.815(a)(8), and meeting one or more of the following considerations: (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.

The National Marine Fisheries Service (NMFS) and regional Fishery Management Councils (Councils) must describe and identify EFH in fishery management plans (FMPs), minimize to the extent practicable the adverse effects of fishing on EFH, and identify other actions to encourage the conservation and enhancement of EFH. Federal agencies that authorize, fund, or undertake actions that may adversely affect EFH must consult with NMFS, and NMFS must provide conservation recommendations to federal and state agencies regarding actions that would adversely affect EFH. Councils also have the authority to comment on federal or state agency actions that would adversely affect the habitat, including EFH, of managed species.

The EFH Final Rule strongly recommends regional fisheries management councils and NMFS to conduct a review and revision of the EFH components of fisheries management plans every five years (600.815(a)(10)). The council's FEPs state that new EFH information should be reviewed, as necessary, during preparation of the annual reports by the Plan Teams. Additionally, the EFH Final Rule states: "Councils should report on their review of EFH information as part of the annual Stock Assessment and Fishery Evaluation (SAFE) report prepared pursuant to §600.315(e)." The habitat portion of the annual report is designed to meet the FEP requirements and EFH Final Rule guidelines regarding EFH reviews.

National Standard 2 guidelines recommend that the SAFE report summarize the best scientific information available concerning the past, present, and possible future condition of EFH described by the FEPs. To this point, the annual report summarizes the available information on habitat condition for all fisheries.

2.6.1.1 EFH Information

The EFH components of fisheries management plans include the description and identification of EFH, lists of prey species and locations for each managed species, and optionally, habitat areas of particular concern. Impact-oriented components of FMPs include federal fishing activities that may adversely affect EFH; non-federal fishing activities that may adversely affect EFH; non-fishing activities that may adversely affect EFH; conservation and enhancement recommendations; and a cumulative impacts analysis on EFH. The last two components include the research and information needs section, which feeds into the Council's Five Year Research Priorities, and the EFH update procedure, which are described in the FEP but implemented in the annual report.

The Council has described EFH for five management unit species (MUS) under its management authority: pelagic (PMUS), bottomfish (BMUS), crustaceans (CMUS), coral reef ecosystem (CREMUS), and precious corals (PCMUS). The Mariana FEP describes EFH for the BMUS, CMUS, CREMUS, and PCMUS. The 2015 SAFE report summarizes the precious corals EFH information, which was prioritized for review in 2015 by Council, PIRO, and PIFSC habitat staff because the Council's consideration of EFH was most out of date with respect to available abundance information.

2.6.1.2 Habitat Objectives of FEP

The habitat objective of the FEP is to refine EFH and minimize impacts to EFH, with the following subobjectives:

a. Review EFH and HAPC designations every five years based on the best available scientific information and update such designations based on the best available scientific information, when available
b. Identify and prioritize research to: assess adverse impacts to EFH and HAPC from fishing (including aquaculture) and non-fishing activities, including, but not limited to, activities that introduce land-based pollution into the marine environment.

This annual report reviews the precious coral EFH components, resetting the five-year timeline for review of the precious corals fishery. The Council's support of non-fishing activities research is monitored through the program plan and five year research priorities, not the annual report.

2.6.1.3 Response to Previous Council Recommendations

At its 163rd meeting in Honolulu, HI, the Council endorsed a plan team working group on the HAPC process: "The working group will produce a report exploring HAPC designation options for the Western Pacific region within a year." The working group report is included as Appendix 1 to the habitat section of this report.

At its 165th meeting in Honolulu, HI, the Council recommended the revised Regional Operating Agreement be adopted as presented including the ESA-MSA Integration Agreement, Action Plan Template and Council diagram as appendixes and directs staff to finalize the EFH Policy to include the five-year EFH review and the EFH consultation coordination processes. The Council endorsed the inclusion of major federal actions with more than minimal adverse effect on EFH and those identified by the Council or its advisory bodies in the scope of the EFH consultation agreement.

In developing the EFH policy, staff will consider the HAPC Process working group report findings.

2.6.2 Habitat Use by MUS and Trends in Habitat Condition

The Mariana Archipelago is a chain of islands in the western Pacific roughly oriented north-south. It is anchored at the southern end by the relatively large island of Guam at 13.5° north latitude. The Commonwealth of the Northern Mariana Islands (CNMI) stretch off to the north. The entire chain is approximately 425 miles long. The archipelago was named by Spanish explorers in the 16th Century in honor of Spanish Queen Mariana of Austria.

The total land area of Guam is approximately 212 square miles and its EEZ is just over 84,000 square miles. The CNMI consists of 14 main islands. From north to south these are: Farallon de

Pajaros, Maug, Asuncion, Agrihan, Pagan, Alamagan, Guguan, Sarigan, Anatahan, Farallon de Medinilla, Saipan, Tinian, Aguijan, and Rota. Only Saipan, Rota, and Tinian are permanently inhabited, with 90% of the population residing on the island of Saipan. The total land area of the CNMI is 176.5 square miles and its EEZ is almost 300,000 square miles.

Guam and the southern islands of the CNMI are limestone, with level terraces and fringing coral reefs. The CNMI's northern islands are volcanic and sparsely inhabited, with active volcanoes on several islands, including Anatahan, Pagan, and Agrihan (the highest, at 3,166 feet). The archipelago has a tropical maritime climate moderated by seasonal northeast trade winds. While there is little seasonal temperature variation, there is a dry season (December to June) and a rainy season (July to November). The rainy season coincides with the northern hemisphere hurricane season, and the Mariana Archipelago is periodically impacted by powerful typhoons.

The Mariana Trench is located to the east of the chain. The trench includes the deepest point in the world's oceans. The vertical measurement from the seafloor to Saipan's highest point (Mount Tapotchau) is 37,752 ft.

Essential fish habitat in the Marianas for the four MUS comprises all substrate from the shoreline to the 700 m isobath. The entire water column is described as EFH from the shoreline to the 700 m isobath, and the water column to a depth of 400 m is described as EFH from the 700 m isobath to the limit or boundary of the exclusive economic zone (EEZ). While the coral reef ecosystems surrounding the islands in the Marianas have been the subject of a comprehensive monitoring program through the PIFSC Coral Reef Ecosystem Division (CRED) biennially since 2003, surveys are focused on the nearshore environments surrounding the islands, atolls and reefs (PIFSC 2011). Remote reefs and shoals were surveyed in some years.

The mission of the PIFSC Coral Reef Ecosystem Division (CRED) is to "provide high-quality, scientific information about the status of coral reef ecosystems of the U.S. Pacific islands to the public, resource managers, and policymakers on local, regional, national, and international levels" (PIFSC 2011). CRED's Reef Assessment and Monitoring Program (RAMP) conducts comprehensive ecosystem monitoring surveys at about 50 island, atoll, and shallow bank sites in the Western Pacific Region on a one to three year schedule (PIFSC 2008). CRED coral reef monitoring reports provide the most comprehensive description of nearshore habitat quality in the region. The benthic habitat mapping program provides information on the quantity of habitat.

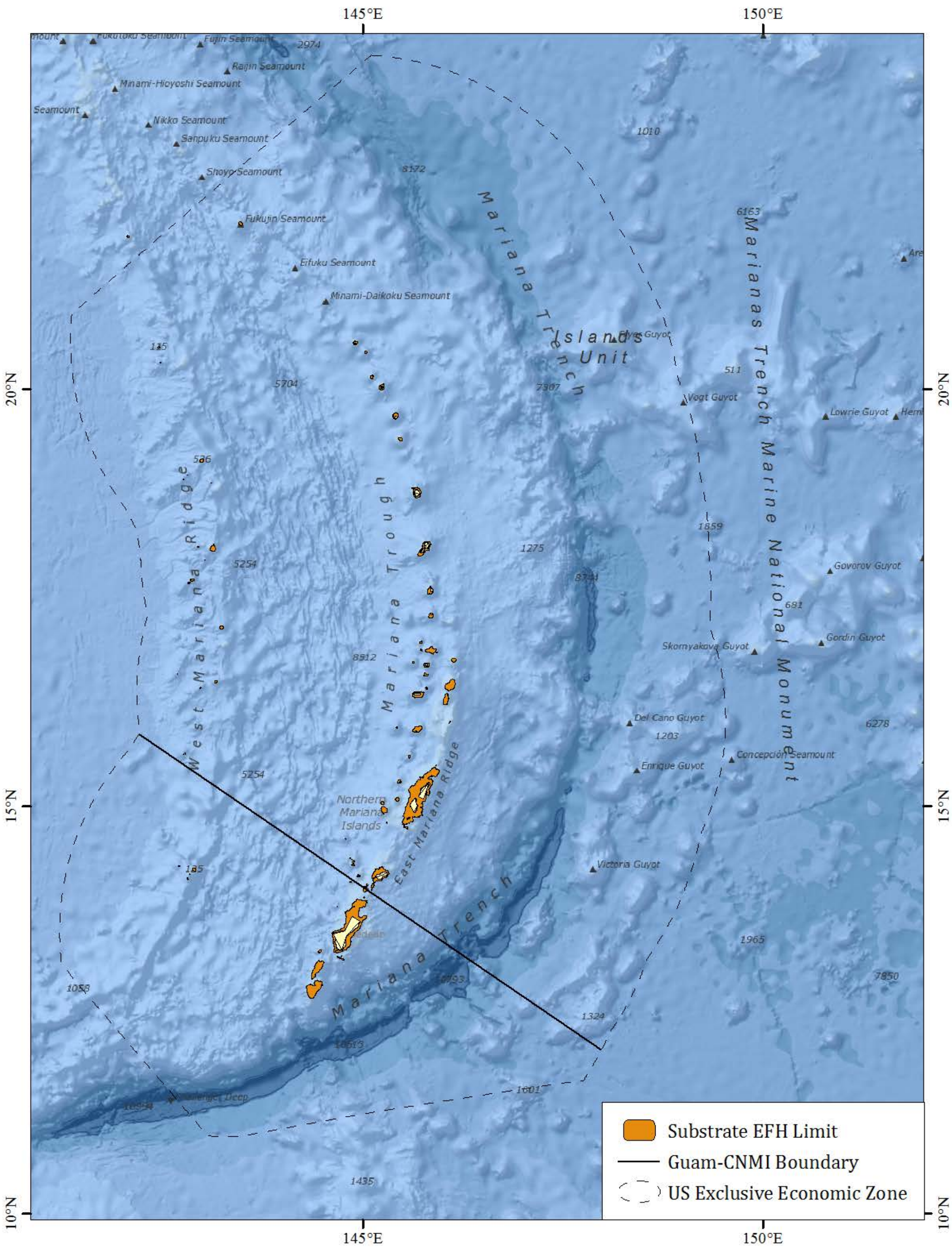


Figure 27. Substrate EFH Limit of 700 m isobath around the islands and surrounding banks of the Mariana Archipelago. Data Source: GMRT.

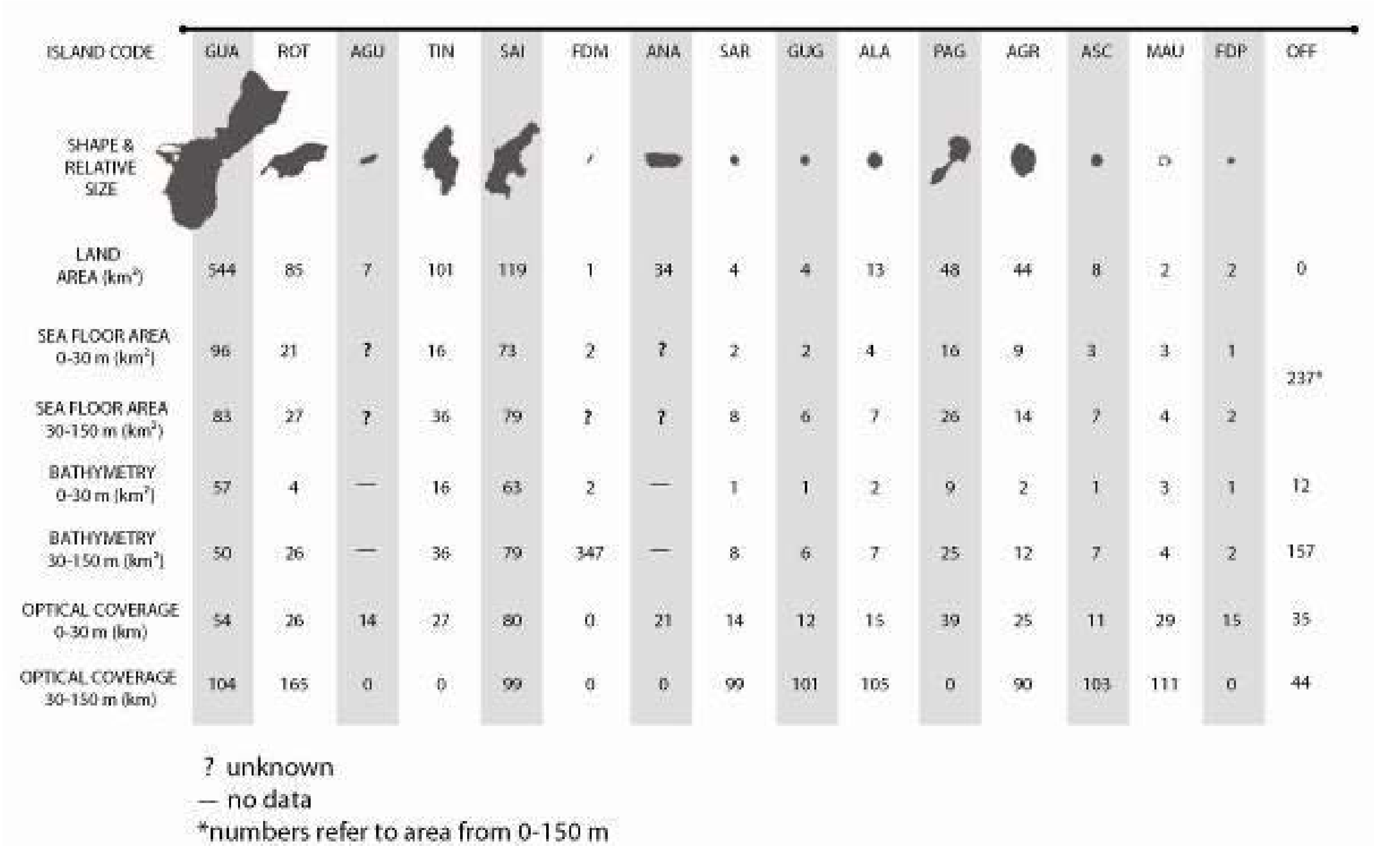
2.6.2.1 Habitat Mapping

Interpreted IKONOS benthic habitat maps in the 0 – 30 m depth range have been completed for all islands in the CNMI (CRCP 2011). Mapping products for the Marianas are available from the Pacific Islands Benthic Habitat Mapping Center.

Table 58. Summary of habitat mapping in the Marianas

Depth Range	Timeline/Mapping Product	Progress	Source
0-30 m	IKONOS Benthic Habitat Maps	All Islands	CRCP 2011
	2000-2010 Bathymetry	70%	DesRochers 2016
	2011-2015 Multibeam Bathymetry	-	DesRochers 2016
	2011-2015, Satellite Worldview 2 Bathymetry	15%	DesRochers 2016
30-150 m	2000-2010 Bathymetry	85%	DesRochers 2016
	2011-2015 Multibeam Bathymetry	-	DesRochers 2016
15-2000 m	Multibeam Bathymetry	Complete around all islands except Guam, Rota, and Agrigan	Pacific Islands Benthic Habitat Mapping Center
	Derived Products	Backscatter available for all 60 m multibeam Geomorphology products – see website	Pacific Islands Benthic Habitat Mapping Center

The land and seafloor area surrounding the islands of the Marianas as well as primary data coverage are reproduced from CRCP 2011 in Figure 28.



ISLAND CODE	GUA	ROT	AGU	TIN	SAI	FDM	ANA	SAR	GUG	ALA	PAG	AGR	ASC	MAU	FDP	OFF
SHAPE & RELATIVE SIZE																
LAND AREA (km^2)	544	85	7	101	119	1	34	4	4	13	48	44	8	2	2	0
SEA FLOOR AREA 0-30 m (km^2)	96	21	?	16	73	2	?	2	2	4	16	9	3	3	1	237*
SEA FLOOR AREA 30-150 m (km^2)	83	27	?	36	79	?	?	8	6	7	26	14	7	4	2	
BATHYMETRY 0-30 m (km^2)	57	4	—	16	63	2	—	1	1	2	9	2	1	3	1	12
BATHYMETRY 30-150 m (km^2)	50	26	—	36	79	347	—	8	6	7	25	12	7	4	2	157
OPTICAL COVERAGE 0-30 m (km)	54	26	14	27	80	0	21	14	12	15	39	25	11	29	15	35
OPTICAL COVERAGE 30-150 m (km)	104	165	0	0	99	0	0	99	101	105	0	90	103	111	0	44

? unknown
— no data
*numbers refer to area from 0-150 m

Figure 28. Marianas Land and Seafloor Area and Primary Data Coverage from CRCP 2011.

2.6.2.2 Benthic Habitat

Juvenile and adult life stages of coral reef MUS and crustaceans including spiny and slipper lobsters and Kona crab extends from the shoreline to the 100 m isobath (64 FR 19067, April 19, 1999). All benthic habitat is considered EFH for crustaceans species (64 FR 19067, April 19, 1999), while the type of bottom habitat varies by family for coral reef species (69 FR 8336, February 24, 2004). Juvenile and adult bottomfish EFH extends from the shoreline to the 400 m isobath (64 FR 19067, April 19, 1999), and juvenile and adult deepwater shrimp habitat extends from the 300 m isobath to the 700 m isobath (73 FR 70603, November 21, 2008).

2.6.2.2.1 RAMP Indicators

Benthic percent cover of coral, macroalgae, and crustose coralline algae from CRED are found in the following tables. CRED uses the benthic towed-diver survey method to monitor changes in benthic composition. In this method, "a pair of scuba divers (one collecting fish data, the other collecting benthic data) is towed about 1 m above the reef roughly 60 m behind a small boat at a constant speed of about 1.5 kt. Each diver maneuvers a towboard platform, which is connected to the boat by a bridle and towline and outfitted with a communications telegraph and various survey equipment, including a downward-facing digital SLR camera (Canon EOS 50D, Canon Inc., Tokyo). The benthic towed diver records general habitat complexity and type (e.g., spur and groove, pavement), percent cover by functional-group (hard corals, stressed corals, soft corals, macroalgae, crustose coralline algae, sand, and rubble) and for macroinvertebrates (crown-of-thorns seastars, sea cucumbers, free and boring urchins, and giant clams).

Towed-diver surveys are typically 50 min long and cover about two to three km of habitat. Each survey is divided into five-min segments, with data recorded separately per segment to allow for later location of observations within the ~ 200-300 m length of each segment. Throughout each survey, latitude and longitude of the survey track are recorded on the small boat using a GPS; and after the survey, diver tracks are generated with the GPS data and a layback algorithm that accounts for position of the diver relative to the boat. (PIFSC Website, 2016).

Table 59. Mean percent cover of live coral from RAMP sites collected from towed-diver surveys in the Marianas

	2003	2005	2007	2009	2011	2014
Agrihan	16.03	15.45	13.68	16.03	19.83	
Aguijan	17.88	17.25	11.68	15.61	21.88	33.46
Alamagan	18.23	17.39	22.21	23.34	30.28	27.58
Anatahan	7.93					
Arakane	24.06	11.83				
Asuncion	18.15	15.58	15.66	18.57	28	40.56
Farallon de Pajaros	10.13	4.82	4.94	11.28	11.69	16.45
Guam	19.58	23.3	11.72	13.71	19.06	17.58
Guguan	23	10.18	26.58	24.97	30.23	37.23
Maug	26.86	21.43	26.25	28.09	38	46.17
Pagan	18.51	9.84	12.04	13.09	16.23	27.87
Pathfinder	24.17	24.75				
Rota	8.98	6.04	4.36	4.45	9.94	17.39
Saipan	20.85	10.63	10.18	10.18	13.73	24.99
Santa Rosa	7.31	7.8				
Sarigan	18.02	12.88	14.21	23.37	18.01	31.98
Stingray	54.86					
Supply	38.75					
Tatsumi	7.92					
Tinian	12.46	8.99	8.08	9.33	12.02	17.37

Table 60. Mean percent cover of macroalgae from RAMP sites collected from towed-diver surveys in the Marianas

	2003	2005	2007	2009	2011	2014
Agrihan	48.25	22.65	8.55	3.2	4.63	
Aguijan	44.56	38.81	28.31	20.8	21.52	25.1
Alamagan	41.21	26.03	15.65	15.47	12.81	8.33
Anatahan	14.31					
Arakane	52.26	45.75				
Asuncion	51.1	5.37	19.11	7.54	7.47	3.86
Farallon de Pajaros	60.2	4.32	3.38	0.05	0.91	0.18
Guam	46.19	52.67	43.22	26.82	29.61	41.64

Guguan	45	10.18	19.5	17	12.59	8.66
Maug	45.91	27.2	8.17	3.26	4.37	12.01
Pagan	45.96	18.4	16.74	9.84	7.36	19.3
Pathfinder	37.29	29				
Rota	54.34	56.05	38.76	30.95	35.16	29.33
Saipan	48.57	30.75	31.87	20.39	15.26	25.18
Santa Rosa	42.5	70.54				
Sarigan	42.23	23.95	16.47	12.51	9.41	11.55
Stingray	33.89					
Supply	19.17					
Tatsumi	67.22					
Tinian	46.94	56.38	39.95	30.4	25.92	34.91

Table 61. Mean percent cover of crustose coralline algae from RAMP sites collected from towed-diver surveys in the Marianas

	2003	2005	2007	2009	2011	2014
Agrihan	8.64	5.7	9.94	5.57	3.91	
Aguijan	14.69	10.59	12.67	7.32	11.47	18.33
Alamagan	7.63	4.85	10.29	5.33	4.29	6.25
Anatahan	7.72					
Arakane	5.28	3.58				
Asuncion	7.96	8.99	9.53	3.67	4.62	2.19
Farallon de Pajaros	3.44	8.03	5.39	2.94	2.29	0.05
Guam	12.75	4.04	8.54	6.13	9.39	6.9
Guguan	17.13	15	12.95	14.59	7.35	9.91
Maug	10.22	7.53	12.32	7.73	5.38	8.23
Pagan	6.61	12.41	14.16	8.42	6.33	2.48
Pathfinder	5.56	10				
Rota	18.39	4.56	12.42	5.22	6.67	5.49
Saipan	10.04	8.74	15.03	8.27	6.31	5.61
Santa Rosa	7.13	0.55				
Sarigan	10.64	3.24	7.58	3.84	2.59	4.57
Stingray	1.54					
Supply	35					
Tatsumi	6.11					
Tinian	6.25	5.18	16.16	4.07	7.59	5.96

2.6.2.3 Oceanography and Water Quality

The water column is also designated as EFH for selected MUS life stages at various depths. For larval stages of all species except deepwater shrimp, the water column is EFH from the shoreline to the EEZ. Coral reef species egg and larval EFH is to a depth of 100 m; crustaceans, 150m; and bottomfish, 400 m. Please see the Ecosystem and Climate Change section for information related to oceanography and water quality.

2.6.3 Report on Review of EFH Information

The precious corals biological components were reviewed through production of this annual report. The non-fishing impact and cumulative impacts components are scheduled for review in 2016. Precious corals information can be found in Attachment 2.

2.6.4 EFH Levels

NMFS guidelines codified at 50 C.F.R. § 600.815 recommend Councils organize data used to describe and identify EFH into the following four levels:

1. Level 1: Distribution data are available for some or all portions of the geographic range of the species.
2. Level 2: Habitat-related densities of the species are available.
3. Level 3: Growth, reproduction, or survival rates within habitats are available.
4. Level 4: Production rates by habitat are available.

The Council adopted a fifth level, denoted Level 0, for situations in which there is no information available about the geographic extent of a particular managed species' life stage. The existing level of data for individual MUS in each fishery are presented in tables per fishery. Each fishery section also includes the description of EFH, method used to assess the value of the habitat to the species, description of data sources used if there was analysis; and description of method for analysis. A section summarizing the annual review that was performed follows.

2.6.4.1 Precious Corals

Essential Fish Habitat for precious corals was originally designated in Amendment 4 to the Precious Corals Fishery Management Plan (64 FR 19067, April 19, 1999), using the level of data found in the table.

Table 62. Level of EFH information available for the Western Pacific precious corals management unit species complex.

Species	Pelagic phase (larval stage)	Benthic phase
Pink Coral		
Corallium secundum	0	4
C. regale	0	2
C. laauense	0	2
Gold Coral		
Gerardia spp	0	2
Callogorgia gilberti	0	2
Narella spp.	0	2
Bamboo Coral		
Lepidisis olapa	0	2
Acanella spp.	0	2
Black Coral		
Antipathes dichotoma	0	4
A. grandis	0	4
A. ulex	0	2

2.6.4.2 Bottomfish and Seamount Groundfish

Essential Fish Habitat for bottomfish and seamount groundfish was originally designated in Amendment 6 to the Bottomfish and Seamount Groundfish FMP (64 FR 19067, April 19, 1999).

Table 63. Level of EFH information available for Western Pacific bottomfish and seamount groundfish management unit species complex.

Life History Stage	Eggs	Larvae	Juvenile	Adult
Bottomfish: (scientific/english common)				
Aphareus rutilans (red snapper/silvermouth)	0	0	0	2
Aprion virescens (gray snapper/jobfish)	0	0	1	2
Caranx ignoblis (giant trevally/jack)	0	0	1	2
C lugubris (black trevally/jack)	0	0	0	2
Epinephelus faciatus (blacktip grouper)	0	0	0	1
E quernus (sea bass)	0	0	1	2
Etelis carbunculus (red snapper)	0	0	1	2
E coruscans (red snapper)	0	0	1	2
Lethrinus amboinensis (ambon emperor)	0	0	0	1
L rubrioperculatus (redgill emperor)	0	0	0	1
Lutjanus kasmira (blueline snapper)	0	0	1	1
Pristipomoides auricilla (yellowtail snapper)	0	0	0	2
P filamentosus (pink snapper)	0	0	1	2
P flavipinnis (yelloweye snapper)	0	0	0	2
P seiboldi (pink snapper)	0	0	1	2
P zonatus (snapper)	0	0	0	2
Pseudocaranx dentex (thicklip trevally)	0	0	1	2
Seriola dumerili (amberjack)	0	0	0	2
Variola louti (lunartail grouper)	0	0	0	2
Seamount Groundfish:				
Beryx splendens (alfonsin)	0	1	2	2
Hyperoglyphe japonica (ratfish/butterfish)	0	0	0	1
Pseudopentaceros richardsoni (armorhead)	0	1	1	3

2.6.4.3 Crustaceans

Essential Fish Habitat for crustaceans MUS was originally designated in Amendment 10 to the Crustaceans FMP (64 FR 19067, April 19, 1999). EFH definitions were also approved for deepwater shrimp through an amendment to the Crustaceans FMP in 2008 (73 FR 70603, November 21, 2008).

Table 64. Level of EFH information available for the Western Pacific crustacean management unit species complex.

Life History Stage	Eggs	Larvae	Juvenile	Adult
Crustaceans: (english common\scientific)				
Spiny lobster (*Panulirus marginatus*)	2	1	1-2	2-3
Spiny lobster (*Panulirus pencillatus*)	1	1	1	2
Common slipper lobster (*Scyllarides squammosus*)	2	1	1	2-3
Ridgeback slipper lobster (*Scyllarides haanii*)	2	0	1	2-3
Chinese slipper lobster (*Parribacus antarcticus*)	2	0	1	2-3
Kona crab (*Ranina ranina*)	1	0	1	1-2

2.6.4.4 Coral Reef

Essential Fish Habitat for coral reef ecosystem species was originally designated in the Coral Reef Ecosystem FMP (69 FR 8336, February 24, 2004). An EFH review of CREMUS will not be undertaken until the Council completes its process of redesignating certain CREMUS into the ecosystem component classification. Ecosystem component species do not require EFH designations, as they are not a managed species.

2.6.5 Research and Information Needs

Based, in part, on the information provided in the tables above the Council identified the following scientific data which are needed to more effectively address the EFH provisions:

2.6.5.1 All FMP Fisheries

- Distribution of early life history stages (eggs and larvae) of management unit species 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
- Growth, reproduction and survival rates for MUS within habitats

2.6.5.2 Bottomfish Fishery

- 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-water and shallow-water bottomfish complexes
- High resolution maps of bottom topography/currents/water masses/primary productivity
- Habitat utilization patterns for different life history stages and species

2.6.5.3 Crustaceans Fishery

- Identification of post-larval settlement habitat of all CMUS
- Identification of "source/sink" relationships in the NWHI and other regions (ie, relationships between spawning sites settlement using circulation models, genetic techniques, etc)
- 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, habitat relief

2.6.5.4 Precious Corals Fishery

- Distribution, abundance and status of precious corals in the CNMI and Guam.

2.6.6 References

Annette DesRochers. "Benthic Habitat Mapping." NOAA Fisheries Center, Honolulu, HI. Presentation. April 6, 2016.

Coral Reef Ecosystem Program; Pacific Islands Fisheries Science Center 2016. Benthic Percent Cover Derived from Analysis of Benthic Images Collected during Towed-diver Surveys of the U.S. Pacific Reefs Since 2003 (NCEI Accession <unassigned>). NOAA National Centers for Environmental Information. Unpublished Dataset. April 5, 2016.

Miller, J; Battista, T.; Pritchett, A; Rohmann, S; Rooney, J. Coral Reef Conservation Program Mapping Achievements and Unmet Needs. March 14, 2011. 68 p.

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Pacific Islands Fisheries Science Center (2011) Coral reef ecosystems of American Samoa: a 2002–2010 overview. NOAA Fisheries Pacific Islands Fisheries Science Center, PIFSC Special Publication, SP-11-02, 48 p.

Pacific Islands Fisheries Science Center (2010) Coral reef ecosystems of the Mariana Archipelago: a 2003–2007 overview. NOAA Pacific Islands Fisheries Science Center, PIFSC Special Publication, SP-10-002, 38 p.

Pacific Islands Fisheries Science Center (2012) Coral reef ecosystem monitoring report of the Mariana Archipelago: 2003-2007. NOAA Pacific Islands Fisheries Science Center, PIFSC Special Publication, SP-12-01, 1124 p.

2.7 Marine Planning

2.7.1 Introduction

Marine planning is a science-based tool being utilized regionally, nationally and globally to identify and address issues of multiple human uses, ecosystem health and cumulative impacts in the coastal and ocean environment. The Council's efforts to incorporate marine planning in its actions began in response to Executive Order (EO) 13547, Stewardship of the Ocean, Our Coasts, and the Great Lakes, issued by President Barack Obama on June 19, 2010. EO 13547 adopted the recommendations of the Interagency Ocean Policy Task Force and directed executive agencies to implement those recommendations as the National Ocean Policy. A third of the Task Force document addressed marine planning.

In 2015, the Council adopted its Marine Planning and Climate Change (MPCC) Policy, drafted by the Council's MPCC Committee, to help it coordinate development and amendment of its fishery ecosystem plans, programs, and other relevant activities. The policy uses the definition of marine planning from the National Ocean Policy Implementation Plan. The MPCC policy recognizes a set of overarching and specific principles and specific policy points for the Council, its advisory bodies and its staff to consider and incorporate in the Mariana Archipelago Fishery Ecosystem Plan (FEP). Of the MPCC policy's overarching principles, three relate to marine planning. The MPCC policy recognizes marine planning as an appropriate approach to reconciling intersecting human use, ocean resource, and ecosystem health at multiple geographic scales. The MPCC policy also recognizes that traditional resource management systems, such as the ahupua`a system in Hawai`i and Fa`a Samoa in American Samoa can provide an appropriate context for marine planning. Lastly, the MPCC Policy states that marine protected areas (MPAs), a tool used in marine planning, can and should be used for climate change reference and human use and impact research.

In promoting the ecosystem approach to management, the Council will carefully consider the impact on fisheries and fishery resources, including traditional fisheries, resources, knowledge, and fishing rights when participating in marine planning for activities such as offshore energy development. A key component of the MPCC policy is collaboration with existing organizations in data and information collection, dissemination and outreach. The Council intends to work with the Pacific Islands Regional Planning Body (RPB), community members, the private sector, schools, policymakers and others in Hawai`i, American Samoa, Guam and the Commonwealth of the Northern Mariana Islands (CNMI). The MPCC Policy can be found on the Council's website.

The Council's Plan Team (restructured in 2015) includes a marine planning expert to oversee inclusion of marine planning in the annual report. The marine planning annual report attempts to bring together available data related to marine planning that are relevant to the Council's roles in marine planning on an annual scale. Marine planning concerns with timelines shorter than a year are not included in this report. These roles are:

1. Implementation of the Magnuson-Stevens Fishery Conservation and Management Act (MSA)
2. Implementation of the National Environmental Policy Act (NEPA)
3. Stakeholder in non-MSA planned ocean activities
4. Member of the Pacific Islands RPB

2.7.1.1 MSA and NEPA Implementation

Marine planning is relevant to the implementation of the MSA through:

- Responding to previous Council recommendations relevant to its marine planning role
- Monitoring achievement of FEP objectives
- Defining essential fish habitat (EFH) and EFH Information
- Working with the National Marine Fisheries Service (NMFS) Pacific Islands Regional Office (PIRO) to identify and provide conservation and enhancement recommendations on activities that may cause adverse effects to essential fish habitat (EFH), and
- Tracking any changes in the cumulative impact of fishing, non-MSA fishing, and non-fishing activities on EFH.

Similarly, NEPA requires federal agencies to analyze the cumulative impacts of their actions with past, present, and reasonably foreseeable future activities.

At its 165th meeting in March 2016, in Honolulu, Hawaii, the Council approved the following objective for the FEPs: Consider the Implications of Spatial Management Arrangements in Council Decision-making. The following sub-objectives apply:

a. Identify and prioritize research that examines the positive and negative consequences of areas that restrict or prohibit fishing to fisheries, fishery ecosystems, and fishermen, such as the Bottomfish Fishing Restricted Areas, military installations, NWHI restrictions, and Marine Life Conservation Districts.
b. Establish effective spatially-based fishing zones.
c. Consider modifying or removing spatial-based fishing restrictions that are no longer necessary or effective in meeting their management objectives.
d. As needed, periodically evaluate the management effectiveness of existing spatial-based fishing zones in Federal waters.

In order to monitor implementation of this objective, this annual report includes the Council's spatially-based fishing restrictions or marine managed areas (MMAs), the goals associated with those, and the most recent evaluation. Non-Council MPAs are also reported on. Council research needs are identified and prioritized through the Five Year Research Priorities and other processes, and are not tracked in this report.

In order to meet the EFH and NEPA mandates, this annual report tracks activities that occur in the ocean that are of interest to the Council and incidents that may contribute to cumulative impact. While the Council is not responsible for NEPA compliance, monitoring the environmental effects of ocean activities for the FEP's EFH cumulative impacts section is duplicative of the agency's NEPA requirement, and therefore, this report can provide material or suggest resources to meet both mandates.

2.7.1.2 Stakeholder in Non-fishing Activities

Tracking activities also assists the Council in its role as a stakeholder in other offshore activities. In the Western Pacific Region, fisheries compete with other activities for access to and use of fishing grounds. These activities include, but are not limited to, military bases and training activities, commercial shipping, marine protected areas, recreational activities and off-shore energy projects. Between the Bureau of Ocean Energy Management (BOEM), the Army Corps of Engineers (USACE), and the National Marine Fisheries Service (NMFS), most permits for offshore energy development, dredging or mooring projects that occur in the waters of the US, and offshore aquaculture are captured. Department of Defense activities regarding military bases and training are assessed in environmental impact statements (EISs) on a five year cycle and include assessments of potential conflict with fisheries; the EISs are available through the Federal Register. Due to the sheer volume of ocean activities and the annual frequency of this report, only major activities on multi-year planning cycles or those permitted by NMFS Sustainable Fisheries Division are tracked in this report.

The Council may comment on actions of any type that interact with fisheries and fishing communities. The Council may specifically provide conservation and enhancement recommendations (MSA §305(b)(3)) on activities that may adversely affect EFH in coordination with or independently from the NMFS PIRO Habitat Conservation Division.

2.7.1.3 Member of the Pacific Islands Regional Planning Body

EO 13547 (July 22, 2010), Stewardship of the Ocean, Our Coasts, and the Great Lakes, established the National Ocean Council and among other things, directed "the development of coastal and marine spatial plans that build upon and improve existing Federal, State, tribal, local, and regional decision-making and planning processes." The EO described the Pacific Islands (includes American Samoa, CNMI, Guam, and Hawaii) as one of nine regions where a regional planning body (RPB) would be established for development of a coastal and marine spatial (CMS) plan. The EO adopted the Final Recommendations of the Interagency Ocean Policy Task Force as the National Ocean Policy.

The Council is a member of the Pacific Islands (PI) RPB and as such, the interests of the Council will be incorporated into the CMS plan. It is through the Council member that the Council may submit recommendations to the PI RPB. Section 2.7.5 contains a summary of the PI RPB progress to date in developing CMS plan for the Pacific Islands region.

2.7.1.4 Organization of the Report

The annual report is organized by MMAs, activities, incidents that may contribute to cumulative impact, the RPB report, references, and finally a maps section.

2.7.2 Marine Managed Areas

2.7.2.1 MMAs established under FMPs

Council-established marine managed areas (MMAs) were compiled in Table 65 from 50 CFR § 665, Western Pacific Fisheries, the Federal Register, and Council amendment documents. Geodesic areas were calculated in square kilometers in ArcGIS 10.2. These marine-managed areas are shown in the Spatial Management Areas Established under FMPs map in the maps section. Standing Council recommendations indicating review deadlines and follow up recommendations are copied below.

At its 160th meeting, **Regarding CNMI Fisheries, the Council**:
Directed staff to prepare the final amendment package for transmittal to NMFS with the proposed action being the removal of the 50 nautical mile closure for bottomfish vessels over 40 feet in length around the southern islands of Rota, Tinian, Aguijan and FDM and 10 nm around

Alamagan.

Table 65. MMAs established under FEPs from 50 CFR § 665.

Name	FEP	Island	50 CFR /FR /Amendment Reference	Marine Area (km^2)	Fishing Restriction	Goals	Most Recent Evaluation	Review Deadline
Pelagic Restrictions								
Guam Longline Prohibited Area	Pelagic	Guam	665.806(a)(3) 57 FR 7661 Pelagic FMP Am. 5	50,192.88	Longline fishing prohibited	Prevent gear conflicts between longline vessels and troll/handline vessels	1992	-
CNMI Longline Prohibited Area	Pelagic		665.806(a)(4) 76 FR 37287	88,112.68	Longline fishing prohibited	Reduce potential for nearshore localized fish depletion from longline fishing, and to limit catch competition and gear conflicts between the CNMI-based longline and trolling fleets	2011	-
Bottomfish Restrictions								
CNMI Medium and Large Vessel Prohibited Area	Mariana Archipelago	Alamagan	665.403(b)(2) 73 FR 75615 Bottomfish FMP Am. 10 Marianas FEP Am. 4 In Progress	913.92	Vessels ≥ 40 feet prohibited	Provide for sustained community participation; no longer necessary	2016	-

Name	FEP	Island	50 CFR /FR /Amendment Reference	Marine Area (km^2)	Fishing Restriction	Goals	Most Recent Evaluation	Review Deadline
CNMI Medium and Large Vessel Prohibited Area	Mariana Archipelago	Southern Islands (Rota through Saipan)	665.403(b)(1) 73 FR 75615 Bottomfish FMP Am. 10 Marianas FEP Am. 4 In Progress	53,181.30	Vessels ≥ 40 feet prohibited	Provide for sustained community participation; no longer necessary	2016	-
Guam Large Vessel Prohibited Area	Mariana Archipelago	Guam	665.403(a) 71 FR 64474 Bottomfish FMP Am. 9	29,384.06	Vessels ≥ 50 feet prohibited	To maintain viable participation and bottomfish catch rates by small vessels in the fishery	2006	-
Other Restrictions								
Guam No Anchor Zone	Mariana Archipelago	Guam	665.399 69 FR 8336 Coral Reef Ecosystem FEP	138,992.51	Anchoring by all fishing vessels ≥ 50 ft prohibited on the offshore southern banks located in the U.S. EEZ off Guam	Minimize adverse human impacts on coral reef resources	2004	-

2.7.2.2 Other MPAs in the Region

Marine Protected Area (MPA) data were downloaded from the NOAA Marine Protected Areas Center Data Inventory. Data are current through 2014.

The Excel MPA Inventory was filtered to retain only those records without GIS data for the following management agencies: American Samoa, Bureau of Ocean Energy Management, Guam, Hawaii, Mariana Islands, Marine National Monuments, National Estuarine Research Reserve System, National Marine Fisheries Service, National Park Service, or National Wildlife Refuge System.

MPAs within the 200 nautical mile limit around Hawaii, American Samoa, Guam, the CNMI, Wake Island, Johnston Atoll, Palmyra Atoll and Kingman Reef, Jarvis Island, and Howland and Baker Islands were selected from the MPA GIS inventory and their attributes were exported to a spreadsheet. Fields that matched the Excel inventory were retained.

Type, size, location, and fishery measures are summarized in Table 66. MPAs are shown in the overview maps found in the map section.

Fishery measures for Guam DAWR and CNMI DFW managed areas have been edited from what is provided in the MPA Inventory to show a higher level of detail.

Table 66. Marine Protected Areas in the Western Pacific Region from the MPA Inventory unless otherwise noted

Site ID	Name	State	Marine Area (km^2)	Fishing Restrictions
MNM7	Marianas Trench Marine National Monument	Marine National Monuments	248,455.00	Commercial Fishing Prohibited in Islands Unit Only; no site restrictions in Volcanic and Trench unit
NWR189	Mariana Trench National Wildlife Refuge	National Wildlife Refuge System	205,499.00	No Site Restrictions
NWR188	Mariana Arc Of Fire National Wildlife Refuge	National Wildlife Refuge System	222.57	No Site Restrictions
NWR49	Guam National Wildlife Refuge	National Wildlife Refuge System	133.58	Commercial Fishing Prohibited, Recreational Fishing Restricted
GU10	Pati Point	Guam	20.11	Fishing prohibited except for hook & line from shore and trolling seaward of the reef margin
NPS39	War in the Pacific National Historical Park	National Park Service	7.77	Commercial and Recreational Fishing Restricted
MP3	Managaha Marine Conservation Area	Mariana Islands	5.06	Commercial and Recreational Fishing Prohibited
GU9	Achang Reef Flat	Guam	4.66	Fishing prohibited except for seasonal run species by permit and trolling seaward of the reef margin
GU12	Tumon Bay	Guam	4.57	Fishing prohibited except hook & line from shore and cast net from shore are allowed only for rabbitfish (Sesjun, manahak), juvenile goatfish (Ti'ao), juvenile jacks (I'e') and convict tangs (Kichu); cast net along the

Site ID	Name	State	Marine Area (km^2)	Fishing Restrictions
				reef margin is allowed only for rabbitfish and convict tangs; bottomfishing is allowed seaward of 100 ft contour; and trolling is allowed seaward of the reef margin.
GU3	Piti Bomb Holes	Guam	3.66	Fishing prohibited except for seasonal run species by permit and trolling seaward of the reef margin
GU11	Sasa Bay	Guam	3.14	Fishing prohibited except for seasonal run species by permit and trolling seaward of the reef margin
MP2	Forbidden Island Marine Sanctuary	Mariana Islands	2.53	Commercial and Recreational Fishing Prohibited
MP5	Laulau Bay Sea Cucumber Reserve	Mariana Islands	1.97	Sea Cucumber Harvest Prohibited
MP1	Bird Island Marine Sanctuary	Mariana Islands	1.47	Commercial and Recreational Fishing Prohibited
GU16	Haputo Ecological Reserve Area	Guam	1.24	Restrictions Unknown
MP4	Lighthouse Reef Trochus Reserve	Mariana Islands	1.11	Commercial and Recreational Fishing Restricted
MP7	Sasanhaya Fish Reserve	Mariana Islands	0.84	Commercial and Recreational Fishing Prohibited
MP14	Bird Island Sea Cucumber Reserve	Mariana Islands	0.80	Sea Cucumber Harvest Prohibited

Site ID	**Name**	**State**	**Marine Area (km^2)**	**Fishing Restrictions**
GU7	Orote Ecological Reserve Area	Guam	0.76	Restrictions Unknown
GU13	Tokai Maru	Guam	0.28	Commercial Fishing Restricted
GU14	Cormoran	Guam	0.28	Commercial Fishing Restricted
GU15	Aratama Maru	Guam	0.28	Commercial Fishing Restricted
MP11	Northern Marianas Islands Conservation Areas	Mariana Islands	-	Commercial and Recreational Fishing Prohibited
MP12	Bird Island Wildlife Conservation Area	Mariana Islands	-	Commercial and Recreational Fishing Prohibited
MP13	Kagman Wildlife Conservation Area	Mariana Islands	-	Commercial and Recreational Fishing Prohibited

2.7.3 Activities and Facilities

The following section includes activities or facilities associated with known uses and predicted future uses. The Plan Team will add to this section as new facilities are proposed and/or built.

2.7.3.1 Aquaculture facilities

There are no offshore aquaculture projects in Federal waters, proposed or existing, in Guam or CNMI.

2.7.3.2 Alternative energy facilities

There are no alternative energy facilities in Federal waters, proposed or existing in Guam or CNMI. There is some renewable energy development interest in the Northern Islands, which the Mayors may discuss in their meeting on Pagan (pers. comm., MPCCC meeting, March 30, 2016).

2.7.3.3 Military training and testing activities and impacts

The Department of Defense major planning activities in the region are summarized below. Maps of the Mariana Islands Range Complex from the Mariana Islands Training and Testing (MITT) FEIS are included in the maps section.

Action	Description	Phase	Impacts
Guam and CNMI Military Relocation SEIS	Relocate Marines to Guam and build a cantonment/family housing unit on Finegayan/AAFB, a live-fire individual training range complex at the Ritidian Unit of the Guam National Wildlife Refuge	ROD published August 29, 2015	• Surface danger zone established at Ritidian – access restricted during training. Access will be negotiated between DoN and USFWS • Northern District WWTP is non-compliant with NPDES permit; until plant is upgraded, increased wastewater discharge associated with buildup will significantly impact nearshore water quality. DOD to fund plant upgrades – see Economic Adjustment Committee Implementation Plan.
Mariana Islands Training and Testing	Continue Navy testing and training activities; include use of active sonar and explosives within the Mariana	ROD Published August 4, 2015	• Surface danger zones established – access restricted during training and testing • Explosives and

Action	Description	Phase	Impacts
	Islands Range Complex; pier-side sonar maintenance and testing in Apra Harbor		anchoring may damage shallow reef systems or hard bottom habitat.
CNMI Joint Military Training	Establish unit and combined level training ranges on Tinian and Pagan	Supplemental Draft EIS expected in March 2017	Significant access and habitat impacts
Divert Activities and Exercises, Air Force, Marianas	Improve airports in CNMI for expanding mission requirements in Western Pacific	Final EIS In Prep	Land-based construction impacts will be mitigated in stormwater management plan (standard); access near fuel transfer
Garapan Anchorage *June 2015 CNMI AP Meeting Report*	Military Pre-Positioned Ships anchor and transit	Expired Memorandum of Understanding with the CNMI government. After transfer of submerged lands to CNMI, CNMI may be able to charge anchorage fees to the DOD. As of June 2015, MOU had not been signed.	Access, invasive species, unmitigated damage to reefs

2.7.4 Incidents Contributing to Cumulative Impact

The Coast Guard and NOAA Office of Response and Restoration respond to marine pollution events related to vessels. The following table of incidents since 201 is from selected oil spills off US coastal waters and other incidents where NOAA's Office of Response and Restoration (OR&R) provided scientific support for the spill response (NOAA OR&R). These incidents are included in the overview maps of the map section.

2.7.4.1 Interpretation

There is a grounded longline vessel in the lagoon on Saipan from Soudelor. It has not become an incident yet because the vessel owners filed for bankruptcy; it is unknown how the vessel will be removed (pers. comm., MPCCC, March 30, 2016.)

Table 67. NOAA ORR Incident Response since 2011

Name	**Location**	**Date**	**Commodity**	**Cause**	**Other Cause/Notes**
Barge YON268	Apra Harbor, Guam	2/12/2013	Heavy (waste) oil	Other / Unknown	Derelict vessel
Mystery Sheen	Sasa Bay, Apra Harbor, Guam	5/15/2015	diesel	Sunken Vessel	
F/V DAIKI MARU 7 grounding	Apra Harbor, Guam	2/13/2014	Diesel	Grounding	
Piti Power Plant generator fire	Piti, Guam	8/31/2015	#6 Fuel Oil	Fire / Explosion	
Sunken NPS work boat	Adelup, Guam	7/29/2012		Capsized Vessel	
F/V IL SIN HO	Tinian Island, CNMI	9/13/2013	Diesel	Grounding	
M/V PAUL RUSS	Tanapag Harbor, Saipan	9/8/2014	IFO 380	Grounding	
NOAA SHIP HI'IALAKAI	Maug Islands, CNMI	5/2/2014	Gasoline	Leaking Tank	

2.7.5 Pacific Islands Regional Planning Body Report

The Pacific Islands Regional Planning Body (PI RPB) will meet on March 30-31, 2016, to discuss a number of items. The PI RPB will be brought up to date on the planning activities in American Samoa and then will discuss how much participation the PI RPB would like to have in the development of the American Samoa Ocean Plan, given cross membership. The PI RPB will discuss its operations in the bigger context of efforts associated with climate change, planning efforts, and GIS efforts, as well as discuss a capacity assessment to inform the needs of the PI RPB. PI RPB members will then discuss their data and tools needs, as well as their stakeholder engagement progress.

The American Samoa Ocean Planning Team is meeting on March 28, 29, and April 1, 2016, to finalize their vision for the ocean in American Samoa and develop draft goals and objectives for their ocean plan.

2.7.6 References

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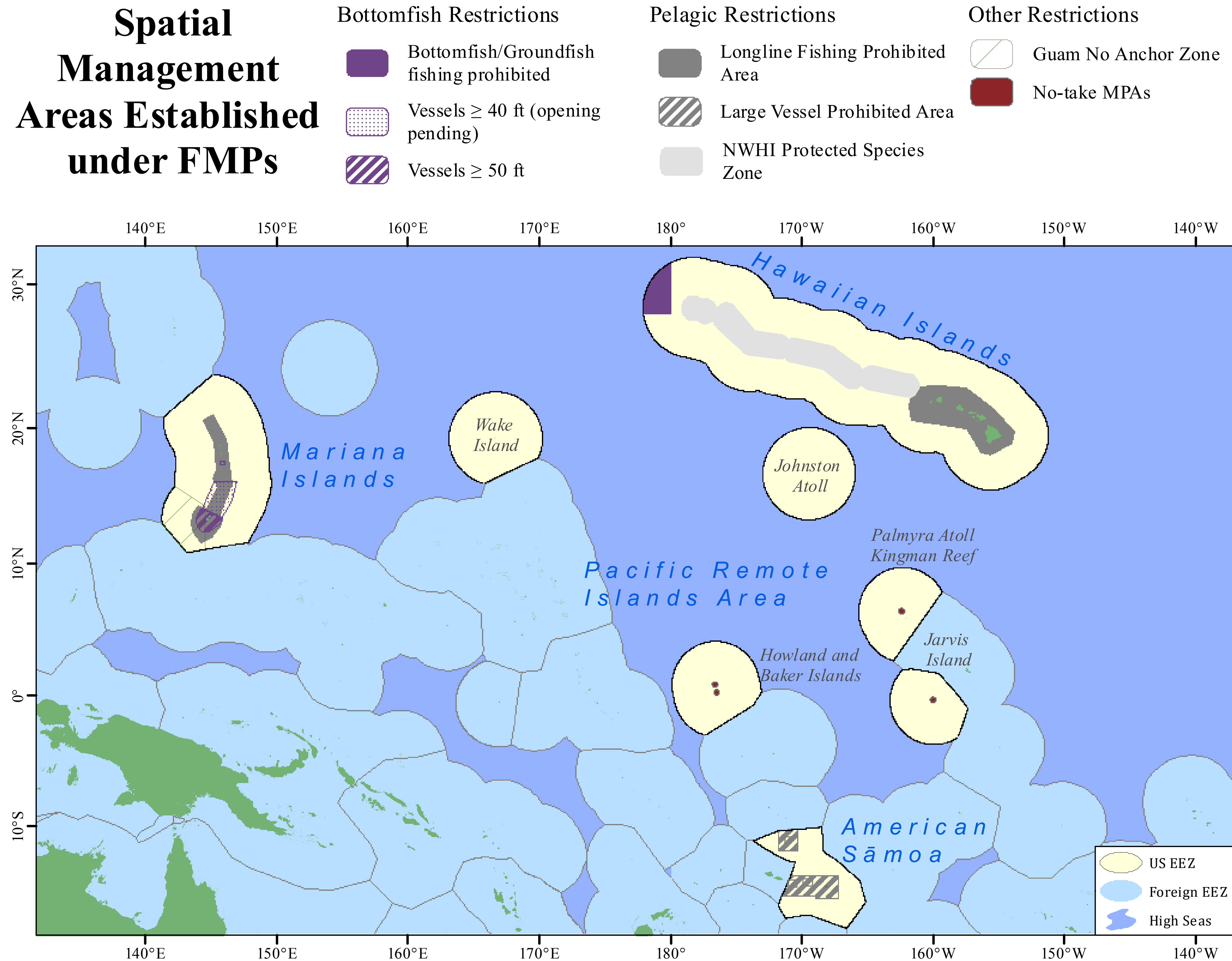
2.7.7 Maps

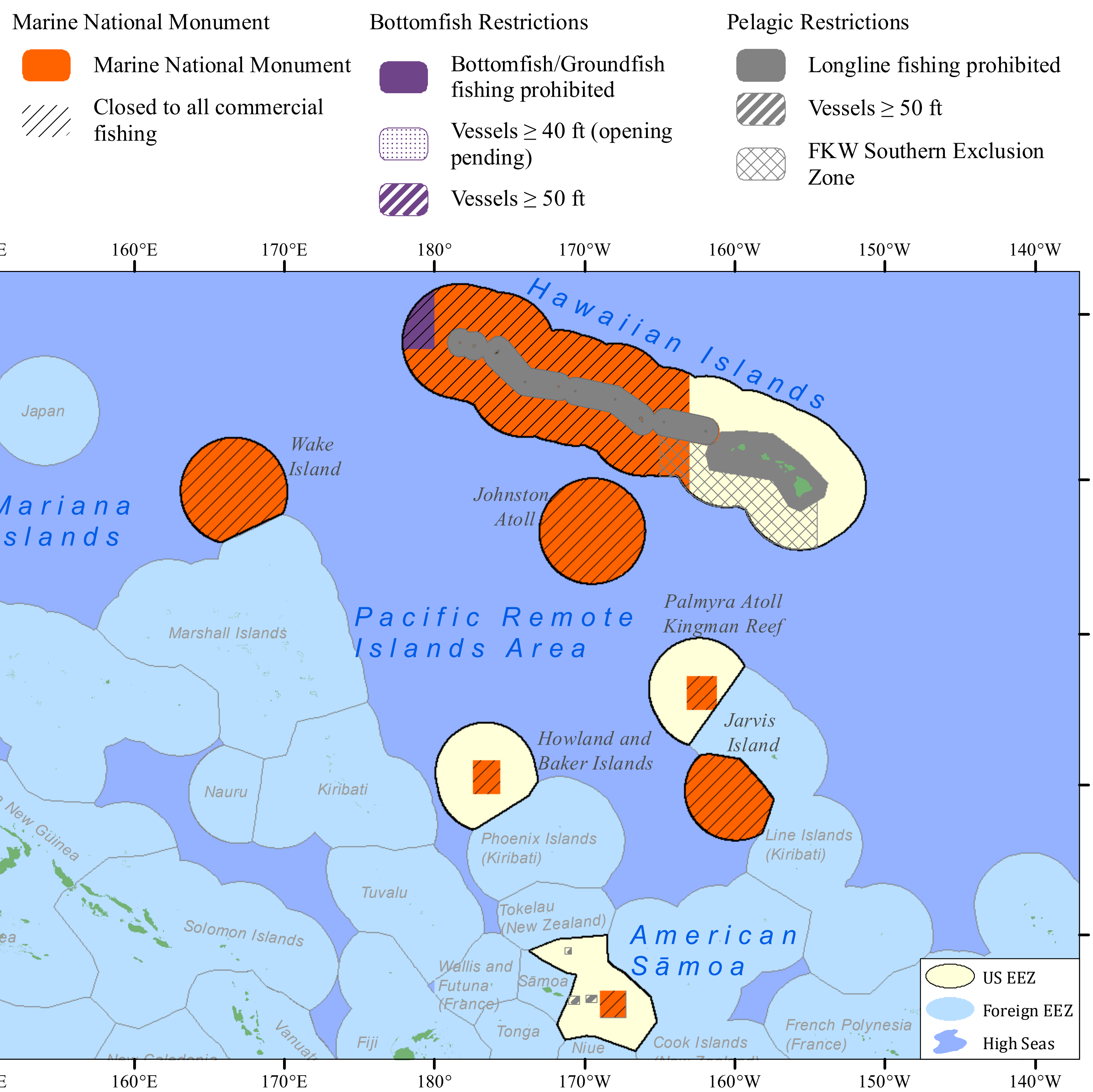
1. Spatial Management Areas Established under FMPs

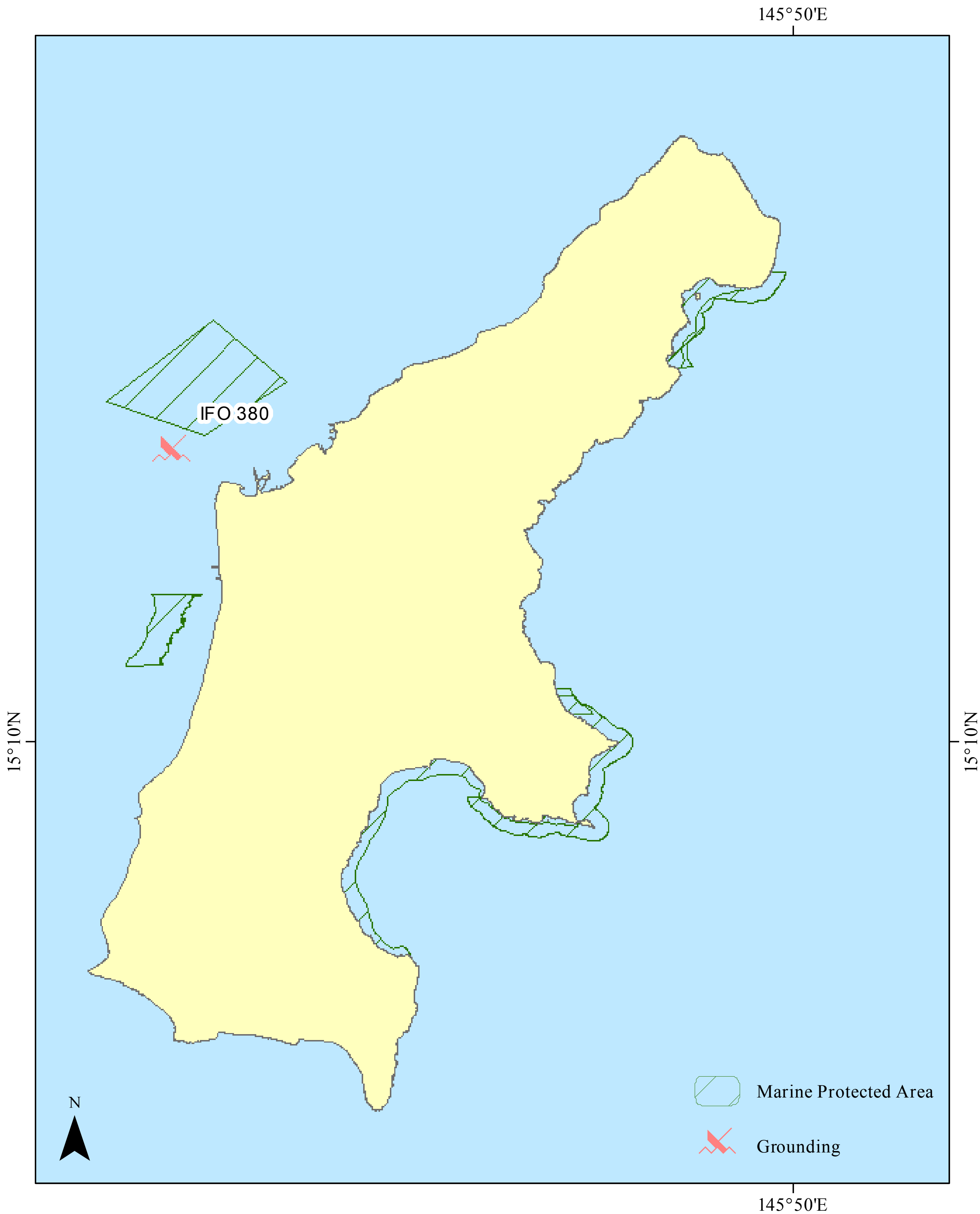
2. Large, Regulated Commercial Fishing Areas of the Western Pacific Region
3. Saipan, CNMI Overview Map
4. Tinian, CNMI Overview Map
5. Rota, CNMI Overview Map
6. Guam Overview Map
7. Mariana Islands Testing and Training Study Area (from MITT FEIS, Chapter 2)
8. Mariana Islands Range Complex Airspace (from MITT FEIS, Chapter 2)
9. Warning Area 517 (from MITT FEIS, Chapter 2)
10. Farallon de Medinilla Restricted Area 7201, 7201A, and Danger Zone (from MITT FEIS, Chapter 2)
11. Apra Harbor Naval Complex (Main base) and Main Base/Polaris Point (from MITT FEIS, Chapter 2)
12. Naval Base Guam Munitions Site (from MITT FEIS, Chapter 2)
13. Naval Base Guam Telecommunications Site (Finegayan) (from MITT FEIS, Chapter 2)
14. Naval Base Guam Barrigada (from MITT FEIS, Chapter 2)
15. Anderson Air Force Base (from MITT FEIS, Chapter 2)
16. Farallon de Medinilla (from MITT FEIS, Chapter 2)
17. Tinian and Saipan (from MITT FEIS, Chapter 2)
18. Rota (from MITT FEIS, Chapter 2)

Spatial Management Areas Established under FMPs



Large, Regulated Commercial Fishing Areas of the US EEZ, Western Pacific Region

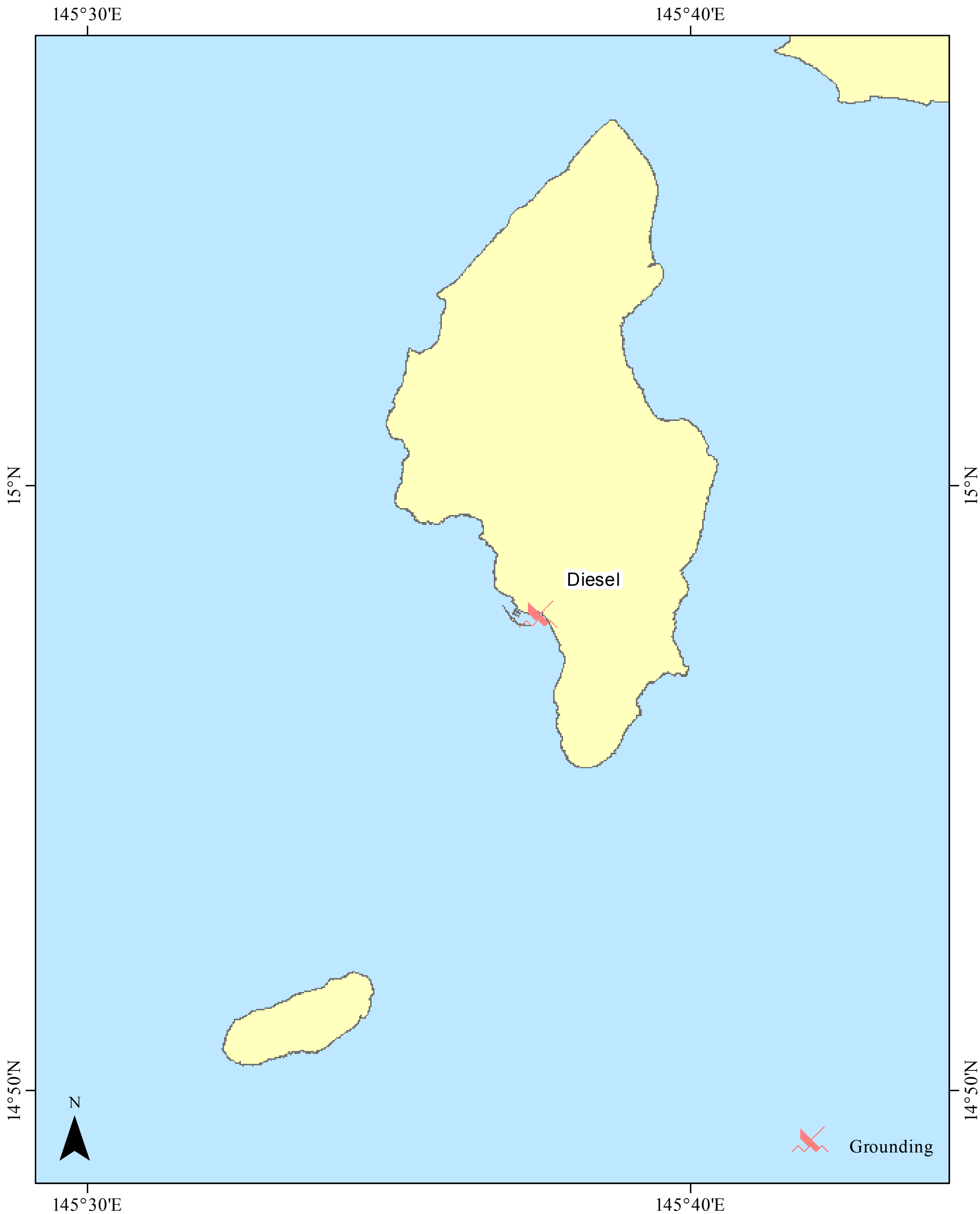




Marine Planning Annual Report

Overview Map

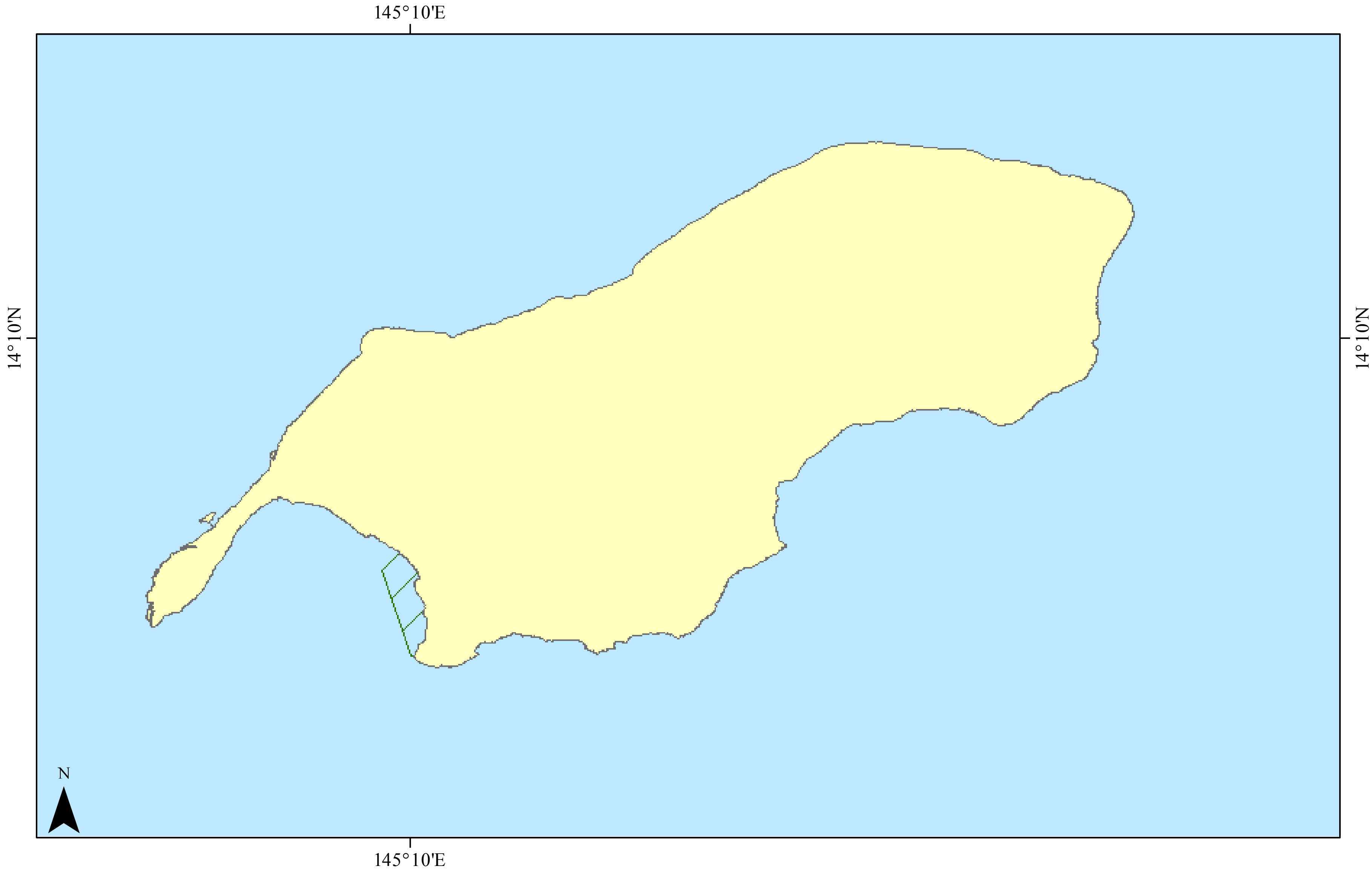
Saipan, CNMI



Marine Planning Annual Report

Overview Map

Tinian, CNMI

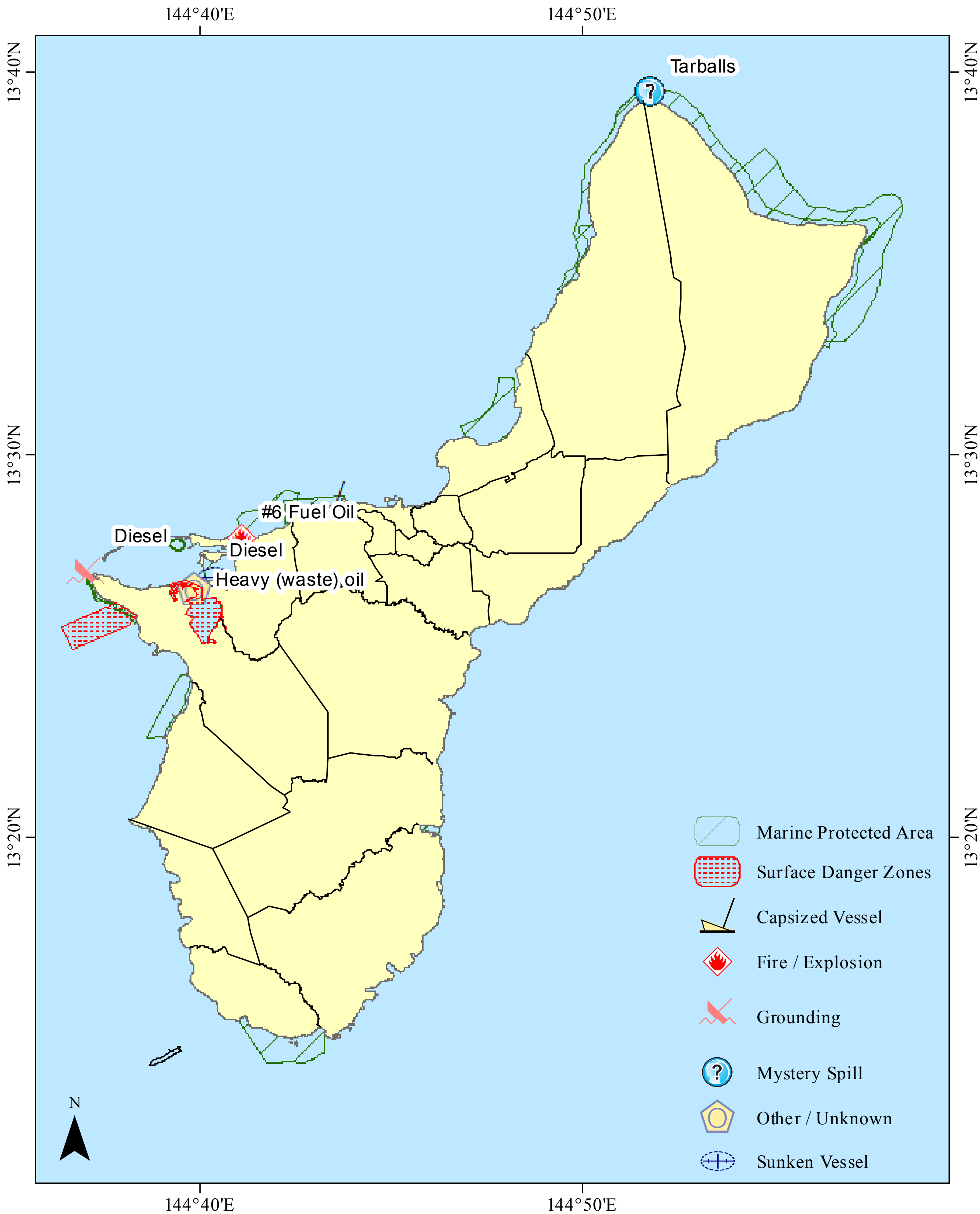


Marine Planning Annual Report

Overview Map

Rota, CNMI

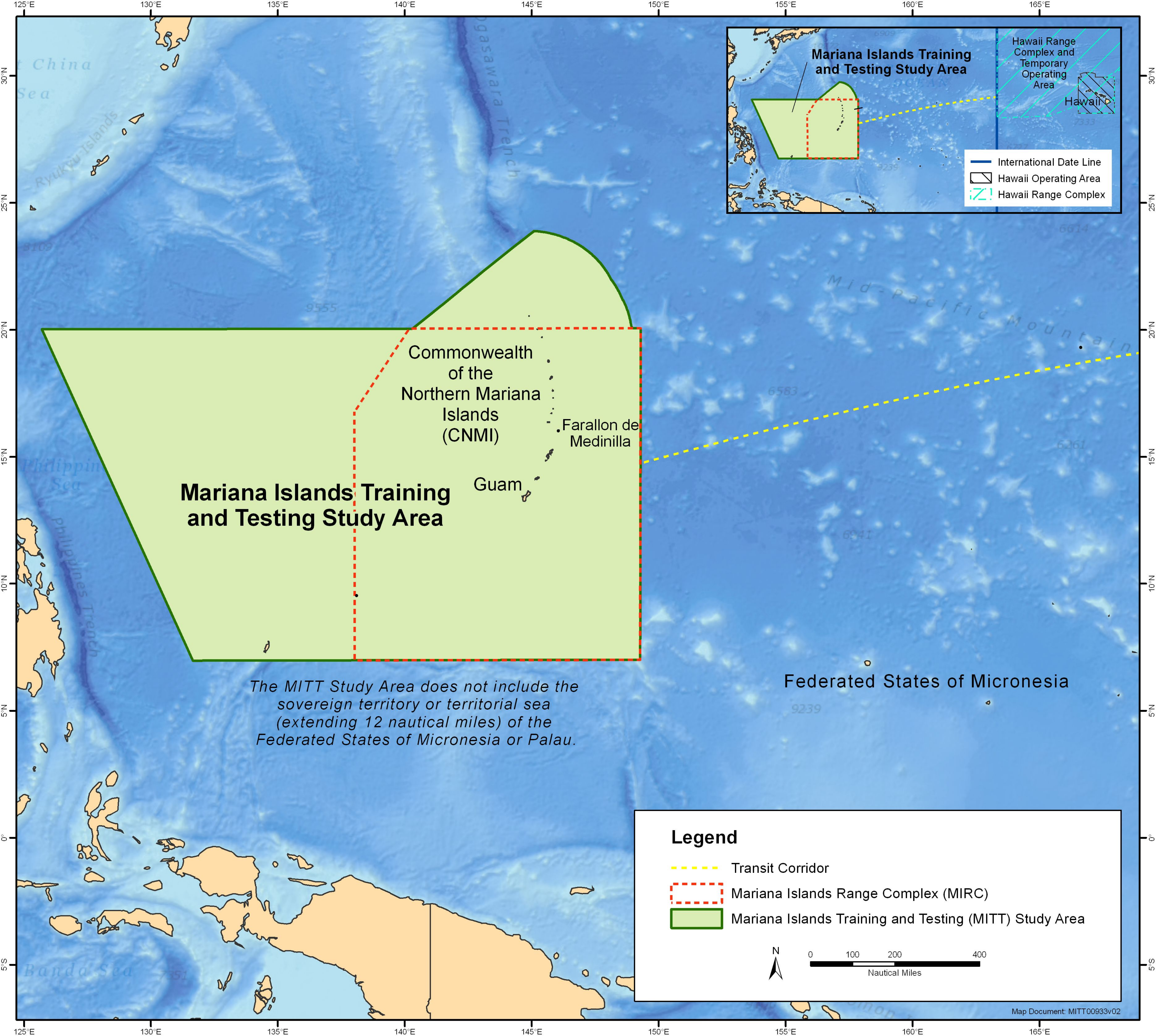
Marine Protected Area



Marine Planning Annual Report

Overview Map

Guam



Mariana Islands Training and Testing Study Area
Commonwealth of the Northern Mariana Islands (CNMI)
Farallon de Medinilla
Guam
Federated States of Micronesia
The MITT Study Area does not include the sovereign territory or territorial sea (extending 12 nautical miles) of the Federated States of Micronesia or Palau.
Philippine Sea
Philippines Trench
Ryukyu Islands
Ogasawara Trench
Mid-Pacific Mountains
Banda Sea
Hawaii Range Complex and Temporary Operating Area
Hawaii
International Date Line
Hawaii Operating Area
Hawaii Range Complex
Legend
Transit Corridor
Mariana Islands Range Complex (MIRC)
Mariana Islands Training and Testing (MITT) Study Area
N
0 100 200 400
Nautical Miles
Map Document: MITT00933v02

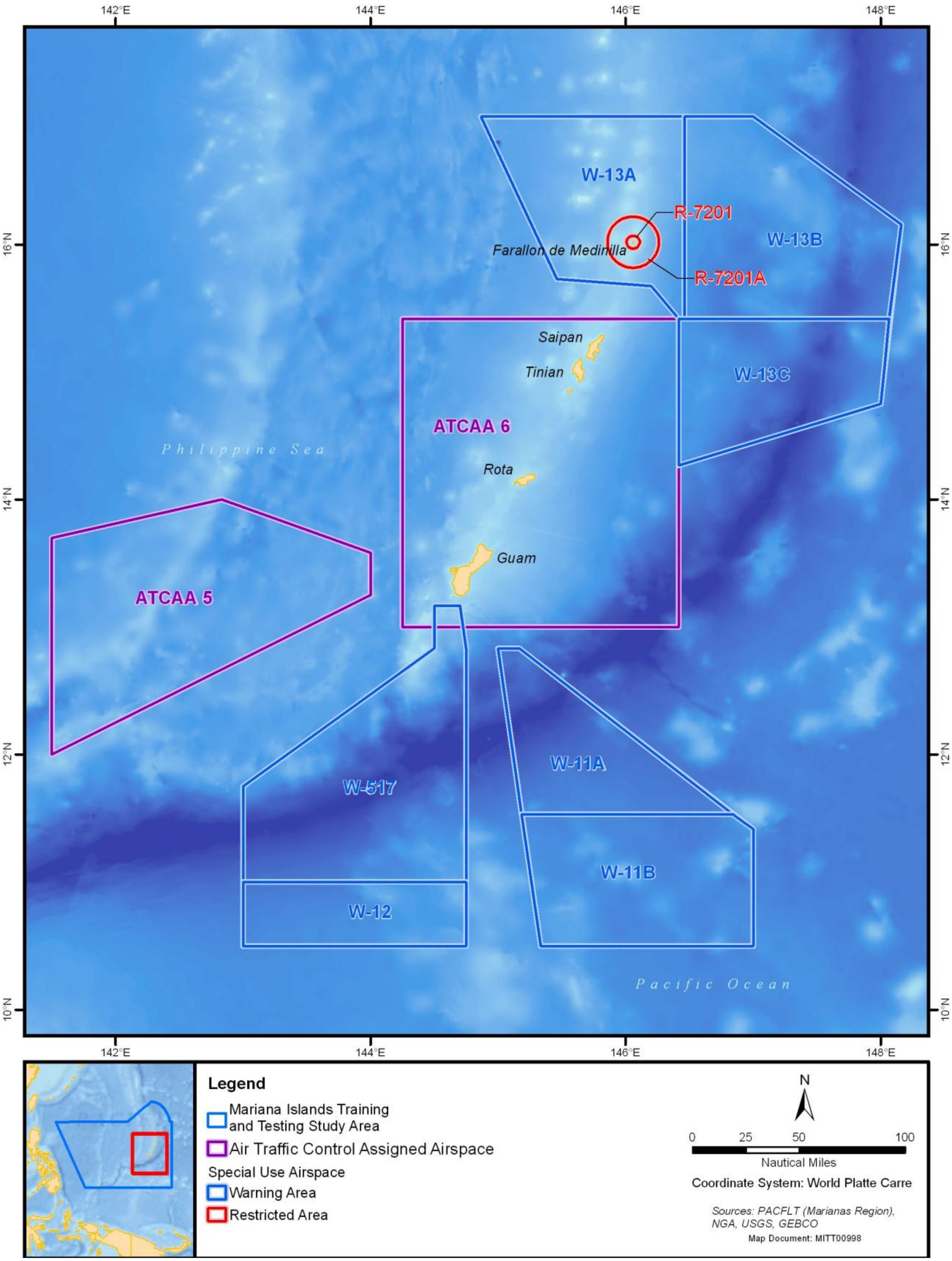


Figure 2.1-2: Mariana Islands Range Complex Airspace

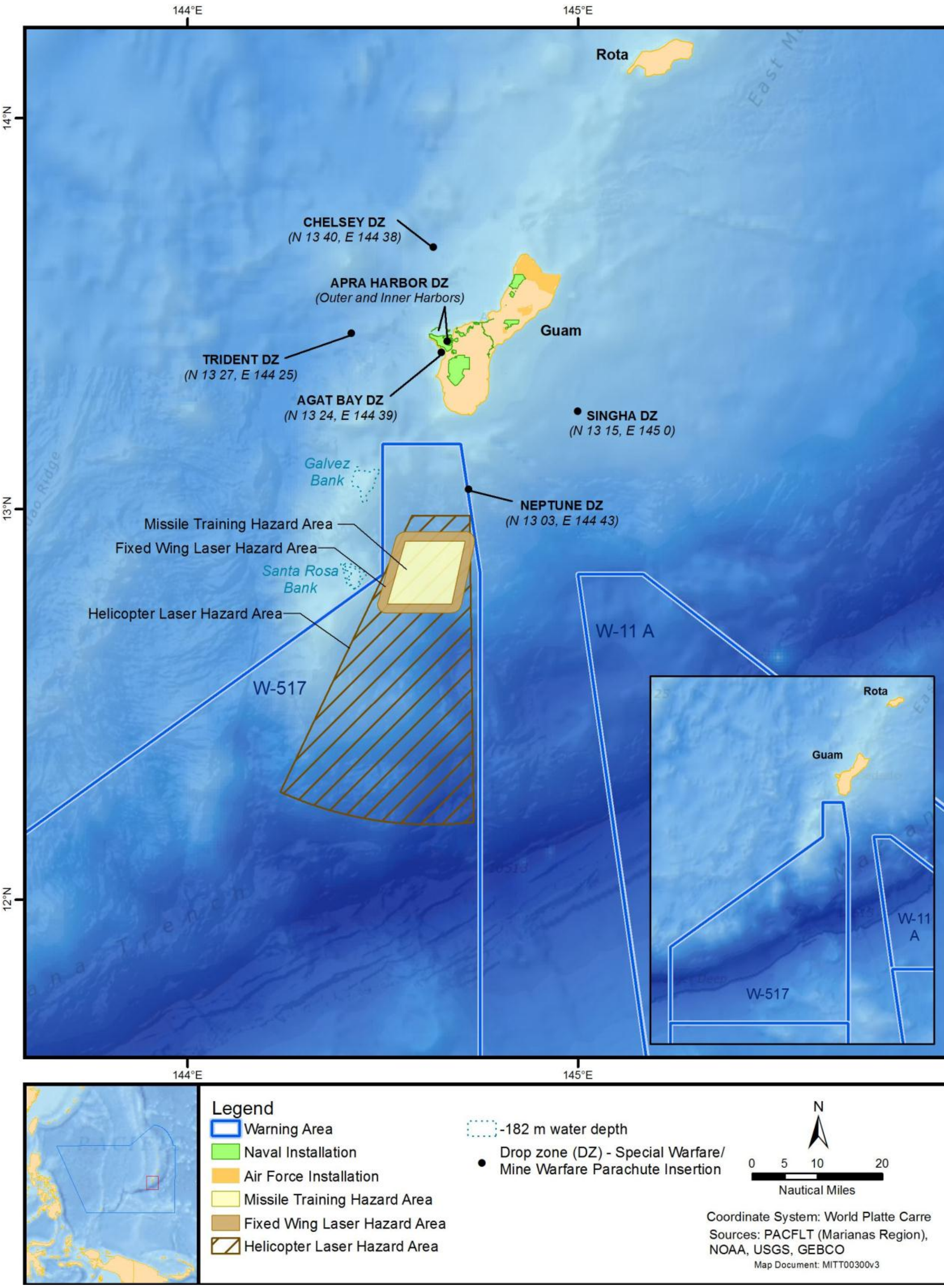


Figure 2.1-3: Warning Area 517

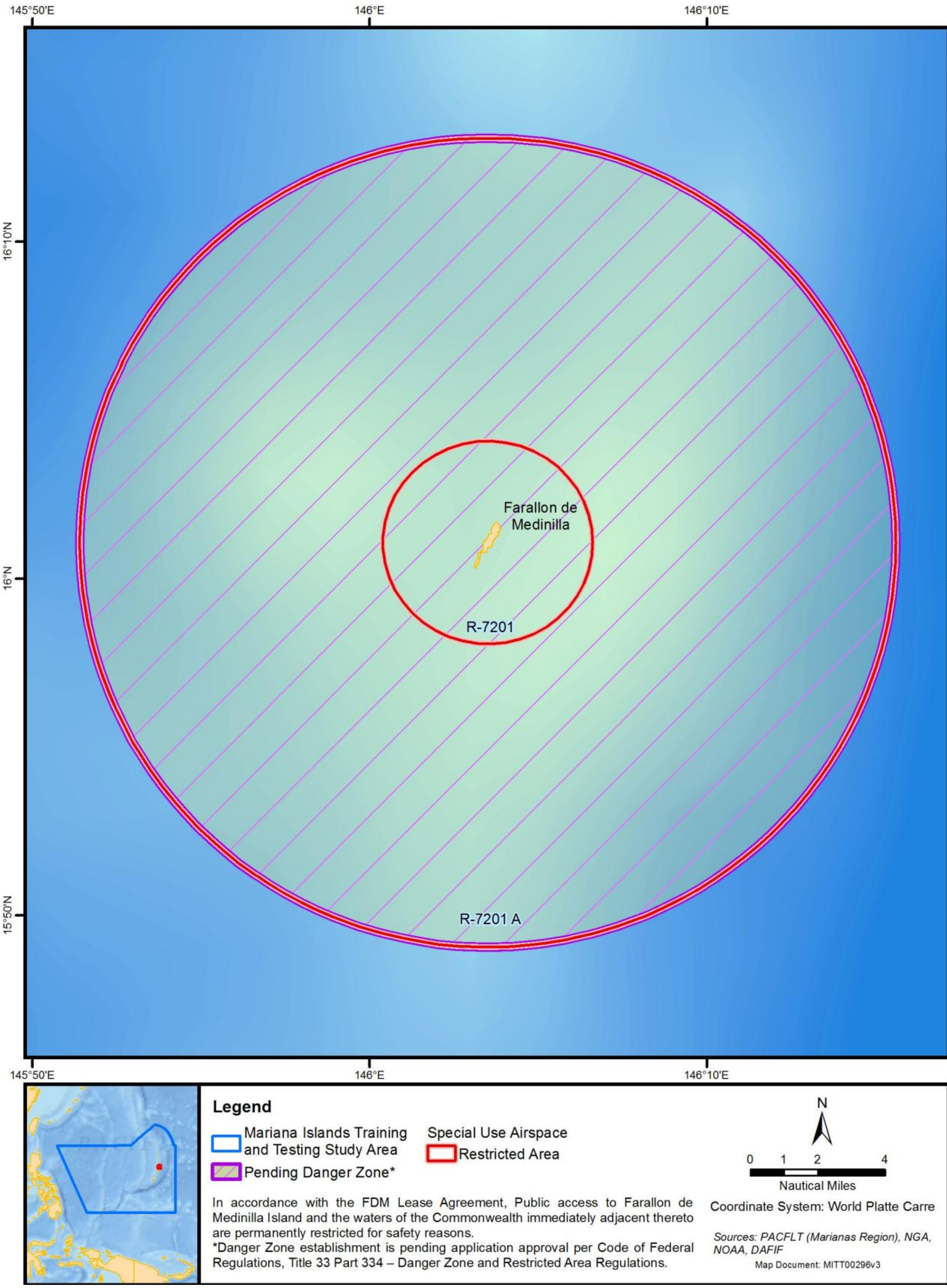


Figure 2.1-4: Farallon de Medinilla Restricted Area 7201, 7201A, and Danger Zone

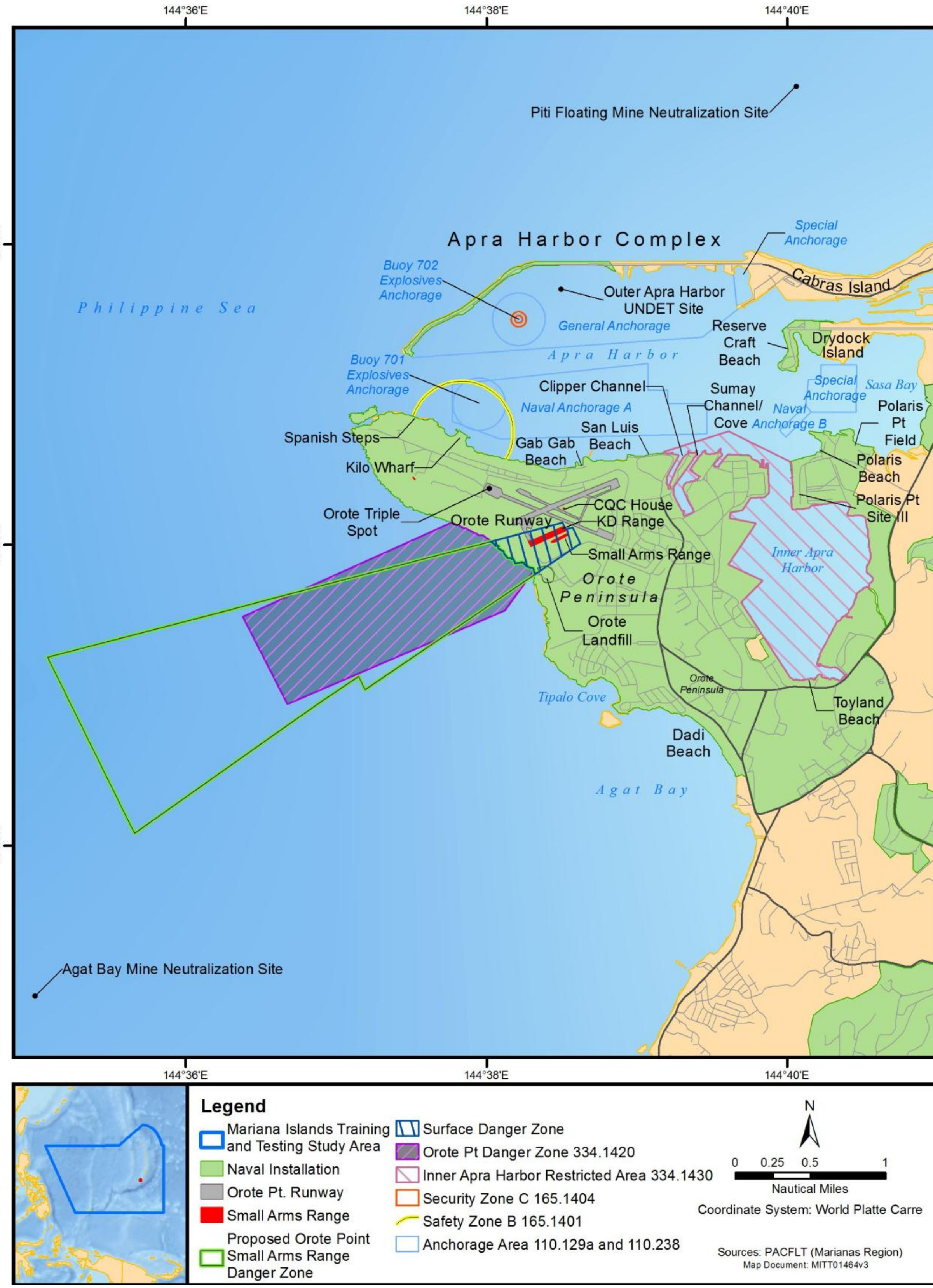


Figure 2.1-5: Apra Harbor Naval Complex (Main Base) and Main Base/Polaris Point

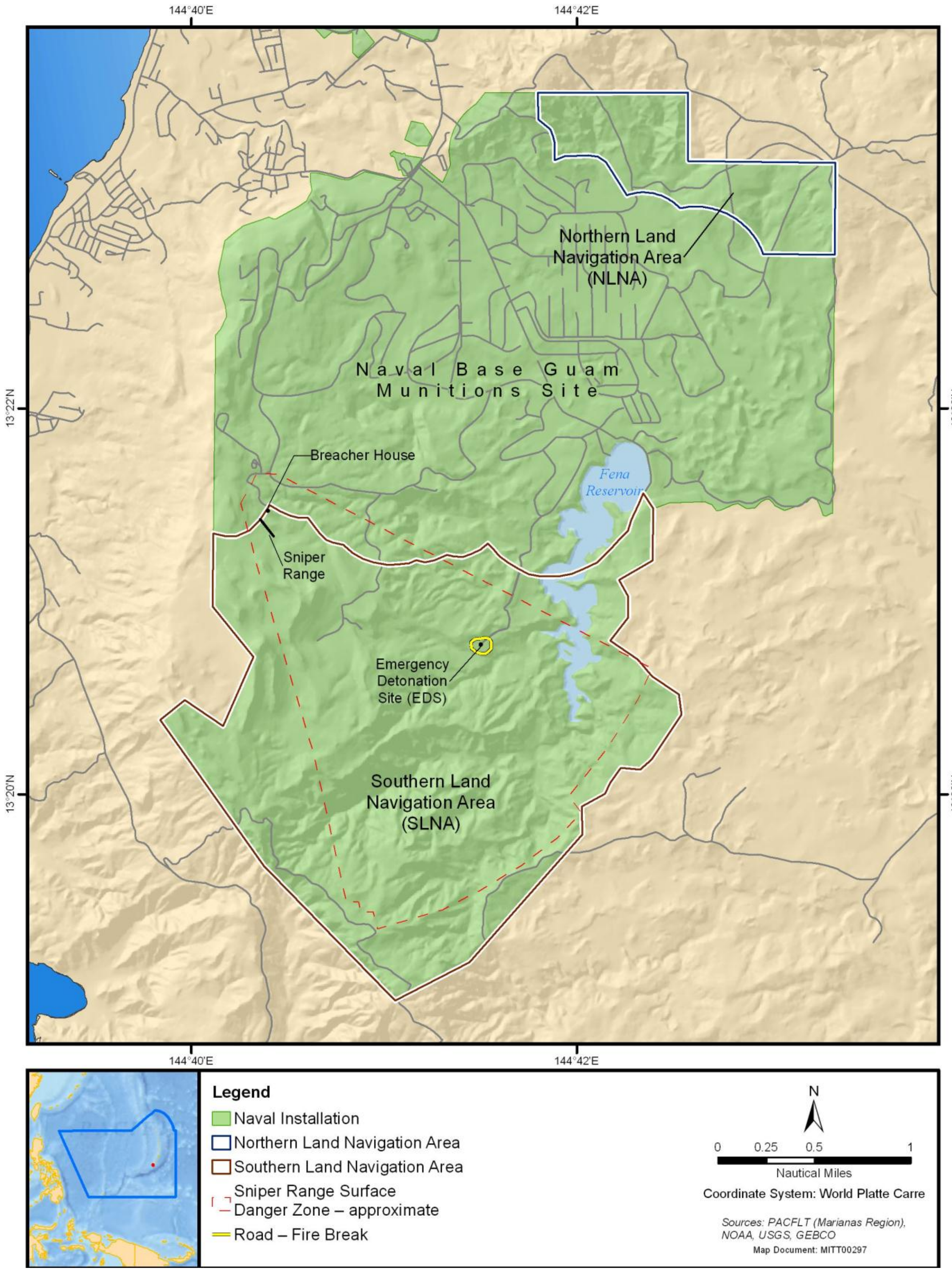


Figure 2.1-6: Naval Base Guam Munitions Site

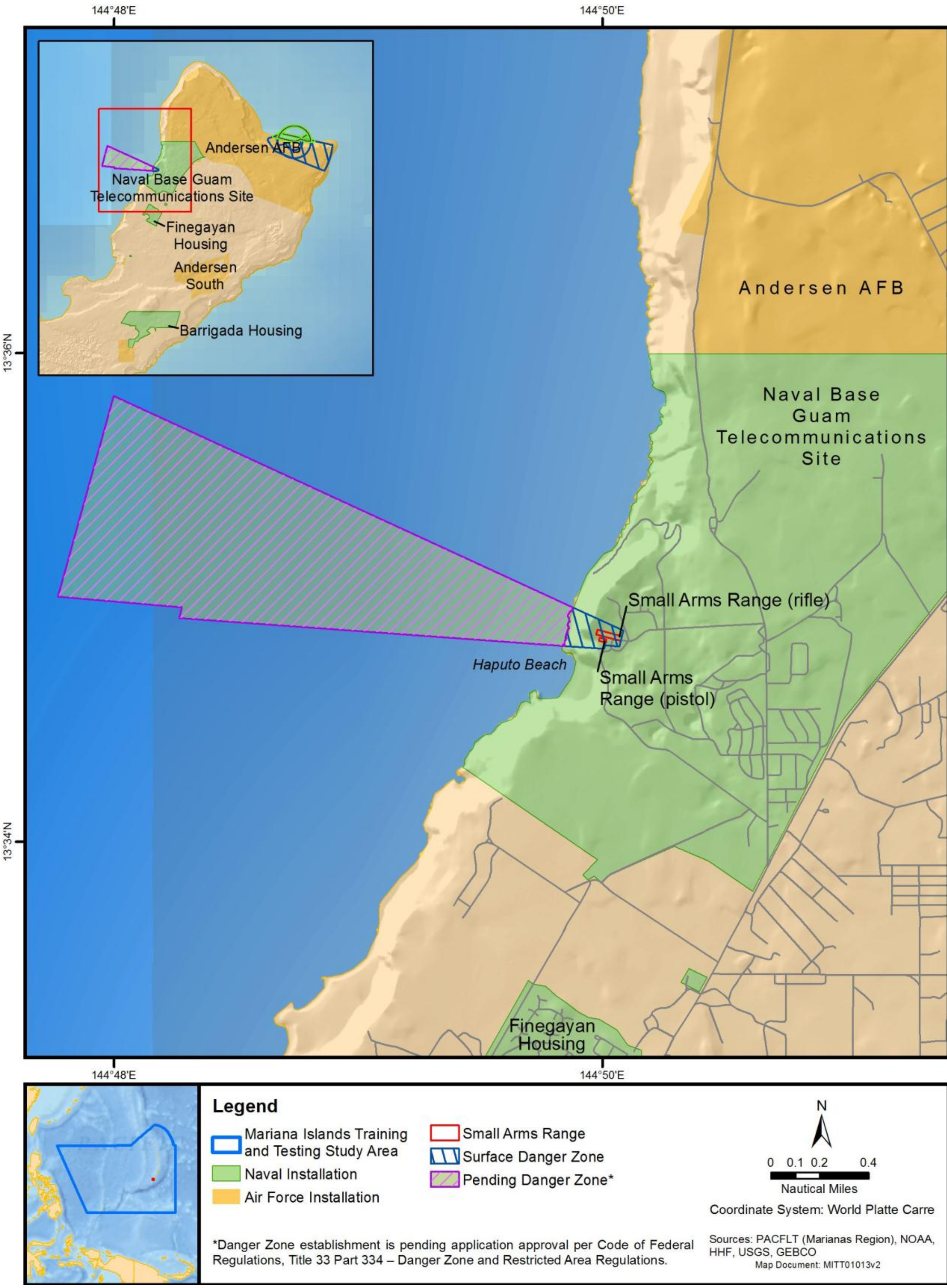


Figure 2.1-7: Naval Base Guam Telecommunications Site (Finegayan)

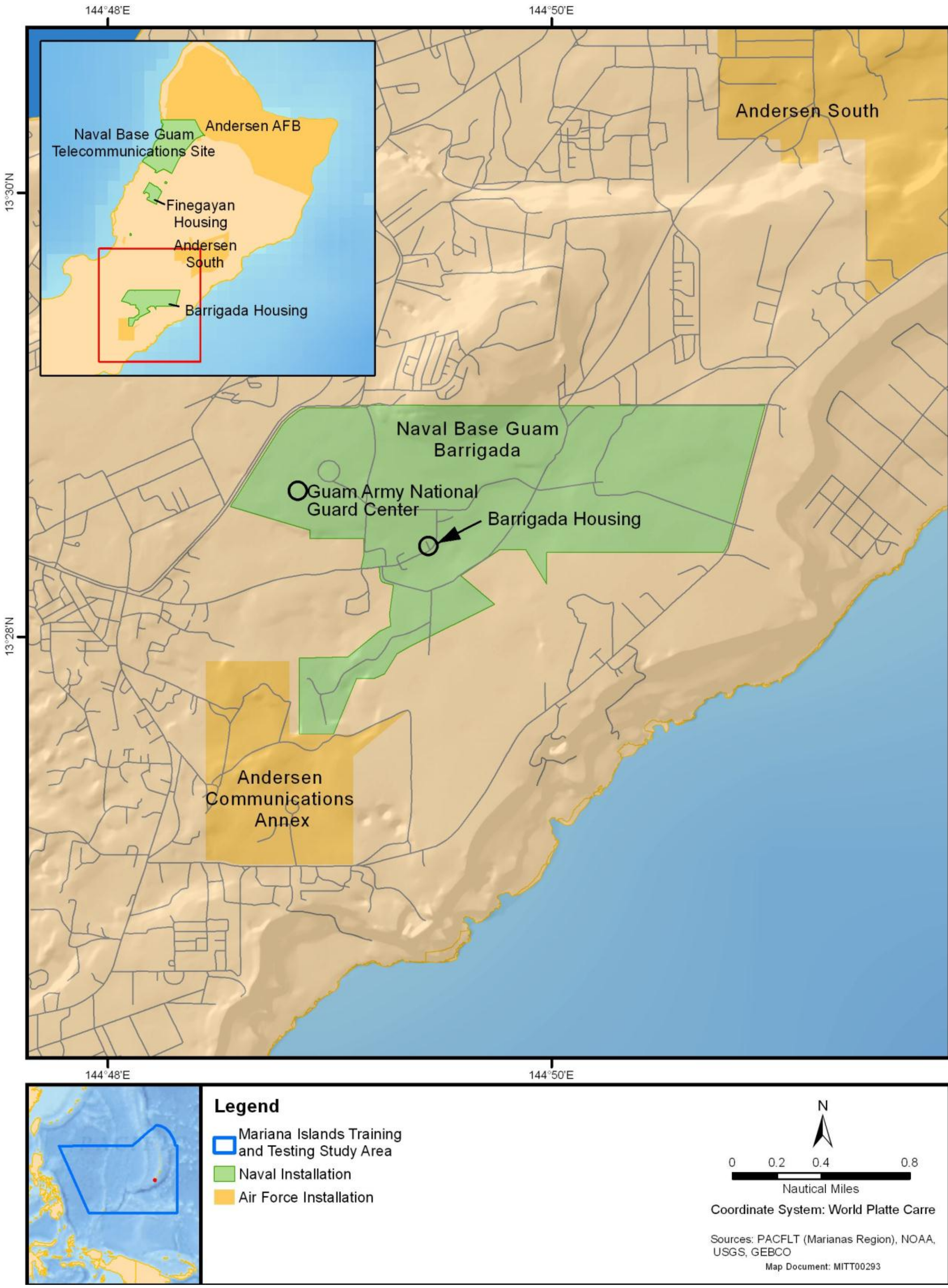


Figure 2.1-8: Naval Base Guam Barrigada

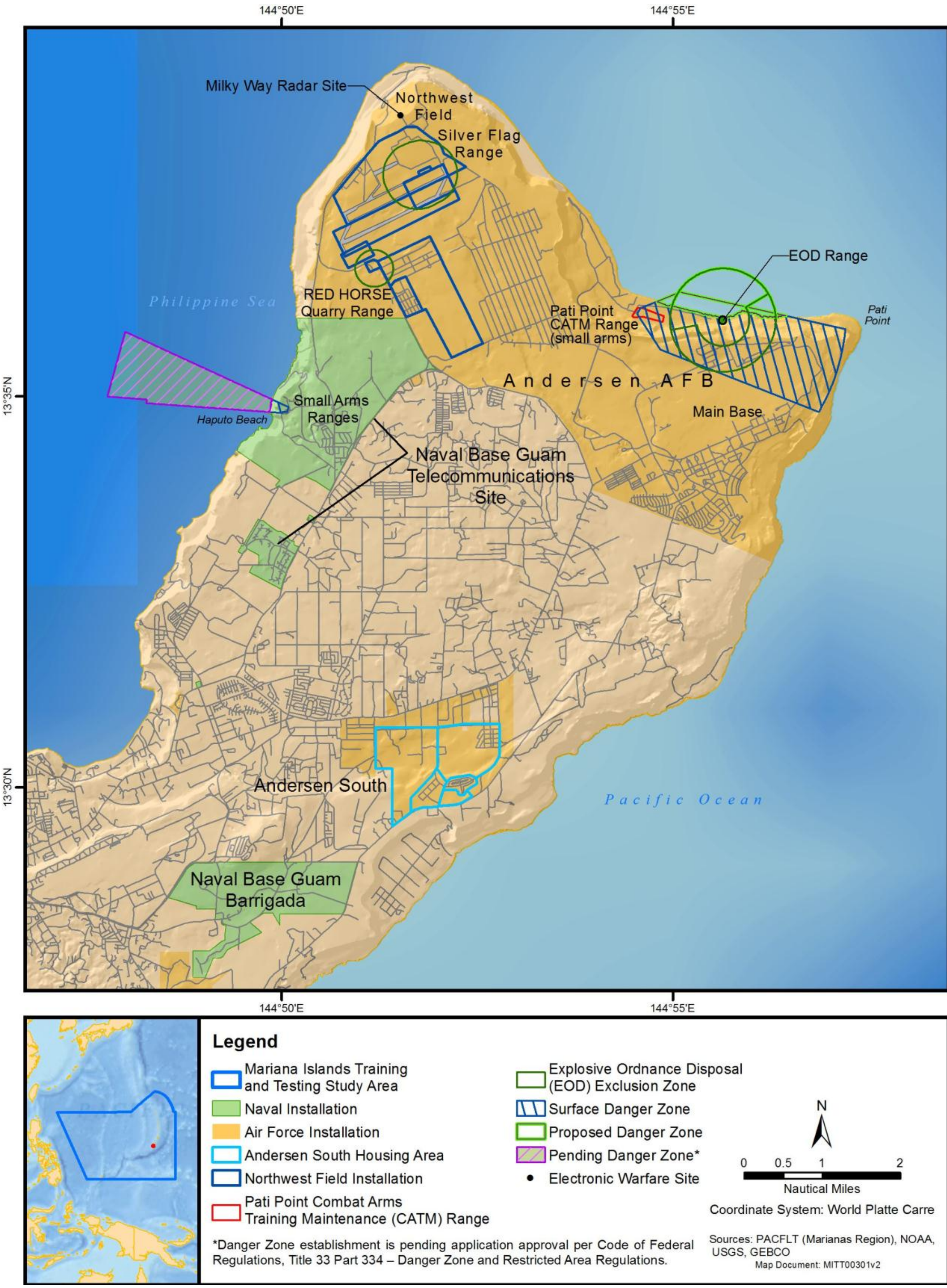


Figure 2.1-9: Andersen Air Force Base

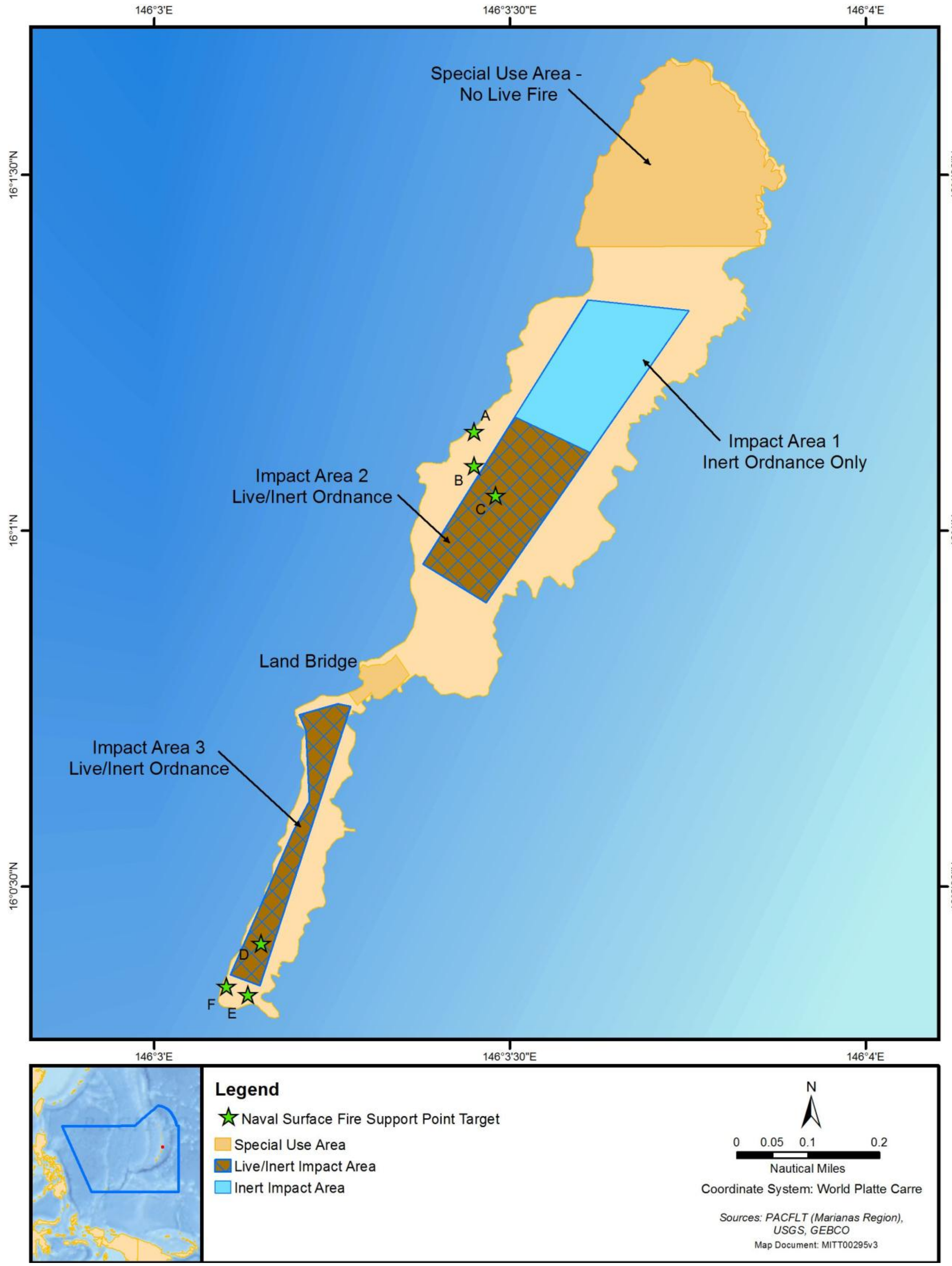


Figure 2.1-10: Farallon de Medinilla

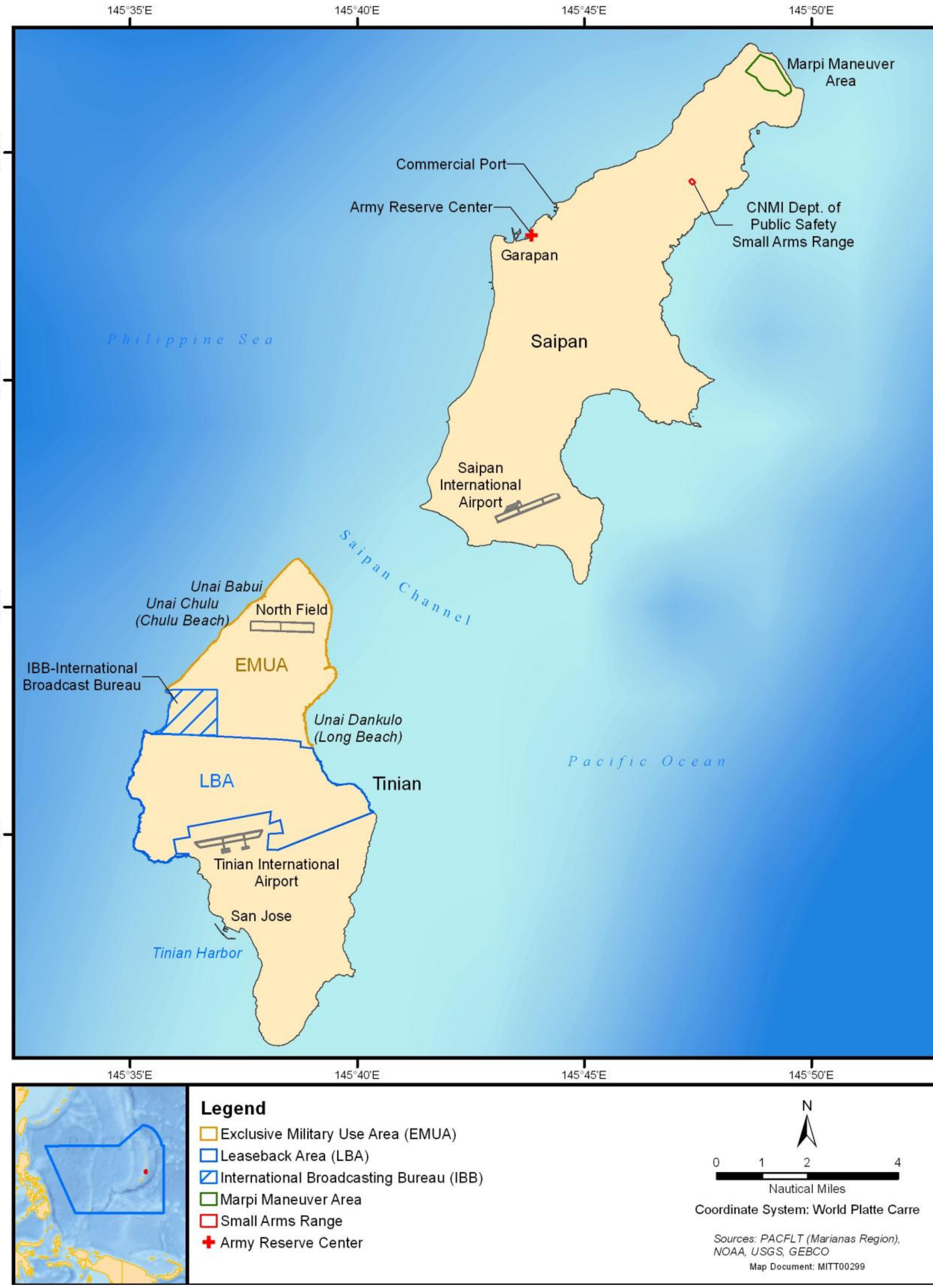


Figure 2.1-11: Tinian and Saipan

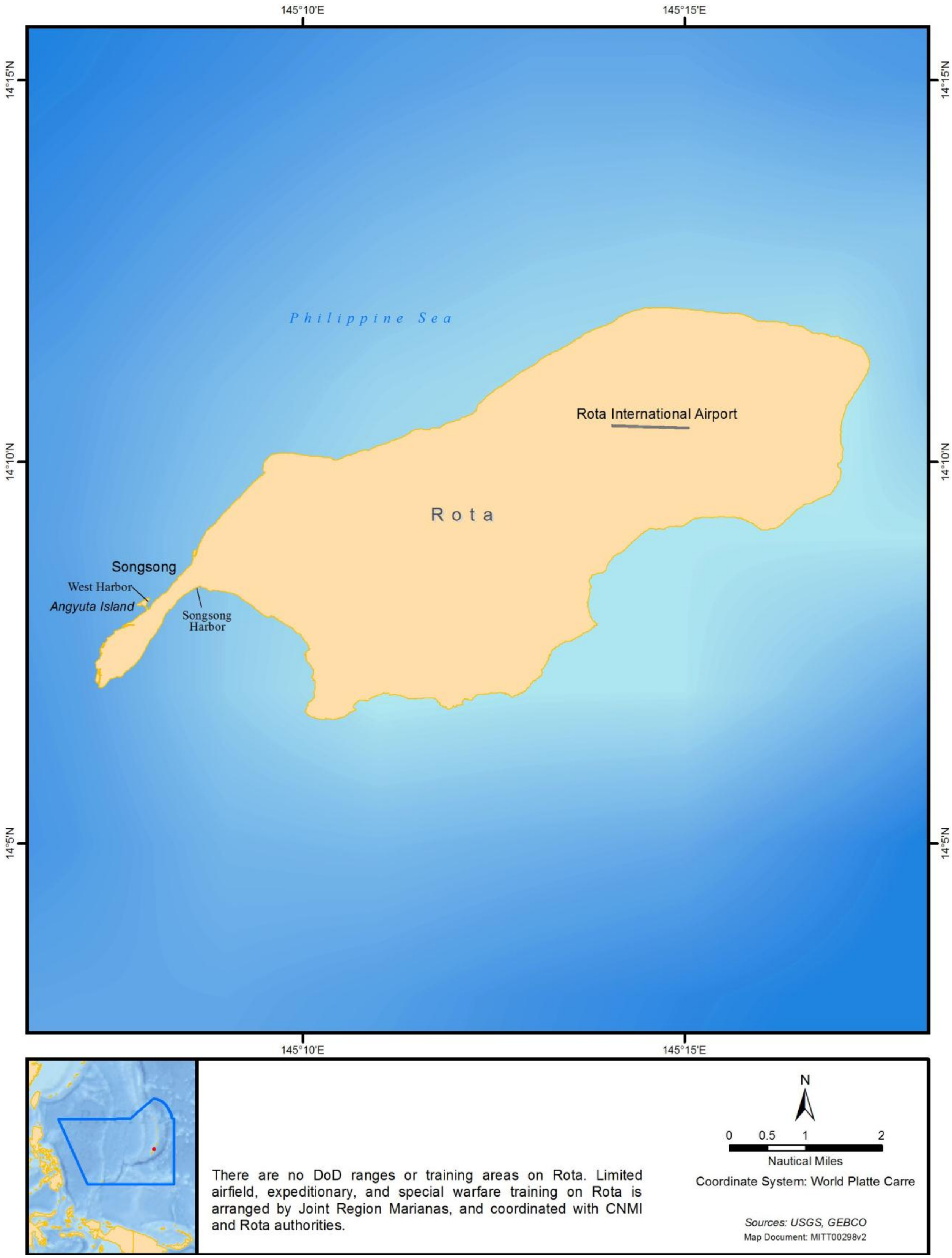


Figure 2.1-12: Rota

3 DATA INTEGRATION

This report will include a data integration chapter in subsequent years, as resources allow.

Attachment 1: Report to the Plan Team

Process Options for Designation of Habitat Areas of Particular Concern
April 11, 2016
Ala Moana Hotel

Background

In 2014 and 2015, the Western Pacific Regional Fishery Management Council (Council) underwent a five year review of its Fishery Ecosystem Plans (FEPs) and management process. Through this process, the Council, its staff, and stakeholders identified areas for change and update of its plans. Essential Fish Habitat (EFH) was an area identified for update and review. The EFH Final Rule[1] strongly encourages Councils to review the EFH information included in fishery management plans on a five year cycle[2]. This report considers the last component of EFH information identified in the EFH Final Rule: the EFH update and review procedure.

The Council recommended that new EFH 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[3]. Habitat Areas of Particular Concern (HAPC) are a subset of the EFH designations. The FEPs do not provide explicit direction in how the Council will designate HAPCs.

According to the EFH Final Rule, Councils may designate HAPCs based on one of the four following considerations:

(i) The importance of the **ecological function** provided by the habitat.
(ii) The extent to which the habitat is **sensitive** to human-induced environmental degradation.
(iii) Whether, and to what extent, development activities are, or will be, **stressing** the habitat type.
(iv) The **rarity** of the habitat type.[4]

While an HAPC designation process is not required, it may focus review efforts and increase consistency, transparency, and defensibility in the implementation of the EFH provisions of the Magnuson-Stevens Act in the Western Pacific Region. The 2015 Plan Team took up the question of how the Council should designate HAPC. They were presented with the following four process options:

1. Continue to address HAPC on a case-by-case basis as issues arise.
2. Consider clarifying the Coral Reef HAPC language only, which suggests designation of previously existing MPAs as HAPC.

[1] 67 FR 2376, Jan. 17, 2002
[2] 50 CFR §600.815(a)(10)
[3] Please see Chapter 6 of any FEP developed by the Western Pacific Fishery Management Council.
[4] 50 C.F.R. 600.815(a)(7)

3. Modify and adopt the process used in the Hawaiian Archipelago bottomfish EFH review.
4. Create a new process through which HAPC candidates areas can be identified and filtered.

The Plan Team formed a working group to explore the options for this process, which was performed through two webinars facilitated by Council staff. The members of the working group were Samuel Kahng (Hawai`i), Brent Tibbats (Guam), Mike Tenorio (CNMI), Mareike Sudek/Domingo Ochavillo (American Samoa), with support from Danielle Jayewardene, Mathew Dunlap, and Michael Parke (NMFS). The findings are reported below.

Working Group Sessions
On the first call on September 2, 2015, working group participants heard a background on the Western Pacific's EFH and HAPC designations, and reviewed the HAPC designation processes used by other Councils. Participants reviewed the options presented to the 2015 Plan Team, discussed if any options should be added, and selected options to address in further detail on the next call. The following three options were chosen for further development:

- No Action, i.e. address HAPC on a case-by-case basis
- Adopting the Hawaiian Archipelago bottomfish EFH review model
- Creating a New Process

The second option, modifying the coral reef language, was rejected from further development. Language in the FEPs is not prescriptive of how coral reef HAPCs will be designated in the future, and therefore does not speak to the HAPC designation process. Concerns were expressed that designating HAPCs based on existing protective status can create overly broad HAPC designations and does not necessarily effectively meet the intent of HAPC designation as per the EFH final rule. Additionally, the Council at its 163rd meeting directed staff to further explore and provide the Council with details in improving the ACL specification process through an omnibus amendment of the Fishery Ecosystem Plans to include, among other item, reclassification of appropriate management unit species into ecosystem components. As EFH does not need to be designated for species listed as ecosystem components, it would be most effective to address coral reef EFH once the ecosystem component species amendment is further developed.

Participants on the first call identified that a successful HAPC designation process would:

- be realistically implementable;
- effectively use the expertise in the region;
- be compatible with jurisdictional management;
- encourage the development of usable HAPC candidate area proposals; and
- occur within a reasonable amount of time.

Based on the first call, Council staff split the HAPC designation process into five separate components: the HAPC designation proposal development phase, the HAPC designation proposal review phase, development of a policy on weighting of HAPC considerations, standardizing the interpretation of the HAPC considerations, and timing for the HAPC designation process (Figure 4). A new process would involve some or all of these components; the bottomfish model for example included all components.

During a second call on November 23, 2015 , participants discussed the pros and cons of options for each of five components to evaluate each HAPC designation process.

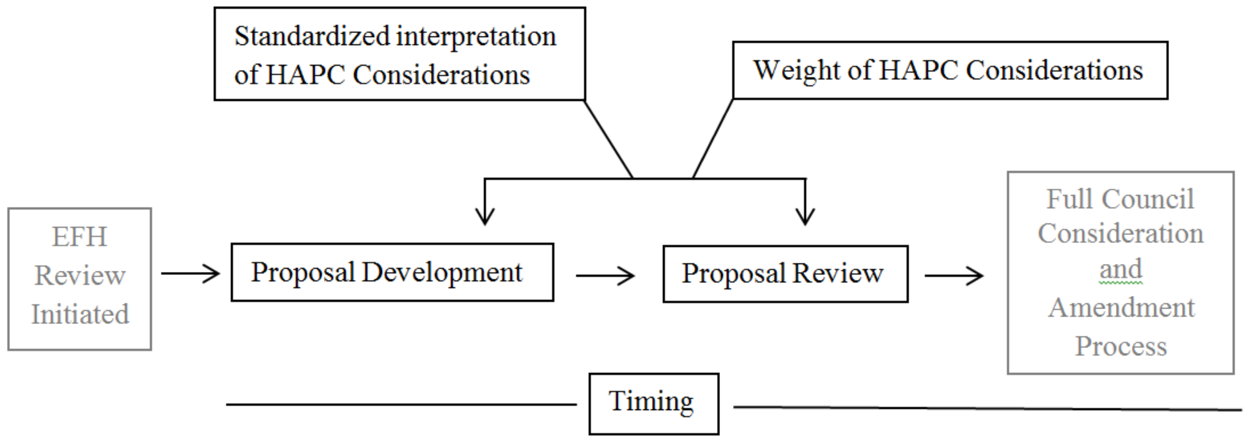


Figure 1. HAPC process components evaluated by the working group. The Council process is included for context.

Evaluation of HAPC Process Components

1. *Proposal Development Options*

During the proposal development phase**,** the participants agreed that it is key to identify a party who has the responsibility, dedication, expertise, and manpower to accomplish the task of submitting HAPC proposals. An option would be to develop and award service contracts, including for a graduate student, to develop proposals. Contractors would be dedicated to the effort, however acquiring funding for EFH review focused work is an ongoing challenge also requires management of the contract. Additionally, stakeholder involvement can be challenging when proposals are developed by contractors outside the Council process.   A second option discussed was for fishermen, who are a key stakeholder group with specialized knowledge of habitat, to develop proposals. However, fisherman constitute only one stakeholder group so may not provide a broad enough perspective. The third option for proposal developers could be the general public.as they would give access to more experts and have increased stakeholder involvement. However according to the experience of other Councils, this approach presents a real risk of an unmanageable number of HAPC proposals being developed that may be irrelevant or incongruent with the Council's management objectives[5]. A fourth option was to have the Council's plan team develop proposals as they have the responsibility for the EFH review already in place. The concern with this approach is that plan team membership may change, and there may not be enough time dedicated in the process to develop supporting rationale for candidate areas. Finally, other Council bodies had the same pros and cons with the exception that the Plan Team is specifically responsible for the EFH review.

Finding

Plan Team members or their staff, and/or contractors seem the most reasonable entities to develop HAPC proposals, i.e. identify candidate HAPC areas for the Council's consideration in

[5] Habitat Working Group of the Council Coordinating Committee , Group Discussion, October 3, 2014

updating FEPs. Use of contractors allows flexibility when additional funding opportunities are available. When candidate HAPCs areas are identified outside the Council process, which would be the case with a contractor, the contract must be carefully managed to ensure the proposal addressed Council priorities and objectives and stakeholders are involved.

2. *Proposal Review Options*

In the proposal review phase, participants discussed the importance for the Pacific Island Fisheries Science Center (PIFSC) stock assessment authors to weigh in on the review of proposals for their stocks. Time management was the leading concern for Council staff and Advisory Panel review of the proposals. In the North Pacific region, Council staff review HAPC proposals to ensure consistency with Council priorities.[6] Advisory Panel review, however, would increase stakeholder participation in the HAPC designation process in the fishing community. This was considered an essential lesson learned from the Hawaiian Archipelago bottomfish EFH review. The Scientific and Statistical Committee (SSC) was recognized as the responsible body for review of all scientific information, and therefore HAPC proposals. The SSC is familiar with the fisheries, giving it an advantage over Center for Independent Expert (CIE) reviews. CIE reviews are managed at PIFSC.

Western Pacific Stock Assessment Review (WPSAR) is an existing peer review procedure for the scientific information that may be used as a basis for federal fisheries management in the region. A WPSAR review would occur as supplemental to the SSC's review, but may slow down the process. The WPSAR Coordinating Committee anticipates what WPSAR reviews may be needed for the region and advises the Steering Committee. The Steering Committee prioritizes and schedules regional science products for review based on its potential influence, available resources, and other factors as appropriate. Due to the implications stock assessments have on setting Annual Catch Limits, the assessments usually get higher priority than other scientific information like EFH or HAPC reviews. An HAPC proposal may be considered by the Steering Committee for the WPSAR schedule through two avenues: recommendation of the Coordinating Committee, or recommendation of the SSC.

Overall, interim checkpoints and the review methodology are important to ensure enough stakeholder involvement without prolonging the process. More levels of review mitigates the risk of rejection by various stakeholders, which may prolong the timeline of the review substantially.

Finding

Flexibility in the process is again important, so that as many reviewers may be exposed to the draft HAPC proposal without unnecessarily prolonging the process. Because the level of review is anticipated to be different for different managed fisheries, a concurrent initial review by Council staff, the PIRO regional EFH Coordinator, and Plan Team Habitat team members as well as the relevant PIFSC stock assessment authors will help to focus further review of the HAPC proposals through the Council process. These desktop reviewers will review the draft for scientific quality and consistency with Council objectives. The reviewers may make recommendations for additional stakeholder meetings if necessary. Comments should be

[6] HAPC Process Document, North Pacific Fishery Management Council and National Marine Fisheries Service, Alaska Region. September 2010.

provided within 45 days to prevent delays in the review process. A flow chart depicting how the review process is integrated with the Council process is shown in Figure 5.

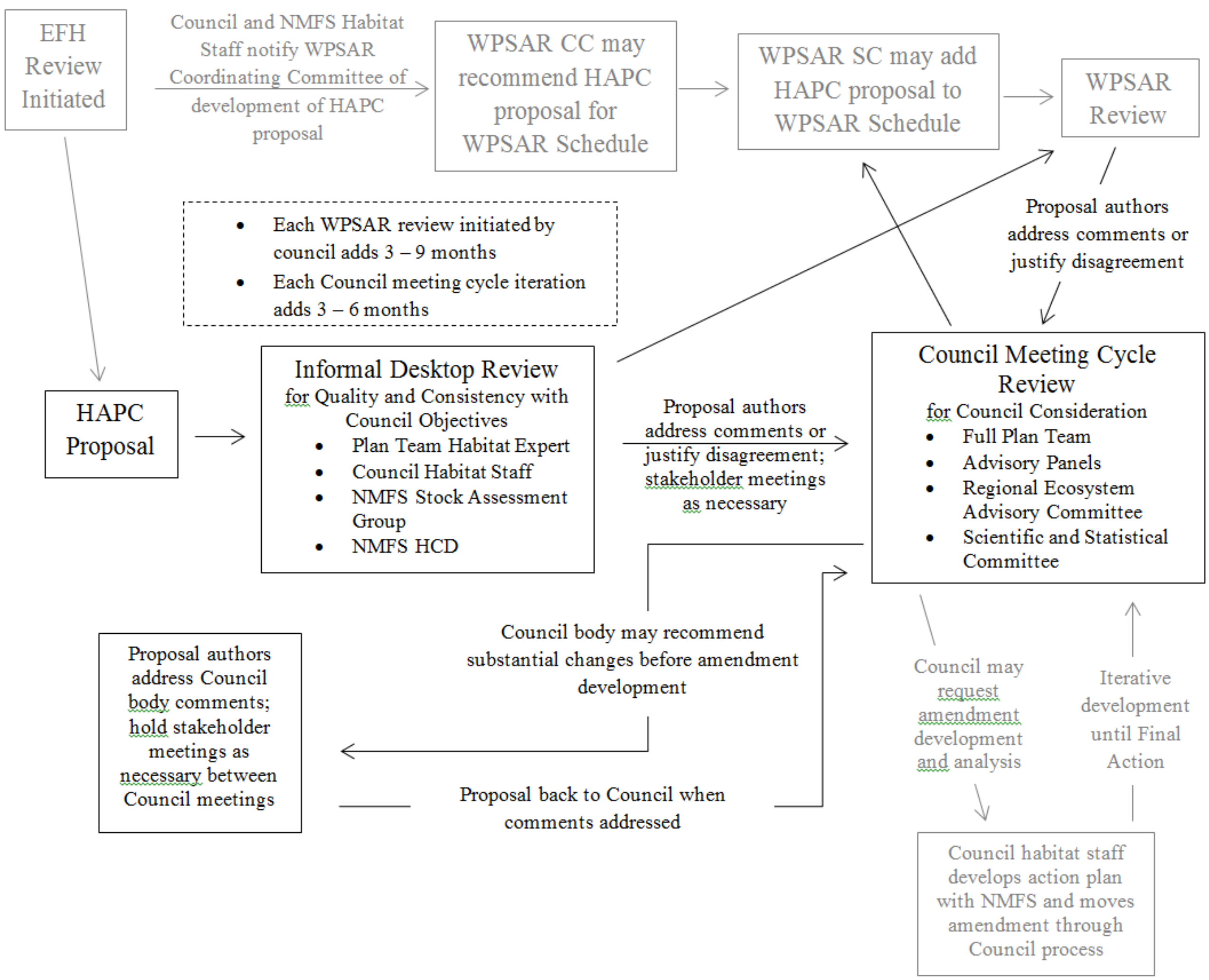


Figure 2. Integration of HAPC Proposal Review with the Council process. HAPC-specific phases are in black while established Council processes are in gray.

3. *Weighting of HAPC Considerations*

The working group discussed the weighting of considerations. In the WPSAR review of the bottomfish candidate areas, the panel determined that all candidate HAPCs must be ecologically important and meet one additional consideration in order to become an HAPC. The working group recognized that if the weighting is left up to the proposal writers or reviewers, the result could be subjective. Without any consideration of weighting, there are fewer restrictions on the proposal process and less quality control built into the process. However, the working group did not feel that recommending particular weights for the considerations was appropriate at this time, as some of the concerns with having no weighting for the considerations could be alleviated through developing terms of reference for candidate HAPC proposals.

4. *Interpretation of Considerations*

Further interpreting the considerations for the region had similar pros and cons as weighting the considerations. Interpreting them for the region may result in a more objective process, but runs the danger of producing overly restrictive proposals. Other Councils have interpreted the HAPC considerations further than in the EFH Final Rule, such as the North Pacific. This may be more appropriate in other regions that do authorize fishing gears with substantial adverse effects on EFH, where HAPC has been associated with gear closures. However, the Western Pacific Council does not authorize these gear types.

The working group did discuss the interpretation of the third consideration: "Whether, and to what extent, development activities are, or will be, stressing the habitat type." Participants agreed that local or regional actions/ threats should be given more consideration than global threats when the stressor/s associated with the global threats are not identifiable at a habitat and/or site specific scale.

Findings

The primary purpose of further interpreting and weighting the HAPC considerations is to increase the quality and refine the HAPC candidate areas received in a proposal. Terms of reference for the development of HAPC proposals could address these goals, while involving members of other Council bodies that are more appropriate for policy, not FEP, development.

Proposed HAPC Process and Recommendations

The working group recommends to the Plan Team that Council staff develop an HAPC policy from the working group discussions. The policy should include terms of reference for proposals from the HAPC guidance documents, working group discussions, and additional input from other relevant sources including Council bodies. If contractors are used to identify candidate areas, a term of the contract must be to gather information from the Council's advisory bodies and NMFS before submitting a final proposal for review to the Plan Team, Scientific and Statistical Committee, Advisory Panels, and Council. In addition to the regular Council process and WPSAR process, the HAPC process will include an initial desktop review of the HAPC proposal by Council habitat staff and Plan Team member, stock assessment scientists from the PIFSC Stock Assessment group, and NMFS Habitat Conservation Division. Producing a policy, instead of amending the FEPs with an HAPC update procedure, will facilitate flexibility in the process by not requiring a new amendment for revision of the process.

ATTACHMENT 2: DRAFT Precious Corals Species Descriptions Update

1 PRECIOUS CORALS SPECIES

1.1 General Distribution of Precious Corals

This document is an update of the 2015 "Essential Fish Habitat Source Document for Western Pacific Archipelagic, Remote Island Areas, and Pelagic Fishery Ecosystem Plan Management Unit Species" for precious corals. Important new references and data points have been added to the original documentation. Many older observations continue to be cited because no newer studies have been completed, with a few notable exceptions. While the original sources are still relevant, new research has revealed important distribution, life history, growth rate, age, and abundance information that is relevant to precious coral management. Some progress has also been made toward clarifying some of the vexing taxonomic challenges presented by these organisms. First, the name of the most important species of gold coral, *Gerardia* sp., has been updated to *Kulamanamana haumeaae* by Sinniger, *et al.* (2013). Second, two of the most important species in the family Coralliidae, *Corallium secundum* (pink coral) and *Corallium regale* (red coral) have been placed into separate genera, the latter also becoming a different species (Figueroa & Baco, 2014). Their new names are now *Pleurocorallium secundum* and *Hemicorallium laauense*, respectively. Third, two changes have taken place in the black corals. *Antipathes dichotoma* is now *Antipathes griggi* and *Antipathes ulex* has been moved to a different genus and is now *Myriopathes ulex* (Opresko, 2009). These changes are shown in Table 1.

Most research related to precious corals has been limited to the Hawaiian archipelago, and the majority of the more recent efforts have been directed at taxonomy or simply documenting species distributions, with a few works on growth and life history (*Parrish et al.*, 2015). However, significant new insights have been gained into the genetics (Baco and Cairns, 2012; Sinniger, *et al.*, 2013; Figueroa and Baco, 2014), reproductive biology (Waller and Baco, 2007; Wagner, *et al.*, 2011; Wagner *et al.*, 2012; Wagner *et al.*, 2015), growth and age (Parrish and Roark 2009; Roark *et al.*, 2009), and community structure (Kahng *et al*., 2010; Long and Baco, 2014; Parrish, 2015; Wagner, *et al*., 2015) of precious coral and black coral species.

The U.S. Pacific Islands Region under jurisdiction of the Western Pacific Regional Fisheries Management Council consists of more than 50 oceanic islands, including the Hawaiian and Marianas archipelagos, American Samoa, Johnston, Wake, Palmyra, Kingman, Jarvis, Baker and Howland, and numerous seamounts in proximity to each of these groups. These islands fall under a variety of political jurisdictions, and include the State of Hawaii, the Commonwealth of the Northern Mariana Islands (CNMI), and the territories of Guam and American Samoa, as well as nine sovereign Federal territories—Midway Atoll, Johnston Atoll, Kingman Reef, Palmyra Atoll, Jarvis Island, Howland Island, Baker Island, Rose Atoll, and Wake Island. Precious corals (with currently accepted species names) are known to exist in American Samoa, Guam, Hawaii and the Northern Mariana Islands, as well as throughout the other US islands in the Pacific (Tables 1 and 2), but the only detailed assessments of precious corals have been in Hawaii (Parrish and Baco, 2007, Parrish *et al*., 2015; Wagner, *et al*., 2015). Over the last 10 years, we have begun to better understand the distribution and abundance of these corals, but many areas remain unexplored, and conditions which lead to their settlement, growth and distribution are still uncertain. Modelling efforts have provided some insight into the global distribution and habitat requirements of deep-water corals (Rogers *et al.*, 2007; Tittensor *et al.*, 2009, Clark *et al.*, 2011, Yesson *et al.*, 2012, Schlacher *et al.*, 2013), but have provided little certainty regarding localized distribution or the specific conditions required for growth of precious corals. Antipatharians, commonly known as black corals, have been exploited for years, but are still among the taxonomic groups containing precious corals that have been inadequately surveyed, as evidenced by the high rates of species discoveries from deep-water surveys around the Hawaiian Islands (Opresko 2003b; Opresko 2005a; Baco 2007; Parrish & Baco 2007; Parrish *et al.*, 2015; Roark, 2009; Wagner *et al.*, 2011, 2015; Wagner, 2011, 2013). Despite this ongoing research, only a few places are known to have dense agglomerations of precious corals. A summary of the known distribution and abundance of precious corals in the central and western Pacific Islands region follows.

Table 1: Precious corals covered under the FMP

Species	**Common name**
Pleurocorallium secundum (prev. *Corallium secundum*)	Pink coral
Hemicorallium laauense (prev. *C. regale*)	Red coral
Kulamanamana haumeaae (prev. *Gerardia* sp.)	Gold coral
Narella sp.	Gold coral
Calyptrophora sp.	Gold coral
Callogorgia gilberti	Gold coral
Lepidisis olapa	Bamboo coral
Acanella sp.	Bamboo coral
Antipathes griggi (prev. *A. dichotoma)*	Black coral
Antipathes grandis	Black coral
*Myriopathes ulex (*prev. *Antipathes ulex*)	Black coral

<u>American Samoa</u>

There is little information available for the deepwater species of precious corals in American

Samoa. Much of the information available comes from the personal accounts of fishermen. In the South Pacific there are no known commercial beds of pink coral (Carleton and Philipson 1987). Survey work begun in 1975 by the Committee for Co-ordination of Joint Prospecting for Mineral Resources in South Pacific Offshore Areas (CCOP/SOPAC) identified three areas of *Corralium* off Western Samoa: off eastern Upolu, off Falealupo and at Tupuola Bank (Carleton and Philipson 1987). Pink coral has been reported off Cape Taputapu, but no information concerning the quality or quantity of these corals or the depths where they occur is available. Unidentified precious corals have also been reported in the past off Fanuatapu at depths of around 90 m. Precious corals are known to occur at an uncharted seamount, about three-fourths of a mile off the northwest tip of Falealupo Bank at depths of around 300 m.

Commercial quantities of one or more species of black coral are known to exist at depths of 40 m and deeper. However, these are found in the territorial waters of American Samoa and, therefore, are not subject to the Council's authority. Wagner (personal communication, 2015) has tentatively identified as many as 12 species (not previously catalogued in Am. Samoa) of black corals in depths between 50m and 90m, with 6 of these potential new species exhibiting growth forms that could lead to harvestable sizes. However, Wagner did not see find any locations with the types of densities and sizes that would support any commercial harvest of these corals.

<u>Guam and the Commonwealth of the Northern Marianas</u>

There are no known commercial quantities of precious corals in the Northern Mariana Islands archipelago (Grigg and Eldredge 1975). In the past, Japanese fishermen claimed to have taken some *Corralium* north of Pagan Island and off Rota and Saipan. Surveys are planned for the Marianas Islands in 2016 that may provide more information regarding abundance and distribution of certain precious corals found in waters deeper than 250 m.

<u>U.S. Pacific Island Remote Areas</u>

There are no known commercial quantities of precious corals in the remote Pacific Island areas, though individual colonies of precious corals have been seen at Jarvis, Palmyra, Kingman (Parrish and Baco, 2007) and Johnston Atoll, and planned surveys in 2017 may provide more information about abundance and distribution of precious corals found in waters deeper than 250 meters in these areas.

<u>Hawaii</u>

In the Hawaiian Archipelago there are seven legally-defined beds of pink, gold and bamboo corals, which are shown in Table 2. It is difficult to determine from the publication record exactly why these particular areas were singled out for legal recognition, other than the fact that they contain some unspecified densities of precious corals within their geographic boundaries. In the MHI, the Makapuu bed is located off Makapuu, Oahu, at depths of between 250 and 575 meters. Discovered in 1966, it the precious coral bed that has been most extensively surveyed in the Hawaiian chain. Its total area is about 4.5 km^2. Its substrate consists largely of hard limestone (Grigg, 1988). Careful examination during numerous dives with a submersible has determined that about 20% of the total area of the Makapuu bed is comprised of irregular lenses of thin sand, sediments and barren patches (WPRFMC, 1979). These sediment deposits are found primarily in low lying areas and depressions (Grigg, 1988). Thus, the total area used for extrapolating coral density is 3.6 km^2, or 80% of 4.5 km^2 (WPRFMC, 1979).

Precious coral beds have also been found in the deep inter-island channels such as Auau, Alalakeiki, and Kolohi channels off of Maui, around the edges of Penguin Banks, off promontories such as Keahole Point, on older lava flows south from Keahole to Ka Lae, and off of Hilo Harbor, and off of Cape Kumukahi on the Big Island of Hawaii (Oishi, 1990; Grigg, 2001, 2002). On Oahu, there is a bed off Kaena Point, and multiple precious coral observations have been made from offshore Barber's Point extending to offshore Pearl Harbor, Oahu. On Kauai, a bed of black corals has been identified offshore of Poipu (WPRFMC, 1979).

A dense bed has been located on the summit of Cross Seamount, southwest of the island of Hawaii. This bed covers a pinnacle feature on the top of the summit, but does not contain numbers of corals large enough to sustain commercial harvests (Kelley, pers. comm., 2015).

Table 2: Location of legally-defined precious coral beds. Source: WPRFMC 1979

Area Name	**Description**
Makapu'u (Oahu)	**includes the area within a radius of 2.0 nm of a point at 21°18.0′ N. lat., 157°32.5′ W. long.**
Auau Channel, Maui	**includes the area west and south of a point at 21°10′ N. lat., 156°40′ W. long., and east of a point at 21° N. lat., 157° W. long., and west and north of a point at 20°45′ N. lat., 156°40′ W. long.**
Keahole Point, Hawaii	**includes the area within a radius of 0.5 nm of a point at 19°46.0′ N. lat., 156°06.0′ W. long.**
Kaena Point, Oahu	**includes the area within a radius of 0.5 nm of a point at 21°35.4′ N. lat., 158°22.9′ W. long.**
Brooks Banks	**includes the area within a radius of 2.0 nm of a point at 24°06.0′ N. lat., 166°48.0′ W. long.**
180 Fathom Bank, north of Kure Island	**N.W. of Kure Atoll, includes the area within a radius of 2.0 nm of a point at 28°50.2′ N. lat., 178°53.4′ W. long.**
WesPac Bed, between Nihoa and Necker Islands	**includes the area within a radius of 2.0 nm of a point at 23°18′ N. lat., 162°35′ W. long. ***

* This area falls within the boundaries of the Papahanaumokuakea National Marine so

precious corals here are no longer subject to harvest or removal.
In the NWHI, a small bed of deepwater precious corals have been found on WestPac bed, between Nihoa and Necker Islands and east of French Frigate Shoals. This bed is not large enough to sustain commercial harvests. Precious coral beds have also been discovered at Brooks Banks, Pioneer Bank, Bank 8, Seamount 11, Laysan, and French Frigate shoals (Parrish and Baco, 2007; Parrish *et al*., 2015). ROV surveys conducted throughout the NWHI by the Okeanos Explorer during 2015 discovered multiple places that had dense colonies of deep-sea corals. Few of these colonies were precious corals, but these dives were mostly conducted in waters deeper than normal distributions of precious corals (>1500 meters). However, large areas of potential habitat exist in the NWHI on seamounts and banks near 400 m depth. Based on the abundance of potential habitat, it is thought that stocks of precious corals may be more abundant in the northwestern end of the island chain. All precious coral stocks within the boundaries of the Paphanaumokuakea National Marine Monument are protected from harvest, and most habitat suitable for precious corals growth falls within the boundaries of the monument.

Precious corals have also been discovered at the 180 Fathom Bank, north of Kure Island. The extent of this bed is not known. Precious corals have been observed during submersible and ROV dives throughout the Northwestern Hawaiian Islands, and in EEZ waters surrounding Johnston, Jarvis, Palmyra, and Kingman atolls, but little can be definitively said about the overall distribution and abundance of precious corals in the central Pacific region.

In addition to these legally defined areas of precious corals, many other sites have been discovered that sustain populations of precious corals (Parrish and Baco, 2007; Parrish *et al*., 2015; Wagner *et al*., 2015). The map below (Figure 1) provides a color-coded illustration of some of these 8600 observations (Kelley and Drysdale, 2012, *unpublished data*). Given the number of observations and the wide distribution of precious corals in the main Hawaiian Islands, it is almost certain that undiscovered beds of precious corals exist in the EEZ waters of the region managed by the WPRFMC. Whether these beds would contain organisms at sufficient densities and size distributions to support commercial harvests is yet to be determined.

1.2 Systematics of the Deepwater Coral Species

Published records of deep corals from the Hawaiian Archipelago include more than 137 species of gorgonian octocorals and 63 species of azooxanthellate scleractinians (Parrish and Baco, 2007). A total of 6 new genera and 20 new species of octocorals, antipatharians, and zoanthids have been discovered in Hawaii since the 2007 report (Parrish *et al.*, 2015). These are either new to science, or new records for the Hawaiian Archipelago (Cairns & Bayer 2008, Cairns 2009, Opresko 2009, Cairns 2010, Wagner *et al.*, 2011a, Opresko *et al.*, 2012, Sinniger *et al.*, 2013). Taxonomic revisions currently underway for several groups of corals, e.g., isidids, coralliids, plexaurids and paragorgiids, are also likely to yield additional species new to science and new records for Hawaii (Parrish *et al.*, 2015). Only a handful of these deep coral species are considered economically *precious* and have any history of exploitation.

Recent molecular phylogenetic and morphologic studies of the family Coralliidae, including Hawaiian precious corals, have illuminated taxonomic relationships. These studies synonymized

Paracorallium into the genus Corallium, and resurrected the genera Hemicorallium (Ardila *et al*., 2012; Figueroa & Baco, 2014; Tu *et al*., 2015) and Pleurocorallium (Figueroa & Baco, 2014; Tu *et al*.,2015) for several species, including several species in the precious coral trade. A molecular and morphological analysis of octocoral-associated zoanthids collected from the deep slopes in the Hawaiian Archipelago revealed the presence of at least five different genera including the gold coral (Sinniger *et al*.,2013). This study describes the five new genera and species and proposes a new genus and species for the Hawaiian gold coral, *Kulamanamana haumeaae*, an historically important species harvested for the jewelry trade and the only Hawaiian zoanthid that appears to create its own skeleton.

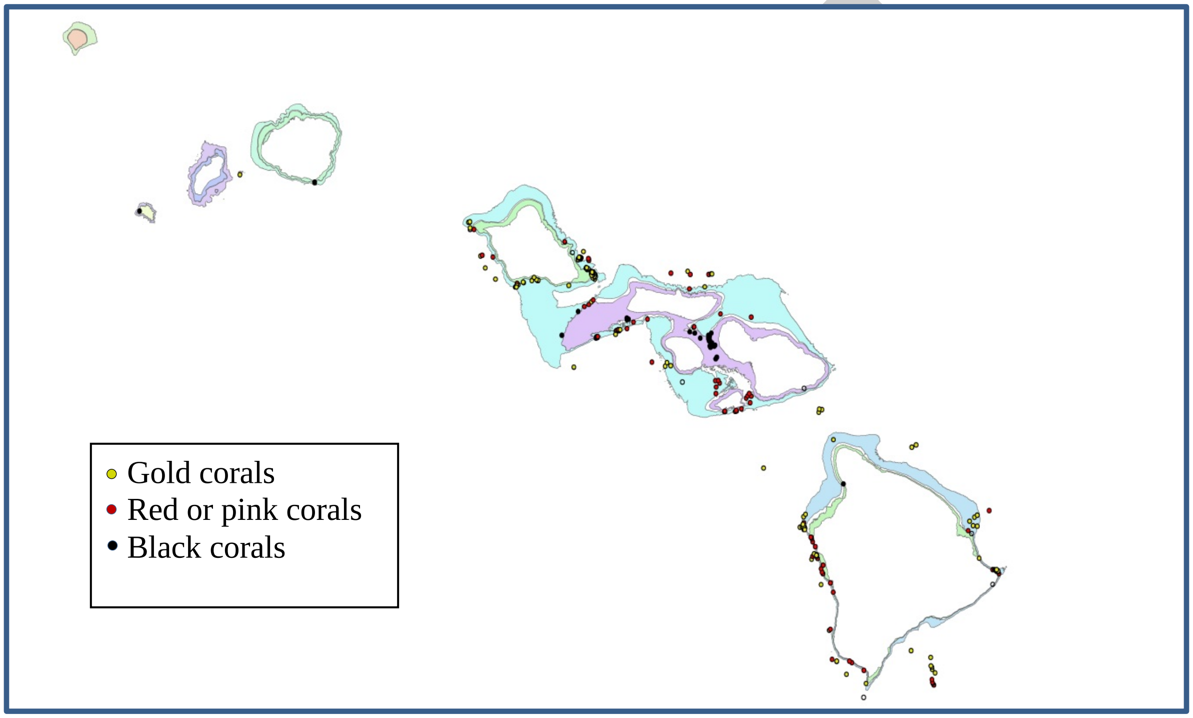


Figure 1. Observations of precious corals in the main Hawaiian Islands

Precious corals are found principally in three orders of the class Anthozoa: Gorgonacea, Antipatharia, and Zoanthiae (Grigg, 1984). In the western Pacific region, pink coral (*Pleurocorallium secundum*), red coral (*Hemicorallium laauense*), gold coral (*Kulamanamana haumeaae*), black coral (*Antipathes* sp.) and bamboo coral (*Lepidisis olapa*) are the primary species/genera of commercial importance. Of these, the most valuable precious corals are species of the genera *Pleurorallium* and *Hemicorallium*, the pink and red corals (Grigg, 1984). Pink coral (*P. secundum*) and Midway deep-sea coral (*Corallium* sp. nov,) are two of the principal species of commercial importance in the Hawaiian and Emperor Seamount chain (Grigg, 1984). *P. secundum*, is found in the Hawaiian archipelago from Milwaukee Banks in the Emperor Seamounts (36^{o}N) to the Island of Hawaii (18^{o}N); *Corallium* sp. nov. is found between 28^{o}–36^{o}N, from Midway to the Emperor Seamounts (Grigg, 1984). In addition to the pink corals, the bamboo corals, *Lepidistis olapa* and *Acanella* sp., are commercially important precious corals in the western Pacific region (Grigg, 1984). Pink coral and bamboo coral are found in the order

Gorgonacea in the subclass Octocorallia of the class Anthozoa, in the Phylum Coelenterata (Grigg, 1984).

The final two major groups of commercially important precious corals, gold coral and black coral, are found in separate orders, Zoanthidea and Antipatharia, in the subclass Hexacorallia, in the class Anthozoa and the phylum Coelenterata. The gold coral, *Kulamanamana haumeaae* (prev. *Gerardia* sp.) (Sinneger, *et.al.*, 2013), is endemic to the Hawaiian and Emperor Seamount chain (Grigg 1984). It inhabits depths ranging from 300–400 m (Grigg 1974, 1984). In Hawaii, gold coral, *Kulamanamana haumeaae,* grows mostly on bamboo hosts (e.g. *Acanella, Keratoisis*) as a parasitic overgrowth (Brown, 1976; Grigg, 1984; Parrish, 2015). Gold coral is, therefore, only found growing in areas that were previously inhabited by colonies of *Acanella* (Grigg, 1993) and possibly other bamboo corals (Parrish, 2015). Despite its ecological significance and long history of exploitation, the Hawaiian gold coral has never been subject to taxonomic studies or a formal species description. As a result of this, the nomenclature concerning the Hawaiian gold coral has been relatively confused. Symptomatic of the order, a suite of other zoanthids, besides the Hawaiian gold coral, have been observed and collected in Hawaii, but far less is known of their biology and ecology and they have not been described taxonomically.(Sinnegar *et al.,* 2013).

Grigg (1984) classified black corals in the order *Antipatharia,* and identified fourteen genera of black corals reported from the Hawaii-Pacific region with species found in both shallow and deep habitats Grigg, 1965). Wagner (2015) noted that there are over 235 known species of black coral that occur in the oceans of the world, and of this total, only about 10 species are of commercial importance (Grigg, 1984). Wagner (2011) confirmed 8 species of black corals in Hawaii, including (1) *Antipathes griggi* Opresko, 2009, (2) *Antipathes grandis* Verrill, 1928, (3) *Stichopathes echinulata* Brook, 1889, (4) an undescribed *Stichopathes* sp., (5) *Cirrhipathes* cf. *anguina* Dana, 1846, (6) *Aphanipathes verticillata* Brook, 1889, (7) *Acanthopathes undulata* (Van Pesch, 1914), and (8) *Myriopathes* cf. *ulex* Ellis & Solander, 1786. A new name for the Hawaiian species of antipatharian coral previously identified as *Antipathes dichotoma* (Grigg and Opresko, 1977) is described as *Antipathes griggi* (Opresko, 2009).

Many species of gorgonian corals are known to occur within the habitat of pink, gold and bamboo corals in the Hawaiian Islands. At least 37 species of precious corals in the order Gorgonacea have been identified from the Makapuu bed (Grigg and Bayer, 1976). In addition, 18 species of black coral (order Antipatharia) have been reported to occur in Hawaiian waters (Grigg and Opresko, 1977; Oishi, 1990; Wagner, 2011.), but only 3 of these species have been subject to commercial harvest (Oishi, 1990; Wagner *et al.,* 2015).

1.3 Biology and Life History

The management and conservation of deep-sea coral communities is challenged by their commercial harvest for the jewelry trade and damage caused by deep-water fishing practices. In light of their unusual longevity, a better understanding of deep-sea coral ecology and their interrelationships with associated benthic communities is needed to inform coherent international conservation strategies for these important deep-sea habitat-forming species (Bruckner, 2013).

Most of the interior of the global ocean remains unobserved. This leaves questions of trophic connectivity, longevity, and population dynamics of many deep-sea communities unanswered. Deep-sea megafauna provide a complex, rich, and varied habitat that promotes high biodiversity and provides congregation points for juvenile and adult fish (Freiwald *et al.,* 2004; Husebo *et al.,* 2002; Smith *et al.,* 2008).

Precious corals may be divided primarily into two groups of species based on their depth ranges: the deepwater species (200-600m) and the shallow water species (20-120m). Other precious corals can be found in depths down to 2000 m, but these species are not exploited in the U.S. for commercial purposes. Deep-sea corals are found on hard substrates on seamounts and continental margins worldwide at depths of 300 to 3,000 m.

Deep Corals

The Pacific Islands deepwater precious coral species include pink coral, *Pleurocorallium secundum* (prev. *Corallium secundum*), red coral, *Hemicorallium laauense* (prev. *C. regale or C. laauense*), gold coral, *Kulamanamana haumeaae (*prev. *Gerardia sp*.) and bamboo coral, *Lepidistis olapa*. As previously discussed, the most valuable precious corals are gorgonian octocorals (Grigg, 1984). There are seven varieties of pink and red precious corals in the western Pacific region, six of which used to be recognized as distinct species of *Corallium* (Grigg, 1981), but have been reclassified (Parrish *et al.,* 2015). The two species of commercial importance in the EEZ around the Hawaiian Islands are the pink coral *Pleurocorallium secundum* (prev. *Corallium secundum*), and the red coral, *Hemicorallium laauense* (prev. *C. laauense*). The Gorgonian octocorals are by far the most abundant and diverse corals in the Hawaiian Archipelago. Two species, *Pleurocorallium secundum* and *Hemicorallium laauense* are known to occur at depths of 300-600 m on islands and seamounts throughout the Hawaiian Archipelago (Grigg 1974, 1993; Parrish *et al.,* 2015; Parrish and Baco, 2007). Parrish (2007) surveyed *Pleurocorallium secundum* and *Hemicorallium laauense* at 6 precious coral beds in the lower Hawaiian chain, from Brooks Bank to Keahole Point, Hawaii, in depths ranging from 350m to 500m. He found corals on summits, flanks, and shallow banks, with bottom substrate and relief at these sites ranging from a homogenous continuum of one type to a combination of many types at a single site. The survey results show that all three coral taxa colonize both carbonate and basalt/manganese substrates, and the corals favor areas where bottom relief enhances or modifies flow characteristics that may improve the colony's feeding success.

These corals can grow to more than 30 cm in height, and are often found in large beds with other octocorals, zoanthids, and sometimes scleractinians (Parrish *et al.,* 2015; Parrish and Baco, 2007). These species are relatively long lived, with some of the oldest colonies observed within Makapuu Bed about 0.7 m in height and at least 80 years old (Grigg, 1988b, Roark, 2006). Populations of *P. secundum* appear to be recruitment limited, although in favorable environments (e.g., Makapuu Bed) populations are relatively stable, suggesting that recruitment and mortality are in a steady state (Grigg, 1993). A study by Roark *et al.* (2006) showed that the radial growth rate for specimens of *P. secundum* in the Hawaiian Islands is $\sim 170\ \mu m\ yr^{-1}$ and average age is 67 to 71 years, o;der than previously calculated. Individual colonies have been measured as tall as 28 cm. Bruckner (2009) suggested that the minimum allowable size for genus Corallium for harvest should be increased, and supported a potential listing for Corallium within the Appendices of the Convention on International Trade in Endangered Species (CITES). The current size restriction in the 2010 Code of Federal Regulations for Pacific Islands Region is 10 in (25.4 cm).

In Cairn's reviews (2008; 2009; 2010), he summarized the research conducted on Hawaiian Octocorallia taxa, including three gold coral PCMUS genuses, *Narella*, *Calyptrophora* and *Callogorgia*. Octocorallia are distributed over all ocean basins, found in depths ranging from shallow (~ 50m) to deep (~ 4,600) in Alaska. All gold PCMUS in Hawaii were collected in deep water (> 270m), throughout the Hawaiian archipelago and adjacent seamounts. Although these octocorals are managed as PCMUS, the only commercially exploited gold coral is the zoantharian, *Kulamanamana haumeaae* (prev. *Gerardia* sp.). It is probably the most common and largest of the zoanthids in Hawaii, and is widely distributed throughout the Hawaiian Archipelago and into the Emperor Seamount Chain at depths of 350–600 meters (Parrish *et al.*, 2015; Parrish and Baco, 2007). While subject to commercial exploitation from the 1970's until 2001 with an interruption between 1979 and 1999 (Grigg, 2001), the gold coral is not currently exploited in Hawaii due to a moratorium on the fishery. The Hawaiian gold coral is one of the largest and numerically dominant benthic macro-invertebrates in its depth range on hard substrate habitats of the Hawaiian Archipelago, and plays an important ecological role in Hawaiian seamount benthic assemblage (Parrish, 2006; Parrish and Baco, 2007; Parrish, *et al.*, 2015). The Hawaiian gold coral has also been found to be one of the longest-lived species on earth. Earlier ageing attempts on the gold coral focused on ring counts (Grigg, 1974; Grigg, 2002) and led to a maximal estimated age of 70 years and a radial growth rate (increase in branch diameter) of 1 mm/year. Recent studies using radiometric data suggest colonies of Hawaiian gold coral are as old as 2740 year with a radial growth rate of only 15 to 45 µm/year (Roark *et al.*, 2006; Roark *et.al.*, 2009; Parrish and Roark, 2009).

Parrish (2015) has found the host of the parasitic *Kulamanamana haumeaae* to be primarily the bamboo corals (e.g. Acanella, Keratoisis). *K. haumeaae* secretes a protein skeleton that over millennia can grow and more than double the original mean size of the host colony. It is relatively common and even dominant at geologically older sample sites, but recruitment is probably infrequent (Parrish, 2015). Although it can be relatively common compared to some other deep corals, it grows very slowly. Parrish and Roark (2009) determined that the Hawaiian gold coral *Kulamanamana haumeaae* has a mean life span of 950 yrs with an overall radial growth of ~41 µm yr^{-1}, and a gross radiocarbon linear growth rate of 2.2 ± 0.2 mm yr^{-1}. This is a much slower growth rate and longer life span than given in previous studies. Grigg (2002) reported a 1 mm yr^{-1} radial growth rate, equivalent to a 6.6 cm yr^{-1} linear growth for a maximum life span of roughly 70 yrs. This means these corals are growing much slower than previously thought, and have much longer life spans if undisturbed. Newly applied radiocarbon age dates from the deep water proteinaceous corals *Gerardia* and *Leiopathes* show that radial growth rates are as low as 4 to 35 micometers per year and that individual colony longevities are on the order of thousands of years (Roark *et al.*, 2009, 2006). The longest-lived *Gerardia* sp. and *Leiopathes* specimens were estimated to be 2,742 years old and 4,265 years old, respectively. *Gerardia* sp. is a colonial zoanthid with a hard skeleton of hard proteinaceous matter that forms tree-like structures with heights of several meters and basal diameters up to 10s of a centimeter. Black corals of *Leiopathes sp*. also has a hard proteinaceous skeleton and grows to heights in excess of 2 m. In Hawai'ian waters, these corals are found at depths of 300 to 500 m on hard substrates, such as seamounts and ledges.

The two bamboo coral PCMUS in the Pacific Islands Region are classified under two genera, Acanella and Lepidisis. Not much work has been done specifically on these genera, but Parrish (2015) identified branched bamboo colonies such as Acanella as a preferred host for *Kulamanamana haumeaae*. Because of the long colony life span of >3000 yrs and the bony hard bodied calcareous internodes of bamboo corals (family Isididae), geochemists are interested in using them to analyze paleo-oceanographic events and long-term climate change (Hill *et al*. 2011), while biologists use them to size and age deep-sea coral populations. Recent studies show that the subfamily Keratoisidinae (family Isididae) consists of four genera (*Acanella*, *Isidella*, *Lepidisis*, and *Keratoisis*), with two genera (*Tenuisis* and *Australisis*) perhaps belonging elsewhere in the Isididae family (Etnoyer 2008; France 2007). Bamboo corals commonly colonize intermediate to deep water depths (400m to >3000m) of continental slopes and seamounts in the Pacific Ocean.

Shallow Corals

The second group of precious coral species is found in shallow water between 20 and 120 m (Grigg, 1993 and Drysdale, *unpublished data*, 2012; Wagner *et al.*, 2015). The shallow water fishery is comprised of three species of black coral, *Antipathes griggi*, *A. grandis* and *Myriopathes ulex,* which have historically been harvested in Hawaii (Oishi 1990), but over 90% of the coral harvested by the fishery consists of *A. griggi* (Oishi 1990; Parrish *et al.*, 2015; Wagner *et al.*, 2015). Other black coral species are found in the NWHI in a wider depth range (20m to 1,400m), but with lower colony density (Wagner *et al*., 2011). Surveys performed in depths of 40-110 meters in the Au‘au Channel in 1975 and 1998, suggested stability in both recruitment and growth of commercially valuable black coral populations, and thus indicated that the fishery had been sustainable over this time period (Grigg, 2001). Subsequent surveys performed in the channel in 2001 indicated a substantial decline in the abundance of black coral colonies, with likely causes including increases in harvesting pressure and overgrowth of black coral colonies by the invasive octocoral *Carijoa sp.* and the red alga, *Acanthophora spicifera*, especially on reproductively mature colonies at mesophotic depths (Grigg 2003; Grigg 2004; Kahng & Grigg 2005; Kahng, 2006). Together, these factors renewed scrutiny on the black coral fishery and raised questions about whether regulations need to be redefined in order to maintain a sustainable harvest (Grigg, 2004). In addition to these challenges, Wagner has suggested that taxonomic misidentification has led to the mistaken belief that there is a depth refuge that exists for certain harvested species (Wagner *et al.,* 2012; Wagner, 2011). All of these uncertainties and lack of basic life history information regarding black corals complicates effective management of the resource (Grigg, 2004).

In Hawaii, *A. griggi* accounts for around 90% of the commercial harvest of black coral (Oishi 1990). *A. grandis* accounts for 9% and *M. ulex* 1% of the total black corals harvested. In Hawaii, roughly 85% of all black coral harvested are taken from within state waters. Black corals are managed jointly by the State of Hawaii and the Council. Within state waters (0–3 nmi), black corals are managed by the State of Hawaii (Grigg, 1993).

A new name for the Hawaiian species of antipatharian coral previously identified as *Antipathes dichotoma* (Grigg and Opresko, 1977) is described as *Antipathes griggi* Opresko, n. sp. (Opresko, 2009). The shallow water black coral *A. dichotoma* (*A. griggi)* collected at 50m exhibited growth rates of 6.42 cm yr^{-1} over a 3.5 yrs study.

1.4 Growth and Reproduction

There is very limited published literature regarding coral spawning of the PCMUS in the Pacific Islands Region. However, studies by Gleason, *et al*. (2006) and Waller and Baco (2007) indicate that the gold coral *Kulamanamana haumaae* may have seasonal reproduction, and that two pink coral species have a periodic or quasi-continuous reproductive periodicity. Although limited studies about growth rates and life spans of adult PCMUS in the Pacific Islands Region are available, early life history data on larvae, polyps, and juvenile colonies of the PCMUS are unavailable. Many other questions related to genetic connectivity and spatial distribution across the Pacific also remain unanswered. Recent mesophotic coral reef ecosystem studies provide an outline of essential knowledge for the limited deep water coral ecosystem (Kahng, *et al*. 2010). Slow-growing deep-water coral ecosystems are sensitive to many disturbances, such as temperature change, invasive species and destructive fishing techniques.

While different species of precious corals inhabit distinct depth zones, their habitat requirements are strikingly similar. Grigg (1984) noted that these corals are non-reef building and inhabit depth zones below the euphotic zone. In an earlier study, Grigg (1974) determined that precious corals are found in deep water on solid substrate in areas that are swept relatively clean by moderate to strong bottom currents (>25 cm/sec). Strong currents help prevent the accumulation of sediments, which would smother young coral colonies and prevent settlement of new larvae. Grigg (1984) notes that, in Hawaii, large stands of *Corralium* are only found in areas where

Table 3: Depth zonation of precious corals in the Western Pacific. (Source: Grigg 1993, Baco-Taylor, 2007, HURL and Drysdale, 2012)

Species and Common Name	Depth Range (m)
Paracorallium secundum Angle skin coral	250–575
Hemicorallium laauense Red coral	250–575
Corallium sp nov. Midway deepsea coral	1,000–1,500
Kulamanamana haumeaae (prev. *Gerardia* sp.) Hawaiian gold coral	350–575
Lepidisis olapa, *Acanella* spp. bamboo coral	250–1800
Antipathes griggi (prev. *A. dichotoma*), black coral	20–120
Antipathes grandis, pine black coral	20–120
Cirrhipathes cf. *anguina* (prev. *Antipathes anguina*), wire black coral	20–120
Myriopathes ulex (prev. *Antipathes ulex*),	20–220

Species and Common Name	Depth Range (m)
fern black coral	

sediments almost never accumulate, and *P. secundum* appears in large numbers in areas of high flow over carbonate pavement (Parrish *et al.*, 2015; Parrish and Baco, 2007). *Hemicorallium laauense* grows in an intermediate relief of outcrops; and *Kulamanamana haumaae* is most commonly seen growing in high relief areas on pinnacles, walls, and cliffs. These habitat differences may reflect preferred flow regimes for the different corals (e.g., laminar flow for *P. secundum*, alternating flow for *Kulamanamana haumaae*) (Parrish *et al.*, 2015).

Surveys of all potential sites for precious corals in the MHI conducted using a manned submersible show that most shelf areas in the MHI near 400 m are periodically covered with a thin layer of silt and sand (Grigg, 1984). Precious corals are known to grow on a variety of bottom substrate types. Precious coral yields, however, tend to be higher in areas of shell sandstone, limestone and basaltic or metamorphic rock with a limestone veneer. Grigg (1988) concludes that the concurrence of oceanographic features (strong currents, hard substrate, low sediments) necessary to create suitable precious coral habitat are rare in the MHI. Depth clearly influences the distribution of different coral taxa and certainly there is patchiness associated with the presence of premium substrate and environmental conditions (flow, particulate load, etc.). The environmental suitability for colonization and growth is likely to differ among coral taxa.

The habitat sustaining precious corals is generally in pristine condition. There are no known areas that have sustained damage due to resource exploitation, notwithstanding the alleged heavy foreign fishing for corals in the Hancock Seamounts area. Although unlikely, if future development projects are planned in the proximity of precious coral beds, care should be taken to prevent damage to the beds. Projects of particular concern would be those that suspend sediments or modify water-movement patterns, such as deep-sea mining or energy-related operations.

There has been very little research conducted concerning the food habits of precious corals. Precious corals are filter feeders (Grigg, 1984; 1993). The sparse research available suggests that particulate organic matter and microzooplankton are important in the diets of pink and bamboo coral (Grigg, 1970). Many species of pink coral, gold coral (*Kulamanamana haumeaae (*prev. *Gerardia* sp.*)* and black coral (*Antipathes*) form fan shaped colonies (Grigg, 1984; 1993). This type of morphological adaption maximizes the total area of water that is filtered by the polyps (Grigg, 1984; 1993). Bamboo coral (*Lepidisis olapa*), unlike other species of precious corals, is unbranched (Grigg, 1984). Long coils that trail in the prevailing currents maximize the total amount of seawater that is filtered by the polyps (Grigg, 1984). While clearly, the presence of strong currents is a vital factor determining habitat suitability for precious coral colonies, their role to date is not fully understood.

Light is one of the most important determining factors of the upper depth limit of many species of precious corals (Grigg, 1984).The larvae of two species of black coral, *Antipathes grandis* and *A. griggi*, are negatively phototaxic**.**

Grigg (1984) states that temperature does not appear to be a significant factor in delimiting suitable habitat for precious corals. In the Pacific Ocean, species of *Corallium* are found in temperature ranges of 8^{o} to 20^{o}C, he observes. Temperature may determine the lower depth limits of some species of precious coral, including two species of black corals in the MHI. In the MHI, the lower depth range of two species of black corals (*A.griggi* and *A. grandis*) coincides with the top of the thermocline (about 100 m). Although, *A. griggi* can be found to depths of 100 m, it is rare below the 75 m depth limit at which commercial harvest occurs in Hawai‘i. Thus, the supposed depth refuge from harvest does not really exist, and was probably based on taxonomic misidentification, thereby calling into question population models used for the management of the Hawaiian black coral fishery (Wagner *et al.*, 2012; Wagner, 2011).

In pink coral (*P. secundum*), the sexes are separate (Grigg, 1993). Based on the best available data, it is believed that *P. secundum* becomes sexually mature at a height of approximately 12 cm (13 years) (Grigg, 1976). Pink coral reproduce annually, with spawning occurring during the summer, during the months of June and July. Coral polyps produce eggs and sperm. Fertilization of the oocytes is completed externally in the water column (Grigg, 1976; 1993). The resulting larvae, called planulae, drift with the prevailing currents until finding a suitable site for settlement.

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. Grigg (1993) notes that the lengths of the larval stage of all deepwater species of precious corals is unknown. Clean swept areas exposed to strong currents provide important sites for settlement of the larvae, Grigg adds. The larvae of several species of black coral (*Antipathes*) are negatively photoactic, he notes. They are most abundant in dimly lit areas, such as beneath overhangs in waters deeper than 30 m. In an earlier study, Grigg (1976) found that “within their depth ranges, both species are highly aggregated and are most frequently found under vertical dropoffs. Such features are commonly associated with terraces and undercut notches relict of ancient sea level still stands. Such features are common off Kauai and Maui in the MHI. Both species are particularly abundant off of Maui and Kauai, suggesting that their abundance is related to suitable habitat.” Off of Oahu, many submarine terraces that otherwise would be suitable habitat for black corals are covered with sediments (Grigg, 1976).

A variety of invertebrates and fish are known to utilize the same habitat as precious corals. These species of fish include onaga (*Etelis coruscans*), kahala (*Seriola dumerallii*) and the shrimp (*Heterocarpus ensifer*). These species do not seem to depend on the coral for shelter or food.

Densities of pink, gold and bamboo coral have been estimated for an unexploited section of the Makapuu bed (Grigg, 1976). As noted in the FMP for precious corals, the average density of pink coral in the Makapuu bed is 0.022 colonies/m^2. This figure was extrapolated to the entire bed (3.6 million m^2), giving an estimated standing crop of 79,200 colonies. At the 95% confidence limit, the standing crop is 47,500 to 111,700 colonies. The standing crop of colonies was converted to biomass ($3N_iW_i$), resulting in an estimate of 43,500 kg of pink coral in the Makapuu bed. These estimates need to be revised with more rigorous statistical enumeration methodologies.

In addition to coral densities, Grigg (1976) determined the age-frequency distribution of pink coral colonies in Makapuu bed. He applied annual growth rates to the size frequency to calculate the age structure of pink coral at Makapuu Bed (Table 4). More recent work by Roark *et al.* (2006) suggests that annual growth ring dating may underestimate the ages of many species of deep water corals, and that most of the colonies that have been dated using the ring method are probably older and slower growing than first estimated.

Estimates of density were also made for bamboo (*Lepidisis olapa*) and gold coral (*Kulamanamana haumeaae (*prev. *Gerardia* sp.*)* for Makapuu bed. The distributions of both these species are patchy. As noted in the FMP, the area where they occur comprises only half of that occupied by pink coral (1.8 km^2). Estimates of the unexploited abundance of bamboo and gold coral were 18,000 and 5,400 colonies, respectively. Estimates of density for the unexploited bamboo coral and gold coral in the Makapuu bed are 0.01 colonies/m^2 and 0.003 colonies/m^2. Using a rough estimate for the mean weights of gold and bamboo coral colonies (2.2 kg and 0.6 kg), a standing crop of about 11,880 kg of gold coral and 10,800 kg for bamboo for Makapuu bed was obtained. These estimates need to be revised with more rigorous statistical enumeration methodologies.

Growth rates for several species of precious corals found in the western Pacific region have been calculated. Grigg (1976) determines that the height of pink coral (*P. secundum*) colonies increases about 0.9 cm/yr up to about 30 years of age. These growth rates are probably overestimated, and should be revisited using modern methodologies. As noted in the FMP for precious corals, the height of the largest colonies of *Pleurocorallium secundum* at Makapuu bed rarely exceed 60 cm. Colonies of gold coral are known to grow up to 250 cm tall while bamboo corals may reach 300 cm. The natural mortality rate of pink coral at Makapuu bed is believed to be 0.066, equivalent to an annual survival rate of about 93%.

Table 4: Age-Frequency Distribution of *Pleurocorallium secundum* (Source: Grigg, 1973)

Age Group (years)	**Number of Colonies**
0–10	44
10–20	73
0–30	22
30–40	12
40–50	7
50–60	0

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Attachment 3-1: Species list table for the CNMI

1. Bottomfish Multi-species Stock Complex (FSSI)

DFW Creel Species Code	Species Name	Scientific Name
214	red snapper, silvermouth (lehi)	*Aphareus rutilans*
213	grey snapper, jobfish	*Aprion virescens*
112	giant trevally, jack	*Caranx ignoblis*
111	black trevally, jack	*Caranx lugubris*
231	blacktip grouper	*Epinephelus fasciatus*
241	lunartail grouper (lyretail grouper)	*Variola lauti*
203	red snapper (ehu)	*Etelis carbunculus*
210	red snapper (onaga)	*Etelis coruscans*
NONE	ambon emperor	*Lethrinus amboinenis*
350	redgill emperor	*Lethrinus rubrioperculatus*
253	blueline snapper	*Lutjanus kasmira*
NONE	yellowtail snapper	*Pristipomoides auricilla*
212	pink snapper (paka)	*Pristipomoides filamentosus*
209	yelloweye snapper	*Pristipomoides flavipinnis*
207	pink snapper (kalekale)	*Pristipomoides seiboldi*
204	flower snapper (gindai)	*Pristipomoides zonatus*
220	amberjack	*Seriola dumerili*

2. Crustacean deep-water shrimp complex (non-FSSI)

DFW Creel Species Code	Species Name	Scientific Name
508	deepwater shrimp	*Heterocarpus* spp.

3. Crustacean spiny lobster complex (non-FSSI)

DFW Creel Species Code	Species Name	Scientific Name
504	spiny lobster	*Panulirus marginatus*
504	spiny lobster	*Panulirus penicillatus*

4. Crustacean slipper lobster complex (non-FSSI)

DFW Creel Species Code	Species Name	Scientific Name
505	Slipper lobster	Scyllaridae

5. Crustacean Kona crab complex (non-FSSI)

DFW Creel Species Code	Species Name	Scientific Name
502	Kona crab	*Ranina ranina*

6. Precious coral black coral complex (non-FSSI)

DFW Creel Species Code	**Species Name**	**Scientific Name**
none	Black Coral	*Anitpathes dichotoma*
none	Black Coral	*Antipathes grandis*
none	Black Coral	*Antipathes ulex*

7. Exploratory area precious coral (except black coral) (non-FSSI)

DFW Creel Species Code	**Species Name**	**Scientific Name**
none	Pink coral	*Corallium secundum*
none	Pink coral	*Corallium regale*
none	Pink coral	*Corallium laauense*
none	Bamboo coral	*Lepidisis olapa*
none	Bamboo coral	*Acanella* spp.
none	Gold Coral	*Gerardia* spp.
none	Gold Coral	*Callogorgia gilberti*
none	Gold Coral	*Narella* spp.
none	Gold Coral	*Calyptrophora* spp.

8. Coral reef ecosystem (non-FSSI)

DFW Creel Species Code	Species Name	Scientific Name	Grouping
357	Bigeye Emperor	*Monotaxis grandoculus*	Lethrinidae
353	Blackspot Emperor	*Lethrinus harak*	Lethrinidae
310	Emperor (mafute/misc.)	*Lethrinus sp.*	Lethrinidae
356	Flametail Emperor	*Lethrinus fulvus*	Lethrinidae
351	Longnose Emperor	*Lethrinus olivaceus*	Lethrinidae
352	Orangefin Emperor	*Lethrinus erythracanthus*	Lethrinidae
361	Ornate Emperor	*Lethrinus ornatus*	Lethrinidae
358	Stout Emperor	*Gymnocranius sp.*	Lethrinidae
355	Yellowlips Emperor	*Lethrinus xanthochilis*	Lethrinidae
359	Yellowspot emperor	*Gnathodentex aurolineatus*	Lethrinidae
354	Yellowstripe Emperor	*Lethrinus obsoletus*	Lethrinidae
362	Yellowtail Emperor	*Lethrinus atkinsoni*	Lethrinidae
115	Bigeye Trevally	*Caranx sexfasciatus*	Carangidae
113	Bluefin Trevally	*Caranx melampygus*	Carangidae
114	Brassy Trevally	*Caranx papuesis*	Carangidae
105	EE: Juvenile Jacks	*Canranx sp.*	Carangidae
104	Jacks (misc.)	*Caranx sp.*	Carangidae
101	Leatherback	*Scomberoides lysan*	Carangidae
103	Mackerel Scad	*Decapterus macarellus*	Carangidae
410	Rainbow Runner	*Elagatis bipinnulatus*	Carangidae

117	Small-spotted pompano	*Trachinotus bailloni*	Carangidae
116	Snubnose pompano	*Trachinotus blochii*	Carangidae
110	Yellow Spotted Trevally	*Carangoides orthogrammus*	Carangidae
380	Bluebanded Surgeonfish	*Acanthurus lineatus*	Acanthuridae
383	Bluelined Surgeon	*Acanthurus nigroris*	Acanthuridae
384	Bluespine Unicornfish	*Naso unicornis*	Acanthuridae
381	Convict Tang	*Acanthurus triostegus*	Acanthuridae
319	Orangespine Unicornfish	*Naso lituratus*	Acanthuridae
318	Surgeonfish (misc.)	*Acanthurus sp.*	Acanthuridae
320	Unicornfish (misc.)	*Naso sp.*	Acanthuridae
382	Yellowfin Surgeonfish	*Acanthurus xanthopterus*	Acanthuridae
102	Bigeye Scad	*Selar crumenopthalmus*	Atulai
239	Coral Grouper	*Epinephelus corallicola*	Serranidae
237	Flagtail Grouper	*Cephalopholis urodeta*	Serranidae
206	Grouper (misc.)	*Serannidae*	Serranidae
233	Highfin Grouper	*Epinephelus maculatus*	Serranidae
234	Honeycomb Grouper	*Epinephelus merra*	Serranidae
235	Marbled Grouper	*Epinephelus polyphekadion*	Serranidae
236	Peacock Grouper	*Cephalopholis argus*	Serranidae
244	Pink Grouper	*Saloptia powelli*	Serranidae
238	Saddleback Grouper	*Plectropomus laevis*	Serranidae
242	Tomato Grouper	*Cephanopholis sonnerati*	Serranidae
240	White Lyretail Grouper	*Variola albimarginata*	Serranidae
243	Yellow Banded Grouper	*Cephalopholis igarashiensis*	Serranidae

316	Snapper (misc. shallow)	*Lutjanidae*	Lutjanidae
250	Humpback Snapper	*Lutjanus gibbus*	Lutjanidae
251	Onespot Snapper	*Lutjanus monostigmus*	Lutjanidae
254	Red Snapper	*Lutjanus bohar*	Lutjanidae
208	Smalltooth Jobfish	*Aphareus furca*	Lutjanidae
371	Dash & Dot Goatfish	*Parupeneus barberrinus*	Mullidae
321	Goatfish (juvenile-misc)	*Mullidae*	Mullidae
322	Goatfish (misc.)	*Mullidae*	Mullidae
323	Sidespot Goatfish	*Parupeneus pleurostigma*	Mullidae
372	Two-barred Goatfish	*Parupeneus bifasciatus*	Mullidae
370	Yellowstripe Goatfish	*Mulloidichthys flavolineatus*	Mullidae
314	Parrotfish (misc.)	*Scarus sp.*	Scaridae
315	Seagrass Parrotfish	*Leptoscarus vaigiensis*	Scaridae
506	Octopus	*Octopus sp.*	Mollusk
510	Squid	*Teuthida*	Mollusk
516	Trochus	*Trochus sp.*	Mollusk
522	Clam/bivalve	*Bivalvia*	Mollusk
106	Mullet	*Mugilidae*	Mugilidae
304	Rabbitfish (hitting)	*Siganus sp.*	Siganidae
306	Rabbitfish (h.feda)	*Siganus puntatus*	Siganidae
307	Rabbitfish (menahac)	*Siganus sp.*	Siganidae
308	Rabbitfish (sesjun)	*Siganus spinus*	Siganidae
	Bolbometopon muricatum	*Bumphead parrotfish*	
391	Cheilinus undulatus	*Napoleon wrasse*	

	Reef sharks (misc)	*Carcharhinidae*	Carcharhinidae
	Hammerhead shark	*Sphyrnidae*	Carcharhinidae
338	Angelfish	*Pomacanthidae*	Other CRE-Finfish
338	Butterflyfish	*Chaetodontidae*	Other CRE-Finfish
324	Bigeye/glasseye	*Heteropriacanthus cruentatus*	Other CRE-Finfish
396	Blue Razorfish	*Xyrichtys pavo*	Other CRE-Finfish
397	Bronzespot Razorfish	*Xyrichtys celebicus*	Other CRE-Finfish
260	Cardinal Misc.	*Apogonidae*	Other CRE-Finfish
162	Cornetfish	*Fistularia commersonii*	Other CRE-Finfish
332	Damselfish	*Pomacentridae*	Other CRE-Finfish
341	Filefish (misc)	*Monacanthidae*	Other CRE-Finfish
340	Flounder (misc)	*Bothus sp.*	Other CRE-Finfish
328	Fusilier (misc.)	*Caesionidae*	Other CRE-Finfish
325	Goggle-eye	*Priacanthus hamrur*	Other CRE-Finfish
195	Lizardfish misc.	*Synodontidae*	Other CRE-Finfish
180	Milkfish	*Chanos chanos*	Other CRE-Finfish
329	Mojarra	*Gerres sp.*	Other CRE-Finfish
140	Moray eel	*Muraenidae*	Other CRE-Finfish
170	Needlefish	*Belonidae*	Other CRE-Finfish
343	Picasso Trigger	*Rhinecanthus aculeatus*	Other CRE-Finfish
348	Pufferfish	*Tetraodontidae*	Other CRE-Finfish
395	Razorfish (misc)	*Tribe Novaculini*	Other CRE-Finfish
130	Scorpionfishes	*Scorpaenidae*	Other CRE-Finfish
330	Sweetlips	*Plectorhinchus picus*	Other CRE-Finfish

342	Triggerfish (misc.)	*Balistidae*	Other CRE-Finfish
163	Trumpetfish	*Aulostomus chinensis*	Other CRE-Finfish
344	Wedge Trigger	*Rhinecanthus rectangulus*	Other CRE-Finfish
312	Squirrelfish	*Holocentridae*	Squirrelfish
313	Soldierfish (misc.)	*Holocentridae*	Squirrelfish
302	Wrasse	*Labridae*	Wrasse
390	Tripletail Wrasse	*Cheilinus trilobatus*	Wrasse
309	Rudderfish (guilli)	*Kyphosus sp.*	Rudderfish
373	Highfin Rudderfish Silver	*Kyphosus cinerascens*	Rudderfish
374	Highfin Rudderfish Brown	*Kyphosus sp.*	Rudderfish
200	Bottomfish (misc)	*n/a*	Misc. Bottomfish
300	Reef fish (misc)	*n/a*	Misc. Reef Fish
	Shallow bottom	*n/a*	Misc. Shallow bottomfish
501	Crabs (misc)	*n/a*	Crustaceans
503	Coconut Crab	*Birgus latro*	Crustaceans
500	Invertebrates	*n/a*	Other Invertebrates
514	Sea Cucumber	*Cucumariidae*	Other Invertebrates
600	Seaweeds	*n/a*	Algae
602	Lemu	*n/a*	Algae

Attachment 3-2: Species list table for the Guam

1. Bottomfish Multi-species Stock Complex (FSSI)

DAWR Creel Species Code	Species Name	Scientific Name
32302	red snapper, silvermouth (lehi)	Aphareus rutilans
32303	grey snapper, jobfish	Aprion virescens
31404	giant trevally, jack	Caranx ignoblis
31405	black trevally, jack	Caranx lugubris
28919	blacktip grouper	Epinephelus fasciatus
28941	lunartail (lyretail) grouper	Variola lauti
32304	red snapper (ehu)	Etelis carbunculus
32305	red snapper (onaga)	Etelis coruscans
32818	ambon emperor	Lethrinus amboinenis
32809	redgill emperor	Lethrinus rubrioperculatus
32310	blueline snapper	Lutjanus kasmira
32317	yellowtail snapper	Pristipomoides auricilla
32318	pink snapper (paka)	Pristipomoides filamentosus
32319	yelloweye snapper	Pristipomoides flavipinnis
32320	pink snapper (kalekale)	Pristipomoides seiboldi
32321	snapper (gindai)	Pristipomoides zonatus
31414	amberjack	Seriola dumerili

2. Crustacean deep-water shrimp complex (non-FSSI)

DAWR Creel Species Code	Species Name	Scientific Name
67600	deepwater shrimp	Heterocarpus spp.
67601	deepwater shrimp	Pandalus Unid sp 1
67602	deepwater shrimp	Pandalidae
67603	deepwater shrimp	Pandalidae

3. Crustacean spiny lobster complex (non-FSSI)

DAWR Creel Species Code	Species Name	Scientific Name
67913	spiny lobster	Panulirus marginatus
67915	spiny lobster	Panulirus penicillatus

4. Crustacean slipper lobster complex (non-FSSI)

DAWR Creel Species Code	Species Name	Scientific Name
67954	slipper lobster	Scyllaridae
67955	slipper lobster	Scyllaridae

5. Crustacean Kona crab complex (non-FSSI)

DAWR Creel Species Code	Species Name	Scientific Name
69150	Kona crab	Ranina ranina

6. Precious coral black coral complex (non-FSSI)

DAWR Creel Species Code	Species Name	Scientific Name
none	Black Coral	Anitpathes dichotoma
none	Black Coral	Antipathes grandis
none	Black Coral	Antipathes ulex

7. Exploratory area precious coral (except black coral) (non-FSSI)

DAWR Creel Species Code	Species Name	Scientific Name
none	Pink coral	Corallium secundum
none	Pink coral	Corallium regale
none	Pink coral	Corallium laauense
none	Bamboo coral	Lepidisis olapa
none	Bamboo coral	Acanella spp.
none	Gold Coral	Gerardia spp.
none	Gold Coral	Callogorgia gilberti
none	Gold Coral	Narella spp.

none	Gold Coral	Calyptrophora spp.

8. Coral reef ecosystem (non-FSSI)

DAWR Creel Species Code	Species Name	Scientific Name	Species grouping
41201	Achilles tang	Acanthurus achilles	Acanthuridae
41232	Bariene's surgeonfish	Acanthurus bariene	Acanthuridae
41207	Ringtail surgeonfish	Acanthurus blochii	Acanthuridae
41234	Chronixis surgeonfish	Acanthurus chronixis	Acanthuridae
41202	Eye-striped surgeonfish	Acanthurus dussumieri	Acanthuridae
41204	Whitespotted surgeonfish	Acanthurus guttatus	Acanthuridae
41239	Whitebar surgeonfish	Acanthurus leucocheilus	Acanthuridae
41205	Palelipped surgeonfish	Acanthurus leucopareius	Acanthuridae
41206	Blue-banded surgeonfish	Acanthurus lineatus	Acanthuridae
41235	White-Freckled surgeonfish	Acanthurus maculiceps	Acanthuridae
41233	Elongate surgeonfish	Acanthurus mata	Acanthuridae
41203	Whitecheek surgeonfish	Acanthurus nigricans	Acanthuridae
41208	Blackstreak surgeonfish	Acanthurus nigricauda	Acanthuridae
41209	Brown surgeonfish	Acanthurus nigrofuscus	Acanthuridae
41210	Bluelined surgeonfish	Acanthurus nigroris	Acanthuridae
41240	Surgeonfish	Acanthurus nubilus	Acanthuridae
41211	Orangeband surgeonfish	Acanthurus olivaceus	Acanthuridae

41212	Mimic surgeonfish	Acanthurus pyroferus	Acanthuridae
41243	Surgeonfishes/tangs	Acanthuridae	Acanthuridae
41200	Surgeonfishes/tangs	Acanthuridae	Acanthuridae
41213	Thomson's surgeonfish	Acanthurus thompsoni	Acanthuridae
41214	Convict tang	Acanthurus triostegus	Acanthuridae
41215	Yellowfin surgeonfish	Acanthurus xanthopterus	Acanthuridae
41216	Twospot bristletooth	Ctenochaetus binotatus	Acanthuridae
41217	Black surgeonfish	Ctenochaetus hawaiiensis	Acanthuridae
41236	Blue-spotted Bristletooth	Ctenochaetus marginatus	Acanthuridae
41218	Striped bristletooth	Ctenochaetus striatus	Acanthuridae
41231	Yellow-eyed bristletooth	Ctenochaetus strigosus	Acanthuridae
41237	Tomini's surgeonfish	Ctenochaetus tominiensis	Acanthuridae
41219	Whitemargin unicornfish	Naso annulatus	Acanthuridae
41220	Humpback unicornfish	Naso brachycentron	Acanthuridae
41221	Spotted unicornfish	Naso brevirostris	Acanthuridae
41241	Gray unicornfish	Naso caesius	Acanthuridae
41222	Black tongue unicornfish	Naso hexacanthus	Acanthuridae
41223	Orangespine unicornfish	Naso lituratus	Acanthuridae
41238	Naso tang	Naso lopezi	Acanthuridae
41242	Barred unicornfish	Naso thynnoides	Acanthuridae
41224	Humpnose unicornish	Naso tuberosus	Acanthuridae
41225	Bluespine unicornfish	Naso unicornis	Acanthuridae
41226	Bignose unicornfish	Naso vlamingii	Acanthuridae

41227	Hepatus tang	Paracanthurus hepatus	Acanthuridae
41228	Yellow tang	Zebrasoma flavescens	Acanthuridae
41229	Brown tang	Zebrasoma scopas	Acanthuridae
41230	Pacific sailfin tang	Zebrasoma veliferum	Acanthuridae
31401	Pennantfish/threadfin	Alectis ciliaris	Carangidae
31402	Malabar Trevally	Alectis indicus	Carangidae
31400	Jack (misc)	Carangidae	Carangidae
31420		Carangini	Carangidae
31419	Blue kingfish trevally	Carangoides caeruleopinnatus	Carangidae
31431	Shadow kingfish	Carangoides dinema	Carangidae
31422	Bar jack	Carangoides ferdau	Carangidae
31433	Yellow dotted trevally	Carangoides fulvoguttatus	Carangidae
31438	Headnotch trevally	Carangoides hedlandensis	Carangidae
31403	Goldspot trevally	Carangoides orthogrammus	Carangidae
31424	Barcheek trevally	Carangoides plagiotaenia	Carangidae
31425	Jacks (misc)	Carangoides talamparoides	Carangidae
31437	Trevally	Carangoides uii	Carangidae
31429	Trevally	Caranx i'e'	Carangidae
31406	Bluefin trevally	Caranx melampygus	Carangidae
31428	Brassy trevally	Caranx papuensis	Carangidae

31407	Bigeye trevally	Caranx sexfasciatus	Carangidae
31408	Mackerel scad	Decapterus macarellus	Carangidae
31423	Mackerel scad	Decapterus macrosoma	Carangidae
31421	Round scad	Decapterus maruadsi	Carangidae
31430	Round scad	Decapterus russelli	Carangidae
31409	Rainbow runner	Elagatis bipinnulatus	Carangidae
31410	Golden trevally	Gnathanodon speciosus	Carangidae
31439		Megalaspis cordyla	Carangidae
31435	Pilotfish	Naucrates ductor	Carangidae
31440	Elagatis, Scomberoides	Naucratini	Carangidae
31412	Leatherback	Scomberoides lysan	Carangidae
31415	Almaco jack	Seriola rivoliana	Carangidae
31416	Small spotted pompano	Trachinotus bailloni	Carangidae
31417	Silver or Snubnose pompano	Trachinotus blochii	Carangidae
31432	Mandibular kingfish	Ulua mandibularis	Carangidae
31418	Kingfish	Uraspis helvola	Carangidae
31436	Deep trevally	Uraspis secunda	Carangidae
31434	Whitemouth trevally	Uraspis uraspis	Carangidae
31413	Atulai	Selar crumenophthalmus	Atulai
31426	Atulai	Atule mate	Atulai
31427	Atulai	Selar boops	Atulai
32800	Emperors	Lethrinidae	Lethrinidae
32801	Yellow-Spot Emperor	Gnathodentex aurolineatus	Lethrinidae

32802	Grey Bream	Gymnocranius griseus	Lethrinidae
32804	Thumbprint Emperor	Lethrinus harak	Lethrinidae
32805	Yellowtail Emperor	Lethrinus atkinsoni	Lethrinidae
32806	Longface Emperor	Lethrinus olivaceus	Lethrinidae
32807	Ornate Emperor	Lethrinus ornatus	Lethrinidae
32808	Orange-Striped Emperor	Lethrinus obsoletus	Lethrinidae
32810	Black-Blotch Emperor	Lethrinus semicinctus	Lethrinidae
32811	Yellowlip Emperor	Lethrinus xanthochilus	Lethrinidae
32812	Bigeye Emperor	Monotaxis grandoculus	Lethrinidae
32813	Japanese Bream	Gymnocranius euanus	Lethrinidae
32814	Orange-Spotted Emperor	Lethrinus erythracanthus	Lethrinidae
32815	Large-Eye Bream	Wattsia mossambica	Lethrinidae
32816	Stout Emperor	Gymnocranius sp	Lethrinidae
32817	Smtoothed Emperor	Lethrinus microdon	Lethrinidae
32819	Longspine Emperor	Lethrinus genivittatus	Lethrinidae
32820	Pinkear Emperor	Lethrinus lentjan	Lethrinidae
32821	Blue-Spotted Bream	Gymnocranius microdon	Lethrinidae
32822	Longfin Emperor	Lethrinus erythropterus	Lethrinidae
32823	Blue-Lined Bream	Gymnocranius grandoculus	Lethrinidae
32824	Slender Emperor	Lethrinus variegatus	Lethrinidae
36402	Bucktooth Parrotfish	Calotomus carolinus	Scaridae
36420	Spineytooth Parrotfish	Calotomus spinidens	Scaridae
36403	Bicolor Parrotfish	Cetoscarus bicolor	Scaridae

36422	Parrotfish	Chlorurus bleekeri	Scaridae
36431	Parrotfish	Chlorurus bowersi	Scaridae
36408	Tan-Faced Parrotfish	Chlorurus frontalis	Scaridae
36410	Steephead Parrotfish	Chlorurus microrhinos	Scaridae
36433	Parrotfish	Chlorurus pyrrhurus	Scaridae
36416	Bullethead Parrotfish	Chlorurus sordidus	Scaridae
36404	Parrotfish	Hipposcarus longiceps	Scaridae
36405	Seagrass Parrotfish	Leptoscarus vaigiensis	Scaridae
36400	Parrotfishes	Scaridae	Scaridae
36406	Fil-Finned Parrotfish	Scarus altipinnis	Scaridae
36429	Parrotfish	Scarus chameleon	Scaridae
36423	Parrotfish	Scarus dimidiatus	Scaridae
36419	Parrotfish	Scarus festivus	Scaridae
36434	Yellowfin Parrotfish	Scarus flavipectoralis	Scaridae
36417	Tricolor Parrotfish	Scarus forsteni	Scaridae
36407	Vermiculate Parrotfish	Scarus frenatus	Scaridae
36409	Blue-Barred Parrotfish	Scarus ghobban	Scaridae
36411	Parrotfish	Scarus globiceps	Scaridae
36424	Java Parrotfish	Scarus hypselosoma	Scaridae
36418	Parrotfish	Scarus sp.	Scaridae
36432	Black Parrotfish	Scarus niger	Scaridae
36412	Parrotfish	Scarus oviceps	Scaridae
36425	Greenthroat Parrotfish	Scarus prasiognathos	Scaridae
36413	Pale Nose Parrotfish	Scarus psittacus	Scaridae

36426	Parrotfish	Scarus quoyi	Scaridae
36427	Parrotfish	Scarus rivulatus	Scaridae
36414	Parrotfish	Scarus rubroviolaceus	Scaridae
36415	Chevron Parrotfish	Scarus schlegeli	Scaridae
36428	Parrotfish	Scarus spinus	Scaridae
36435	Tricolor Parrotfish	Scarus tricolor	Scaridae
36421	Parrotfish	Scarus xanthopleura	Scaridae
33200	Goatfishes	Mullidae	Mullidae
33201	Yellowstriped Goatfish	Mulloidichthys flavolineatus	Mullidae
33202	Orange Goatfish	Mulloidichthys pflugeri	Mullidae
33219	Juvenile Goatfish	Mulloidichthys ti'ao	Mullidae
33203	Yellowfin Goatfish	Mulloidichthys vanicolensis	Mullidae
33216		Parupeneus barberinoides	Mullidae
33204	Dash And Dot Goatfish	Parupeneus barberinus	Mullidae
33205		Parupeneus bifasciatus	Mullidae
33210	White-Lined Goatfish	Parupeneus ciliatus	Mullidae
33206	Yellow Goatfish	Parupeneus cyclostomus	Mullidae
33208	Redspot Goatfish	Parupeneus heptacanthus	Mullidae
33214	Indian Goatfish	Parupeneus indicus	Mullidae
33211	Multibarred Goatfish	Parupeneus multifasciatus	Mullidae
33209	Sidespot Goatfish	Parupeneus pleurostigma	Mullidae
33217	Goatfish	Parupeneus sp	Mullidae

33218	Goatfish	Upeneus arge	Mullidae
33212	Band-Tailed Goatfish	Upeneus taeniopterus	Mullidae
33215	Blackstriped Goatfish	Upeneus tragula	Mullidae
33213	Yellowbanded Goatfish	Upeneus vittatus	Mullidae
54501	Spiney Chiton	Acanthopleura spinosa	Mollusks
54410	Bubble Shells,Sea Hares	Acteonidae	Mollusks
54603	Antique Ark	Anadara antiquata	Mollusks
54602	Indo-Pacific Ark	Arca navicularis	Mollusks
54601	Ventricose Ark	Arca ventricosa	Mollusks
54600	Ark Shells	Arcidae	Mollusks
57742	Common Paper Nautilus	Argonauta argo	Mollusks
57745	Gruner'S Paper Nautilus	Argonauta gruneri	Mollusks
57741	Brown Paper Nautilus	Argonauta hians	Mollusks
57743	Nodose Paper Nautilus	Argonauta nodosa	Mollusks
57744	Noury'S Paper Nautilus	Argonauta nouri	Mollusks
57740	Paper Nautiluses	Argonautidae	Mollusks
56896	Pacific Sand Clam	Asaphis violescens	Mollusks
56891	Gaudy Sand Clam	Aspaphis deflorata	Mollusks
51751	Peron'S Sea Butterfly	Atlanta peroni	Mollusks
51750		Atlantidae	Mollusks
54424	Wh Pacific Atys	Atys naucum	Mollusks
54604	Almond Ark	Babatia amygdalumtostum	Mollusks
50840	Goblets,Dwarf Tritons	Buccinidae	Mollusks

54421	Ampule Bubble	Bulla ampulla	Mollusks
54420	Bubble Shells	Bullidae	Mollusks
54422	Lined Bubble	Bullina lineata	Mollusks
50796	Giant Frog Shell	Bursa bubo	Mollusks
50791	Warty Frog Shell	Bursa bufonia	Mollusks
50792	Blood-Stain Frog Shell	Bursa cruentata	Mollusks
50793	Granulate Frog Shell	Bursa granularis	Mollusks
50799	Lamarck'S Frog Shell	Bursa lamarcki	Mollusks
50798	Red-Mth Frog Shell	Bursa lissostoma	Mollusks
50794	Udder Frog Shell	Bursa mammata	Mollusks
50797	Ruddy Frog Shell	Bursa rebeta	Mollusks
50795	Wine-Mth Frog Shell	Bursa rhodostoma	Mollusks
50790	Frog Shells	Bursidae	Mollusks
50751	Umbilicate Ovula	Calpurnus verrucosus	Mollusks
50878	File Miter	Cancilla filaris	Mollusks
50842	Smoky Goblet	Cantharus fumosus	Mollusks
50841	Waved Goblet	Cantharus undosus	Mollusks
56721	Varitated Cardita	Cardita variegata	Mollusks
56720	Carditid Clams	Carditidae	Mollusks
50767	Vibex Bonnet	Casmaria erinaceus	Mollusks
50768	Heavy Bonnet	Casmaria ponderosa	Mollusks
50765	Helmet Shells	Cassidae	Mollusks
50766	Horned Helmet	Cassius cornuta	Mollusks
55022	3-Toothed Cavoline	Cavolina tridentata	Mollusks

55023	Unicate Cavoline	Cavolina uncinata	Mollusks
55021	Sea Butterfly	Cavolinia cf globulosa	Mollusks
55020	Sea Butterflies	Cavolinidae	Mollusks
50650	Turret,Worm-Shells	Cerithiidae	Mollusks
50654	Column Certh	Cerithium columna	Mollusks
50651	Giant Knobbed Certh	Cerithium nodulosum	Mollusks
56711	Lazarus Jewel Box	Chama lazarus	Mollusks
56710	Jewel Boxes	Chamidae	Mollusks
50781	Triton Trumpet	Charonia tritonis	Mollusks
50812	Ramose Murex	Chicoreus ramosus	Mollusks
54500	Chitons	Chitonidae	Mollusks
56623	Cook'S Scallop	Chlamys cooki	Mollusks
56621	Squamose Scallop	Chlamys squamosa	Mollusks
56500	Bivalves	Class Bivalvia	Mollusks
55027	Pyramid Clio	Clio cuspidata	Mollusks
55026	Irregular Urchins	Clio pyramidata	Mollusks
50652	Morus Certh	Clypeomorus concisus	Mollusks
56706	Punctate Lucina	Codakia punctata	Mollusks
50847	Maculated Dwarf Triton	Columbraria muricata	Mollusks
50845	Shiny Dwarf Triton	Columbraria nitidula	Mollusks
50846	Twisted Dwarf Triton	Columbraria tortuosa	Mollusks
50920	Cone Shells	Conidae	Mollusks
50952	Sand-Dusted Cone	Conus arenatus	Mollusks
50963	Princely Cone	Conus aulicus	Mollusks

50968	Aureus Cone	Conus aureus	Mollusks
50969	Gold-Leaf Cone	Conus auricomus	Mollusks
50947	Banded Marble-Cone	Conus bandanus	Mollusks
50971	Bubble Cone	Conus bullatus	Mollusks
50942	Captain Cone	Conus capitaneus	Mollusks
50932	Cat Cone	Conus catus	Mollusks
50924	Chaldean Cone	Conus chaldeus	Mollusks
50972	Comma Cone	Conus connectens	Mollusks
50922	Crowned Cone	Conus coronatus	Mollusks
50970	Cylindrical Cone	Conus cylandraceus	Mollusks
50926	Distantly-Lined Cone	Conus distans	Mollusks
50923	Hebrew Cone	Conus ebraeus	Mollusks
50936	Ivory Cone	Conus eburneus	Mollusks
50965	Episcopus Cone	Conus episcopus	Mollusks
50927	Pacific Yellow Cone	Conus flavidus	Mollusks
50928	Frigid Cone	Conus frigidus	Mollusks
50945	General Cone	Conus generalis	Mollusks
50961	Geography Cone	Conus geographus	Mollusks
50955	Acorn Cone	Conus glans	Mollusks
50946	Imperial Cone	Conus imperialis	Mollusks
50964	Ambassador Cone	Conus legatus	Mollusks
50938	Leopard Cone	Conus leopardus	Mollusks
50951	Lithography Cone	Conus lithoglyphus	Mollusks
50937	Lettered Cone	Conus litteratus	Mollusks

50929	Livid Cone	Conus lividus	Mollusks
50958	Luteus Cone	Conus luteus	Mollusks
50966	Dignified Cone	Conus magnificus	Mollusks
50930	Soldier Cone	Conus miles	Mollusks
50939	1000-Spot Cone	Conus miliaris	Mollusks
50935	Morelet'S Cone	Conus moreleti	Mollusks
50934	Muricate Cone	Conus muriculatus	Mollusks
50940	Music Cone	Conus musicus	Mollusks
50943	Weasel Cone	Conus mustelinus	Mollusks
50954	Obscure Cone	Conus obscurus	Mollusks
50959	Pertusus Cone	Conus pertusus	Mollusks
50921	Flea-Bite Cone	Conus pulicarius	Mollusks
50931	Rat Cone	Conus rattus	Mollusks
50967	Netted Cone	Conus retifer	Mollusks
50933	Blood-Stained Cone	Conus sanguinolentus	Mollusks
50957	Leaden Cone	Conus scabriusculus	Mollusks
50925	Marriage Cone	Conus sponsalis	Mollusks
50950	Striatellus Cone	Conus striatellus	Mollusks
50948	Striated Cone	Conus striatus	Mollusks
50956	Terebra Cone	Conus terebra	Mollusks
50944	Checkered Cone	Conus tesselatus	Mollusks
50953	Textile Cone	Conus textile	Mollusks
50962	Tulip Cone	Conus tulipa	Mollusks
50960	Varius Cone	Conus varius	Mollusks

50941	Flag Cone	Conus vexillum	Mollusks
50949	Calf Cone	Conus vitulinus	Mollusks
50832	Eroded Coral Shell	Coralliophila erosa	Mollusks
50831	Violet Coral Shell	Coralliophila neritodidea	Mollusks
50830	Coral Shells	Coralliophilidae	Mollusks
56662	Giant Oyster	Crassostrea gigas	Mollusks
56661	Mangrove Oyster	Crassostrea mordax	Mollusks
50813	Bionic Rock Shell	Cronia biconica	Mollusks
56624	Speciosus Scallop	Cryptopecten speciosum	Mollusks
55025	Cigar Pteropod	Cuvierina columnella	Mollusks
50770	Tritons	Cymatiidae	Mollusks
50784	Clandestine Triton	Cymatium clandestinium	Mollusks
50773	Jeweled Triton	Cymatium gemmatum	Mollusks
50776	Liver Triton	Cymatium hepaticum	Mollusks
50786	Wide-Lipped Triton	Cymatium labiosum	Mollusks
50782	Black-Spotted Triton	Cymatium lotorium	Mollusks
50774	Short-Neck Triton	Cymatium muricinum	Mollusks
50772	Nicobar Hairy Triton	Cymatium nicobaricum	Mollusks
50779	Common Hairy Triton	Cymatium pileare	Mollusks
50771	Aquatile Hairy Triton	Cymatium pilere aquatile	Mollusks
50783	Pear Triton	Cymatium pyrum	Mollusks
50775	Red Triton	Cymatium rubeculum	Mollusks
50785	Dwarf Hairy Triton	Cymatium vespaceum	Mollusks

50703	Gold-Ringer Cowry	Cypraea annulus	Mollusks
50726	Arabian Cowry	Cypraea arabica	Mollusks
50734	Eyed Cowry	Cypraea argus	Mollusks
50739	Golden Cowry	Cypraea aurantium	Mollusks
50738	Beck'S Cowry	Cypraea beckii	Mollusks
50733	Bistro Cowry	Cypraea bistronatata	Mollusks
50702	Snake'S Head Cowry	Cypraea caputserpentis	Mollusks
50710	Carnelian Cowry	Cypraea carneola	Mollusks
50740	Chinese Cowry	Cypraea chinensis	Mollusks
50732	Chick-Pea Cowry	Cypraea cicercula	Mollusks
50721	Clandestine Cowry	Cypraea clandestina	Mollusks
50715	Sieve Cowry	Cypraea cribaria	Mollusks
50713	Sowerby'S Cowry	Cypraea cylindrica	Mollusks
50717	Depressed Cowry	Cypraea depressa	Mollusks
50743	Dillwyn'S Cowry	Cypraea dillywini	Mollusks
50706	Eglantine Cowry	Cypraea eglantina	Mollusks
50708	Eroded Cowry	Cypraea erosa	Mollusks
50736	Globular Cowry	Cypraea globulus	Mollusks
50711	Honey Cowry	Cypraea helvola	Mollusks
50730	Swallow Cowry	Cypraea hirundo	Mollusks
50742	Humphrey'S Cowry	Cypraea humphreysi	Mollusks
50707	Isabelle Cowry	Cypraea isabella	Mollusks
50731	Lined-Lip Cowry	Cypraea labrolineata	Mollusks
50741	Limacina Cowry	Cypraea limicina	Mollusks

50704	Lynx Cowry	Cypraea lynx	Mollusks
50716	Reticulated Cowry	Cypraea maculifera	Mollusks
50705	Map Cowry	Cypraea mappa	Mollusks
50737	Marie'S Cowry	Cypraea mariae	Mollusks
50725	Humpback Cowry	Cypraea mauritiana	Mollusks
50723	Microdon Cowry	Cypraea microdon	Mollusks
50701	Money Cowry	Cypraea moneta	Mollusks
50722	Nuclear Cowry	Cypraea nucleus	Mollusks
50709	Porus Cowry	Cypraea poraria	Mollusks
50714	Punctata Cowry	Cypraea punctata	Mollusks
50729	Jester Cowry	Cypraea scurra	Mollusks
50712	Grape Cowry	Cypraea staphlea	Mollusks
50724	Stolid Cowry	Cypraea stolida	Mollusks
50720	Mole Cowry	Cypraea talpa	Mollusks
50728	Teres Cowry	Cypraea teres	Mollusks
50718	Tiger Cowry	Cypraea tigris	Mollusks
50727	Ventral Cowry	Cypraea ventriculus	Mollusks
50719	Pacific Deer Cowry	Cypraea vitellus	Mollusks
50735	Undulating Cowry	Cypraea ziczac	Mollusks
50700	Cowrys	Cypraeidae	Mollusks
55024	3-Spined Cavoline	Diacria trispinosa	Mollusks
50778	Anal Triton	Distorso anus	Mollusks
55100	Dorid Nudibranchs	Doridae	Mollusks
50823	Clatherate Drupe	Drupa clathrata	Mollusks

50821	Elegant Pacific Drupe	Drupa elegans	Mollusks
50820	Digitate Pacific Drupe	Drupa grossularia	Mollusks
50819	Purple Pacific Drupe	Drupa morum	Mollusks
50818	Prickley Pacific Drupe	Drupa ricinus	Mollusks
50822	Strawberry Drupe	Drupa rubusidacaeus	Mollusks
56622	Spectacular Scallop	Excellichlamys spectiablis	Mollusks
50850	Spindles	Fasciolariidae	Mollusks
56722	Pac Strawberry Cockle	Fragum fragum	Mollusks
56908	Tumid Venus	Gafrarium tumidum	Mollusks
50777	Rosy Gyre Triton	Gyrineum roseum	Mollusks
50780	Purple Gyre Triton	Gyrinium pusillum	Mollusks
50911	Little Love Harp	Harpa amouretta	Mollusks
50913	True Harp	Harpa harpa	Mollusks
50912	Major Harp	Harpa major	Mollusks
50910	Harp Shells	Harpidae	Mollusks
50989	Lance Auger	Hastula lanceata	Mollusks
50988	Pencil Auger	Hastula penicillata	Mollusks
55101	Spanish Dancer	Hexabranchus sanguineus	Mollusks
56881	Giant Clam	Hippopus hippopus	Mollusks
50806	Anatomical Murex	Homalocanthia anatomica	Mollusks
54423	Gr-Lined Paber Bubble	Hydratina physis	Mollusks
50875	Cone-Like Miter	Imbricaria conularis	Mollusks

50873	Olive-Shaped Miter	Imbricaria olivaeformis	Mollusks
50874	Bonelike Miter	Imbricaria punctata	Mollusks
56611	Saddle Tree Oyster	Isognomon ephippium	Mollusks
56610	Tree Oysters	Isognomonidae	Mollusks
54351	Janthina Snail	Janthina janthina	Mollusks
54350	Pelagic Snails	Janthinidae	Mollusks
50682	Chiragra Spider Conch	Lambis chiragra	Mollusks
50685	Ormouth Spider Conch	Lambis crocota	Mollusks
50681	Common Spider Conch	Lambis lambis	Mollusks
50684	Scorpio Conch	Lambis scorpius scorpius	Mollusks
50680	Spider Conch	Lambis sp.	Mollusks
50683	Giant Spider Conch	Lambis truncata	Mollusks
50851	Nobby Spindle	Latirus nodatus	Mollusks
50852	Spindle	Latirus rudis	Mollusks
56681	Fragile Lima	Lima fragilis	Mollusks
56682	Indo-Pac Spiny Lima	Lima vulgaris	Mollusks
56680	Limas	Limidae	Mollusks
56904	Camp Pitar Venus	Lioconcha castrensis	Mollusks
56906	Hieroglyphic Venus	Lioconcha hieroglyphica	Mollusks
56905	Ornate Pitar Venus	Lioconcha ornata	Mollusks
50642	Scabra Periwinkle	Littorina scabra	Mollusks
50641	Undulate Periwinkle	Littorina undulata	Mollusks
50640	Periwinkles	Littorinidae	Mollusks

56705	Lucinas	Lucinidae	Mollusks
50762	Apple Tun	Malea pomum	Mollusks
50811	Pinnacle Murex	Marchia bipinnatus	Mollusks
50809	Fenestrate Murex	Marchia martinetana	Mollusks
54430	Melampus Shells	Melampidae	Mollusks
54431	Yellow Melampus	Melampus luteus	Mollusks
57401	Flamboyant Cuttlefish	Metasepia pfefferi	Mollusks
54425	Mini Lined-Bubble	Micromelo undatus	Mollusks
54411	Ventricose Milda	Milda ventricosa	Mollusks
56626	Miraculous Scallop	Mirapecten mirificus	Mollusks
50897	Imperial Miter	Miter imperalis	Mollusks
50899	Acuminate Miter	Mitra acuminata	Mollusks
50890	Cardinal Miter	Mitra cardinalis	Mollusks
50893	Chrysalis Miter	Mitra chrysalis	Mollusks
50895	Gold-Mth Miter	Mitra chrysostoma	Mollusks
50889	Coffee Miter	Mitra coffea	Mollusks
50898	Contracted Miter	Mitra contracta	Mollusks
50892	Kettle Miter	Mitra cucumaria	Mollusks
50876	Rusty Miter	Mitra ferruginea	Mollusks
50891	Strawberry Miter	Mitra fraga	Mollusks
50888	Tesselate Miter	Mitra incompta	Mollusks
50872	Episcopal Miter	Mitra mitra	Mollusks
50883	Papal Miter	Mitra papalis	Mollusks
50894	Red-Painted Miter	Mitra rubitincta	Mollusks

50871	Pontifical Miter	Mitra stictica	Mollusks
50870	Miter Shells	Mitridae	Mollusks
50000	Mollusca	MOLLUSCA	Mollusks
50801	Burnt Murex	Murex burneus	Mollusks
50800	Murex Shells	Muricidae	Mollusks
56505	Mussels	Mytilidae	Mollusks
50804	Tragonula Murex	Naquetia trigonulus	Mollusks
50803	Triquetra Murex	Naquetia triquetra	Mollusks
50817	Francolina Jopas	Nassa francolina	Mollusks
50855	Nassa Mud Snails	Nassariidae	Mollusks
50858	Granulated Nassa	Nassarius graniferus	Mollusks
50857	Margarite Nassa	Nassarius margaritiferus	Mollusks
50856	Pimpled Basket	Nassarius papillosus	Mollusks
50755	Moon Shells	Naticidae	Mollusks
57300	Nautilus	Nautilidae	Mollusks
57301	Chambered Nautilus	Nautilus ponpilius	Mollusks
50884	Clathrus Miter	Neocancilla clathrus	Mollusks
50896	Flecked Miter	Neocancilla granitina	Mollusks
50901	Butterfly Miter	Neocancilla papilio	Mollusks
50633	Ox-Palate Nerite	Nerita albicilla	Mollusks
50631	Plicate Nerite	Nerita plicata	Mollusks
50632	Polished Nerite	Nerita polita	Mollusks
50634	Reticulate Nerite	Nerita signata	Mollusks
50630	Nerites	Neritidae	Mollusks

50600	Diotocardia	O Archaeogastropoda	Mollusks
57700	Octopus	Octopodidae	Mollusks
57735	Common Octopus	Octopus cyanea	Mollusks
57734	Red Octopus	Octopus luteus	Mollusks
57736	Ornate Octopus	Octopus ornatus	Mollusks
57730	Octopus	Octopus sp	Mollusks
57732	Pelagic Octopus	Octopus sp 1	Mollusks
57733	Long-Armed Octopus	Octopus sp 2	Mollusks
57731	Elongate Octopus	Octopus teuthoides	Mollusks
50861	Amethyst Olive	Oliva annulata	Mollusks
50863	Carnelian Olive	Oliva carneola	Mollusks
50862	Red-Mth Olive	Oliva miniacea	Mollusks
50864	Peg Olive	Oliva paxillus	Mollusks
50860	Olive Shells	Olividae	Mollusks
57500	Squids	Order Teuthoidea	Mollusks
56660	True Oysters	Ostreidae	Mollusks
54412	Cat'S Ear Otopleura	Otopleura auriscati	Mollusks
50753	Common Egg Cowry	Ovula ovum	Mollusks
50750	Egg Shells	Ovulidae	Mollusks
56620	Scallops	Pectinidae	Mollusks
56902	Crispate Venus	Periglypta crispata	Mollusks
56903	Youthful Venus	Periglypta puerpera	Mollusks
56901	Reticulate Venus	Periglypta reticulata	Mollusks
56601	Pearl Oyster	Pinctada margaritfera	Mollusks

56531	Bicolor Pen Shell	Pinna bicolor	Mollusks
56530	Pen Shells	Pinnidae	Mollusks
50756	Breast-Shaped Moon	Polinices mamatus	Mollusks
50757	Pear-Shaped Moon	Polinices tumidus	Mollusks
50844	Strawberry Goblet	Pollia fragaria	Mollusks
50843	Beautiful Goblet	Pollia pulchra	Mollusks
50752	Fruit Ovula	Prionovula fruticum	Mollusks
56600	Pearl Oysters	Pteriidae	Mollusks
50904	Crenulate Miter	Pterygia crenulata	Mollusks
50907	Fenestrate Miter	Pterygia fenestrata	Mollusks
50905	Nut Miter	Pterygia nucea	Mollusks
50902	Rough Miter	Pterygia scabricula	Mollusks
50810	Club Murex	Pterynotus elongatus	Mollusks
50807	Fluted Murex	Pterynotus laqueatus	Mollusks
50808	3-Winged Murex	Pterynotus tripterus	Mollusks
54413	Solid Pupa	Pupa solidula	Mollusks
50816	Perssian Purpura	Purpura persica	Mollusks
54401	Sulcate Pyram	Pyramidella sulcata	Mollusks
54400	Pyram Shells	Pyramidellidae	Mollusks
50833	Quoy'S Coral Shell	Quoyula madreporarum	Mollusks
50834	Rapa Snail	Rapa rapa	Mollusks
50653	Rough Vertigus	Rhinoclavis aspera	Mollusks
50655	Obelisk Vertigus	Rhinoclavis sinensis	Mollusks
50900	Chaste Miter	Sabricola casta	Mollusks

56625	Tiger Scallop	Semipallium tigris	Mollusks
57403	Broadclub Cuttlefish	Sepia latimanus	Mollusks
57402	Cuttlefish	Sepia sp.	Mollusks
57594	Bigfin Reef Squid	Sepioteuthis lessoniana	Mollusks
56511	Box Mussel	Septifer bilocularis	Mollusks
50805	Lacy Murex	Siratus laciniatus	Mollusks
56670	Thorny Oysters	Spondylidae	Mollusks
56671	Ducal Thorny Oyster	Spondyulus squamosus	Mollusks
56532	Baggy Pen Shell	Streptopinna saccata	Mollusks
50660	True Conchs	Strombidae	Mollusks
50665	Samar Conch	Strombus dentatus	Mollusks
50666	Fragile Conch	Strombus fragilis	Mollusks
50663	Gibbose Conch	Strombus gibberulus	Mollusks
50669	Lavender-Mouth Conch	Strombus haemastoma	Mollusks
50667	Silver-Lip Conch	Strombus lentigninosus	Mollusks
50662	Red-Lip Conch	Strombus luhuanus	Mollusks
50664	Micro Conch	Strombus microurceus	Mollusks
50661	Mutable Conch	Strombus mutabilis	Mollusks
50672	Pretty Conch	Strombus plicatus	Mollusks
50670	Laciniate Conch	Strombus sinuatus	Mollusks
50671	Bull Conch	Strombus taurus	Mollusks
50612	Pyramid Top	Tectus pyramis	Mollusks
56894	Box-Like Tellin	Tellina capsoides	Mollusks
56892	Cat'S Tongue Tellin	Tellina linguafelis	Mollusks

56895	Remie'S Tellin	Tellina remies	Mollusks
56893	Rasp Tellin	Tellina scobinata	Mollusks
56890	Tellin Clams	Tellinidae	Mollusks
50668	Terebellum Conch	Terebellum terebellum	Mollusks
50985	Similar Auger	Terebra affinis	Mollusks
50997	Fly-Spotted Auger	Terebra areolata	Mollusks
50996	Eyed Auger	Terebra argus	Mollusks
50987	Babylonian Auger	Terebra babylonia	Mollusks
50990	Certhlike Auger	Terebra cerithiana	Mollusks
50995	Short Auger	Terebra chlorata	Mollusks
50984	Crenulated Auger	Terebra crenulata	Mollusks
50982	Dimidiate Auger	Terebra dimidiata	Mollusks
50994	Tiger Auger	Terebra felina	Mollusks
50991	Funnel Auger	Terebra funiculata	Mollusks
50993	Spotted Auger	Terebra gutatta	Mollusks
50981	Marlinspike Auger	Terebra maculata	Mollusks
50986	Cloud Auger	Terebra nubulosa	Mollusks
50983	Subulate Auger	Terebra subulata	Mollusks
50992	Undulate Auger	Terebra undulata	Mollusks
50980	Auger Shells	Terebridae	Mollusks
50815	Belligerent Rock Shell	Thais armigera	Mollusks
50814	Tuberose Rock Shell	Thais tuberosa	Mollusks
50761	Partridge Tun	Tonna perdix	Mollusks
50760	Tun Shells	Tonnidae	Mollusks

56723	Angulate Cockle	Trachycardium angulatum	Mollusks
56882	Giant Clam	Tridacna crocea	Mollusks
56883	Lagoon Giant Clam	Tridacna derasa	Mollusks
56884	Giant Clam	Tridacna gigas	Mollusks
56885	Common Giant Clam	Tridacna maxima	Mollusks
56886	Fluted Giant Clam	Tridacna squamosa	Mollusks
56880	Giant Clams	Tridacnidae	Mollusks
50610	Top Shells	Trochidae	Mollusks
50611	Top Shell	Trochus niloticus	Mollusks
50613	Radiate Top	Trochus radiatus	Mollusks
50865	Vases	Turbinellidae	Mollusks
50620	Turban Shell	Turbinidae	Mollusks
50622	Silver-Mouth Turbin	Turbo argyrostoma	Mollusks
50623	Tapestry Turbin	Turbo petholatus	Mollusks
50621	Rough Turbin	Turbo setosus	Mollusks
50867	Ceramic Vase	Vasum ceramicum	Mollusks
50866	Common Pacific Vase	Vasum turbinellus	Mollusks
56900	Venus Shells	Veneridae	Mollusks
50887	Bernhard'S Miter	Vexillum bernhardiana	Mollusks
50882	Cancellaria Miter	Vexillum cancellarioides	Mollusks
50880	Saffron Miter	Vexillum crocatum	Mollusks
50879	Roughened Miter	Vexillum exasperatum	Mollusks
50885	Patriarchal Miter	Vexillum patriarchalis	Mollusks

50881	Half-Banded Miter	Vexillum semifasciatum	Mollusks
50903	Specious Miter	Vexillum speciosum	Mollusks
50886	Bumpy Miter	Vexillum tuberosum	Mollusks
50906	Turbin Miter	Vexillum turbin	Mollusks
50877	Decorated Miter	Vexillum unifasciatum	Mollusks
50802	Spotted Vitularia	Vitularia miliaris	Mollusks
41316	Manahak (Forktail Rabbitfish)	Manahak lesso'	Siganidae
41318	Manahak	Manahak sp	Siganidae
41300	Rabbitfish	Siganidae	Siganidae
41301	Fork-Tail Rabbitfish	Siganus argenteus	Siganidae
41307	Seagrass Rabbitfish	Siganus canaliculatus	Siganidae
41308	Coral Rabbitfish	Siganus corallinus	Siganidae
41302	Pencil-Streaked Rabbitfish	Siganus doliatus	Siganidae
41303	Fuscescens Rabbitfish	Siganus fuscescens	Siganidae
41309	Golden Rabbitfish	Siganus guttatus	Siganidae
41311	Lined Rabbitfish	Siganus lineatus	Siganidae
41313	White-Spotted Rabbitfish	Siganus oramin	Siganidae
41310	Masked Rabbitfish	Siganus puellus	Siganidae
41314	Peppered Rabbitfish	Siganus punctatissimus	Siganidae
41304	Gold-Spotted Rabbitfish	Siganus punctatus	Siganidae
41315	Randal'S Rabbitfish	Siganus randalli	Siganidae
41305	Scribbled Rabbitfish	Siganus spinus	Siganidae
41306	Vermiculated Rabbitfish	Siganus vermiculatus	Siganidae
41312	Rabbitfish	Siganus vulpinus	Siganidae

32301	Silvermouth/Jobfish	Aphareus furca	Lutjanidae
32300	Snappers	Lutjanidae	Lutjanidae
32306	River Snapper	Lutjanus argentimaculatus	Lutjanidae
32325	Two-Spot Snapper	Lutjanus biguttatus	Lutjanidae
32307	Red Snapper	Lutjanus bohar	Lutjanidae
32334	Snapper	Lutjanus boutton	Lutjanidae
32326	Checkered Snapper	Lutjanus decussatus	Lutjanidae
32327	Blackspot Snapper	Lutjanus ehrenbergi	Lutjanidae
32335	Snapper	Lutjanus fulviflamma	Lutjanidae
32308	Flametail Snapper	Lutjanus fulvus	Lutjanidae
32309	Humpback Snapper	Lutjanus gibbus	Lutjanidae
32328	Malabar Snapper	Lutjanus malabaricus	Lutjanidae
32312	Onespot Snapper	Lutjanus monostigma	Lutjanidae
32311	Scribbled Snapper	Lutjanus rivulatus	Lutjanidae
32333	Snapper	Lutjanus sebae	Lutjanidae
32329	1/2-Barred Snapper	Lutjanus semicinctus	Lutjanidae
32330	One-Lined Snapper	Lutjanus vitta	Lutjanidae
32332	Bl And Wh Snapper	Macolor macularis	Lutjanidae
32313	Black Snapper	Macolor niger	Lutjanidae
32314	Fusilier	Paracaesio sordidus	Lutjanidae
32315	Yellowtail Fusilier	Paracaesio xanthurus	Lutjanidae
32322	Deepwater Snapper	Randallichthys filamentosus	Lutjanidae
49130	Shallow Snappers	SHALLOW SNAPPERS	Lutjanidae

32331	Sailfin Snapper	Symphorichthys spilurus	Lutjanidae
28901	Red-Flushed Grouper	Aethaloperca rogaa	Serranidae
28956	Grouper	Anyperodon leucogrammicus	Serranidae
28908	Orange Grouper	Cephalopholis analis	Serranidae
28907	Peacock Grouper	Cephalopholis argus	Serranidae
28911	Brownbarred Grouper	Cephalopholis boenack	Serranidae
28909	Ybanded Grouper	Cephalopholis igarashiensis	Serranidae
28910	Leopard Grouper	Cephalopholis leopardus	Serranidae
28945	Coral Grouper	Cephalopholis miniata	Serranidae
28929	Harlequin Grouper	Cephalopholis polleni	Serranidae
28913	6-Banded Grouper	Cephalopholis sexmaculata	Serranidae
28912	Tomato Grouper	Cephalopholis sonnerati	Serranidae
28903	Grouper	Cephalopholis sp	Serranidae
28906	Pygmy Grouper	Cephalopholis spiloparaea	Serranidae
28914	Flag-Tailed Grouper	Cephalopholis urodeta	Serranidae
28915	Grouper	Cromileptes altivelis	Serranidae
28947	Orange Grouper	Epinephelus caeruleopunctatus	Serranidae
28948	Brown-Spotted Grouper	Epinephelus chlorostigma	Serranidae
28960	Orange Spot Grouper	Epinephelus coioides	Serranidae
28957	Grouper	Epinephelus corallicola	Serranidae

28946	Grouper	Epinephelus cyanopodus	Serranidae
28920	Blotchy Grouper	Epinephelus fuscoguttatus	Serranidae
28921	Hexagon Grouper	Epinephelus hexagonatus	Serranidae
28918	Grouper	Epinephelus howlandi	Serranidae
28922	Giant Grouper	Epinephelus lanceolatus	Serranidae
28958	Grouper	Epinephelus macrospilos	Serranidae
28923	Highfin Grouper	Epinephelus maculatus	Serranidae
28950	Malabar Grouper	Epinephelus malabaricus	Serranidae
28949	Bl-Spot Honeycomb Grouper	Epinephelus melanostigma	Serranidae
28925	Honeycomb Grouper	Epinephelus merra	Serranidae
28942	Grouper	Epinephelus miliaris	Serranidae
28916	Grouper	Epinephelus morrhua	Serranidae
28951	Wavy-Lined Grouper	Epinephelus ongus	Serranidae
28926	Marbled Grouper	Epinephelus polyphekadion	Serranidae
28953	Grouper	Epinephelus retouti	Serranidae
28930	7-Banded Grouper	Epinephelus septemfasciatus	Serranidae
28924	Tidepool Grouper	Epinephelus socialis	Serranidae
28952	4-Saddle Grouper	Epinephelus spilotoceps	Serranidae
28928	Greasy Grouper	Epinephelus tauvina	Serranidae
28902	Truncated Grouper	Epinephelus truncatus	Serranidae
28943	Wh-Margined Grouper	Gracila albomarginata	Serranidae

28938	Squaretail Grouper	Plectropomus areolatus	Serranidae
28937	Saddleback Grouper	Plectropomus laevis	Serranidae
28954	Leopard Coral Trout	Plectropomus leopardus	Serranidae
28955	Blue-Lined Coral Trout	Plectropomus oligacanthus	Serranidae
28940	Powell'S Grouper	Saloptia powelli	Serranidae
28900	Sea Basses,Groupers	Serranidae	Serranidae
28944	Whmargin Lyretail Grouper	Variola albimarginata	Serranidae
35902	Fringelip Mullet	Crenimugil crenilabis	Mugilidae
35903	Yellowtail Mullet	Ellochelon vaigiensis	Mugilidae
35901	Engel'S Mullet	Moolgarda engeli	Mugilidae
35906	Bluespot Mullet	Moolgarda seheli	Mugilidae
35904	Gray Mullet	Mugil cephalus	Mugilidae
35900	Mullets	Mugilidae	Mugilidae
35905	Acute-Jawed Mullet	Neomyxus leuciscus	Mugilidae
33900	Rudderfish	Kyphosidae	Kyphosidae
33901	Highfin Rudderfish	Kyphosus cinerascens	Kyphosidae
33902	Lowfin Rudderfish	Kyphosus vaigiensis	Kyphosidae
33903	Insular Rudderfish	Kyphosus bigibbus	Kyphosidae
69251	Spider Crab	Achaeus japonicus	CRE-Crustaceans
67500	Snapping Shrimp	Alphaeidae	CRE-Crustaceans
67501	Snapping Shrimp	Alpheus bellulus	CRE-Crustaceans
67502	Snapping Shrimp	Alpheus paracrinitus	CRE-Crustaceans
64999	Anchylomerids	Anchylomeridae	CRE-Crustaceans

67951	Slipper Lobster	Arctides regalis	CRE-Crustaceans
60101	Acorn Barnacle	Balanus sp	CRE-Crustaceans
62050	Mantis Shrimp	Bathysquillidae	CRE-Crustaceans
69201	Box Crab	Calappa bicornis	CRE-Crustaceans
69202	Box Crab	Calappa calappa	CRE-Crustaceans
69203	Box Crab	Calappa hepatica	CRE-Crustaceans
69200	Box Crabs	Calappidae	CRE-Crustaceans
69252	Decorator Crab	Camposcia retusa	CRE-Crustaceans
69350	Cancrids	Cancridae	CRE-Crustaceans
69501	7-11 Crab	Carpilius convexus	CRE-Crustaceans
69502	7-11 Crab	Carpilius maculatus	CRE-Crustaceans
69401	Red-Legged Sw Crab	Charybdis erythrodactyla	CRE-Crustaceans
69402	Red Sw Crab	Charybdis hawaiiensis	CRE-Crustaceans
69204	Box Crab	Cycloes granulosa	CRE-Crustaceans
69301	Elbow Crab	Daldorfia horrida	CRE-Crustaceans
68202	Marine Hermit Crab	Dardanus gemmatus	CRE-Crustaceans
68204	Marine Hermit Crab	Dardanus megistos	CRE-Crustaceans
68203	Marine Hermit Crab	Dardanus pendunculatus	CRE-Crustaceans
68201	Marine Hermit Crab	Dardanus sp	CRE-Crustaceans
67121	Commensal Shrimp	Dasycaris zanzibarica	CRE-Crustaceans
67000	Decapod Crustaceans	Decapoda	CRE-Crustaceans
68200	Marine Hermit Crabs	Diogenidae	CRE-Crustaceans
69161	Dorippid Crab	Dorippe frascone	CRE-Crustaceans

69171	Sponge Crab	Dromia dormia	CRE-Crustaceans
69170	Sponge Crabs	Dromiidae	CRE-Crustaceans
68701	Mole Crab	Emerita pacifica	CRE-Crustaceans
67851	Soft Lobster	Enoplometopus debelius	CRE-Crustaceans
67852	Hairy Lobster	Enoplometopus occidentalis	CRE-Crustaceans
69553	Redeye Crab	Eriphia sebana	CRE-Crustaceans
69554	Red-Reef Crab	Etisus dentatus	CRE-Crustaceans
69551	Red-Reef Crab	Etisus splendidus	CRE-Crustaceans
69555	Brown-Reef Crab	Etisus utilis	CRE-Crustaceans
62100	Mantis Shrimp	Eurysquillidae	CRE-Crustaceans
68500	Squat Lobsters	Galatheidae	CRE-Crustaceans
69850	Gecarcinids	Gecarcinidae	CRE-Crustaceans
67220	Bbee And Harlequin Shrimp	Gnathophyllidae	CRE-Crustaceans
67221	Bumblebee Shrimp	Gnathophylloides mineri	CRE-Crustaceans
67222	Bumblebee Shrimp	Gnathophyllum americanum	CRE-Crustaceans
62203	Mantis Shrimp	Gonodactylaceus mutatus	CRE-Crustaceans
62201	Mantis Shrimp	Gonodactylellus affinis	CRE-Crustaceans
62200	Mantis Shrimp	Gonodactylidae	CRE-Crustaceans
62202	Mantis Shrimp	Gonodactylus chiragra	CRE-Crustaceans
62204	Mantis Shrimp	Gonodactylus platysoma	CRE-Crustaceans
62205	Mantis Shrimp	Gonodactylus smithii	CRE-Crustaceans
69860	Shore Crabs	Grapsidae	CRE-Crustaceans

69861	Shore Crab	Grapsus albolineatus	CRE-Crustaceans
69862	Shore Crab	Grapsus grapsus tenuicrustat	CRE-Crustaceans
69950	Hapalocarcinids	Hapalocarcinidae	CRE-Crustaceans
62550	Mantis Shrimp	Harposquillidae	CRE-Crustaceans
62300	Mantis Shrimp	Hemisquillidae	CRE-Crustaceans
67104	Deepwater Shrimps	Heteropenaeus sp	CRE-Crustaceans
67210	Hump-Backed Shrimp	Hippolytidae	CRE-Crustaceans
69100	Homolids	Homolidae	CRE-Crustaceans
67853	Soft Lobster	Hoplometopus holthuisi	CRE-Crustaceans
67223	Harlequin Shrimp	Hymenocera picta	CRE-Crustaceans
64810	Hyperid Amphipods	Hyperiidae	CRE-Crustaceans
67921	Slipper Lobster	Ibacus sp	CRE-Crustaceans
69000	True Crabs	Io Brachyura	CRE-Crustaceans
67931	Long-Handed Lobster	Justitia longimanus	CRE-Crustaceans
67211	Hump-Backed Shrimp	Koror misticius	CRE-Crustaceans
69302	Elbow Crab	Lambrus longispinis	CRE-Crustaceans
67111	Palaemonid Shrimp	Leander plumosus	CRE-Crustaceans
68300	Lithodids	Lithodidae	CRE-Crustaceans
69421	Swimming Crab	Lupocyclus grimquedentatus	CRE-Crustaceans
64830	Lycaeids	Lycaeidae	CRE-Crustaceans
69151	3-Toothed Frog Crab	Lyreidus tridentatus	CRE-Crustaceans
62800	Mantis Shrimp	Lysiosquillidae	CRE-Crustaceans
60100	Barnacles	Lythoglyptidae	CRE-Crustaceans

69901	Telescope-Eye Crab	Macrophthalmus telescopicus	CRE-Crustaceans
69250	Spider Crabs	Majidae	CRE-Crustaceans
67101	Penaeid Prawn	Metapenaeopsis sp 1	CRE-Crustaceans
67102	Penaeid Prawn	Metapenaeopsis sp 2	CRE-Crustaceans
67103	Penaeid Prawn	Metapenaeopsis sp 3	CRE-Crustaceans
69205	Box Crab	Mursia spinimanus	CRE-Crustaceans
62900	Mantis Shrimp	Nannosquillidae	CRE-Crustaceans
67850	Soft Lobsters	Nephropidae	CRE-Crustaceans
69902	Large Ghost Crab	Ocypode ceratopthalma	CRE-Crustaceans
69903	Ghost Crab	Ocypode cordimana	CRE-Crustaceans
69904	Ghost Crab	Ocypode saratum	CRE-Crustaceans
69900	Ocypodids	Ocypodidae	CRE-Crustaceans
62350	Mantis Shrimp	Odontodactylidae	CRE-Crustaceans
62351	Mantis Shrimp	Odontodactylus brevirostris	CRE-Crustaceans
62352	Mantis Shrimp	Odontodactylus scyallarus	CRE-Crustaceans
62701	Mantis Shrimp	Oratosquilla oratoria	CRE-Crustaceans
62700	Mantis Shrimp	Oratosquillidae	CRE-Crustaceans
68400	Soldier Hermit Crab	Paguridae	CRE-Crustaceans
68401	Coral Hermit Crab	Paguritta gracilipes	CRE-Crustaceans
68402	Coral Hermit Crab	Paguritta harmsi	CRE-Crustaceans
67110	Palaemonid Shrimp	Palaemonidae	CRE-Crustaceans
67917	Mole Lobster	Palinurellus wieneckii	CRE-Crustaceans

67918	Painted Crayfish	Panulirus albiflagellum	CRE-Crustaceans
67911	Painted Crayfish	Panulirus homarus	CRE-Crustaceans
67912	Painted Crayfish	Panulirus longipes	CRE-Crustaceans
67914	Painted Crayfish	Panulirus ornatus	CRE-Crustaceans
67910	Painted Crayfish	Panulirus sp	CRE-Crustaceans
67916	Painted Crayfish	Panulirus versicolor	CRE-Crustaceans
69300	Elbow Crabs	Parthenopidae	CRE-Crustaceans
67100	Panaeid Prawns	Penaeidae	CRE-Crustaceans
67106	Penaeid Prawn	Penaeus latisulcatus	CRE-Crustaceans
67105	Penaeid Prawn	Penaeus monodon	CRE-Crustaceans
69864	Flat Rock Crab	Percnon planissimum	CRE-Crustaceans
67122	Commensal Shrimp	Periclimenes amboinensis	CRE-Crustaceans
67123	Commensal Shrimp	Periclimenes brevicarpalis	CRE-Crustaceans
67124	Commensal Shrimp	Periclimenes cf ceratophthalmus	CRE-Crustaceans
67125	Commensal Shrimp	Periclimenes holthuisi	CRE-Crustaceans
67126	Commensal Shrimp	Periclimenes imperator	CRE-Crustaceans
67127	Commensal Shrimp	Periclimenes inornatus	CRE-Crustaceans
67128	Commensal Shrimp	Periclimenes kororensis	CRE-Crustaceans
67129	Commensal Shrimp	Periclimenes ornatus	CRE-Crustaceans
67130	Commensal Shrimp	Periclimenes psamathe	CRE-Crustaceans
67131	Commensal Shrimp	Periclimenes soror	CRE-Crustaceans
67132	Commensal Shrimp	Periclimenes tenuipes	CRE-Crustaceans

67133	Commensal Shrimp	Periclimenes venustus	CRE-Crustaceans
68601	Porcelain Crab	Petrolisthes lamarkii	CRE-Crustaceans
64820	Phronimids	Phronimidae	CRE-Crustaceans
69863	Shore Crab	Plagusia depressa tuberculata	CRE-Crustaceans
64840	Platyscelids	Platyscelidae	CRE-Crustaceans
67134	Commensal Shrimp	Pliopotonia furtiva	CRE-Crustaceans
69461	Long-Eyed Swimming Crab	Podophthalmus vigil	CRE-Crustaceans
67135	Commensal Shrimp	Pontonides uncigar	CRE-Crustaceans
67120	Commensal Shrimp	Pontoniidae	CRE-Crustaceans
68600	Porcellanid Crabs	Porcellanidae	CRE-Crustaceans
69400	Swimming Crabs	Portunidae	CRE-Crustaceans
69432	Blue Swimming Crab	Portunus pelagicus	CRE-Crustaceans
69431	Swimming Crab	Portunus sanguinolentus	CRE-Crustaceans
62400	Mantis Shrimp	Protosquillidae	CRE-Crustaceans
62501	Mantis Shrimp	Pseudosquilla ciliata	CRE-Crustaceans
62500	Mantis Shrimp	Pseudosquillidae	CRE-Crustaceans
67231	Hingebeak Prawn	Rhinchocinetes hiatti	CRE-Crustaceans
67230	Hinge-Beaked Prawns	Rhynchocinetidae	CRE-Crustaceans
69471	Mangrove Crab	Scylla serrata	CRE-Crustaceans
67604	Solenocerids	Solenoceridae	CRE-Crustaceans
62600	Mantis Shrimp	Squillidae	CRE-Crustaceans
67136	Commensal Shrimp	Stegopontonia commensalis	CRE-Crustaceans
67200	Cleaner Shrimp	Stenopodidae	CRE-Crustaceans

67201	Banded Coral Shrimp	Stenopus hispidus	CRE-Crustaceans
62000	Mantis Shrimps	Stomatopoda	CRE-Crustaceans
67503	Snapping Shrimp	Synalpheus carinatus	CRE-Crustaceans
60102	Acorn Barnacle	Tetraclitella divisa	CRE-Crustaceans
69481	Swimming Crab	Thalamita crenata	CRE-Crustaceans
67212	Ambonian Shrimp	Thor amboinensis	CRE-Crustaceans
69598	Xanthid Crab	Unid Megalops	CRE-Crustaceans
69499	Portunid Crab	Unid sp 1	CRE-Crustaceans
69599	Xanthid Crab	Unid sp 1	CRE-Crustaceans
69498	Portunid Crab	Unid sp 2	CRE-Crustaceans
69597	Xanthid Crab	Unid sp 2	CRE-Crustaceans
67112	Palaemonid Shrimp	Urocaridella antonbruunii	CRE-Crustaceans
69500	Dark-Finger Coral Crabs	Xanthidae	CRE-Crustaceans
69870	Urchin Crab	Zebrida adamsii	CRE-Crustaceans
69552	Shallow Reef Crab	Zosymus aeneus	CRE-Crustaceans
24300	Squirrel,Soldierfishes	Holocentridae	Holocentridae
24398	Squirrelfishes	Holocentrinae	Holocentridae
24399	Soldierfishes	Myripristinae	Holocentridae
24313	Bronze Soldierfish	Myripristis adusta	Holocentridae
24314	Brick Soilderfish	Myripristis amaena	Holocentridae
24331	Doubletooth Soldierfish	Myripristis amaena	Holocentridae
24315	Bigscale Soldierfish	Myripristis berndti	Holocentridae
24324	Yellowfin Soldierfish	Myripristis chryseres	Holocentridae

24317	Pearly Soldierfish	Myripristis kuntee	Holocentridae
24318	Red Soldierfish	Myripristis murdjan	Holocentridae
24322	Scarlet Soldierfish	Myripristis pralinia	Holocentridae
24319	Violet Soldierfish	Myripristis violacea	Holocentridae
24320	White-Tipped Soldierfish	Myripristis vittata	Holocentridae
24326	White-Spot Soldierfish	Myripristis woodsi	Holocentridae
24309	Clearfin Squirrelfish	Neoniphon argenteus	Holocentridae
24312	Yellowstriped Squirrelfish	Neoniphon aurolineatus	Holocentridae
24310	Blackfin Squirrlefish	Neoniphon opercularis	Holocentridae
24311	Bloodspot Squirrelfish	Neoniphon sammara	Holocentridae
24340	Deepwater Soldierfish	Ostichthys brachygnathus	Holocentridae
24323	Deepwater Soldierfish	Ostichthys kaianus	Holocentridae
24321	Cardinal Squirrelfish	Plectrypops lima	Holocentridae
24301	Tailspot Squirrelfish	Sargocentron caudimaculatum	Holocentridae
24332	3-Spot Squirrelfish	Sargocentron cornutum	Holocentridae
24302	Crown Squirrelfish	Sargocentron diadema	Holocentridae
24330	Spotfin Squirrelfish	Sargocentron dorsomaculatum	Holocentridae
24334	Furcate Squirrelfish	Sargocentron furcatum	Holocentridae
24327	Samurai Squirrelfish	Sargocentron ittodai	Holocentridae
24333	Squirrelfish	Sargocentron lepros	Holocentridae
24328	Blackspot Squirrelfish	Sargocentron melanospilos	Holocentridae
24304	Finelined Squirrelfish	Sargocentron	Holocentridae

		microstoma	
24305	Dark-Striped Squirrelfish	Sargocentron praslin	Holocentridae
24303	Speckled Squirrelfish	Sargocentron punctatissimum	Holocentridae
24306	Long-Jawed Squirrelfish	Sargocentron spiniferum	Holocentridae
24307	Blue-Lined Squirrelfish	Sargocentron tiere	Holocentridae
24308	Pink Squirrelfish	Sargocentron tieroides	Holocentridae
24329	Violet Squirrelfish	Sargocentron violaceum	Holocentridae
92102	Algae	Enteromorpha clathrata	Algae
92200	Algae	Caulerpaceae	Algae
92217	Algae	Caulerpa racemosa	Algae
93602	Algae	Sargassum polycystum	Algae
93604	Algae	Turbinaria ornata	Algae
95000	Algae	Div Anthophyta	Algae
95003	Algae	Halodule uninervis	Algae
36201	Chiseltooth Wrasse	Anampses caeruleopunctatus	Labridae
36297	Geographic Wrasse	Anampses geographicus	Labridae
36268	Wrasse	Anampses melanurus	Labridae
36202	Yellowtail Wrasse	Anampses meleagrides	Labridae
36203	Yellowbreasted Wrasse	Anampses twisti	Labridae
36205	Lyretail Hogfish	Bodianus anthioides	Labridae
36206	Axilspot Hogfish	Bodianus axillaris	Labridae
36288	2-Spot Slender Hogfish	Bodianus bimaculatus	Labridae
36269	Diana'S Hogfish	Bodianus diana	Labridae

36270	Blackfin Hogfish	Bodianus loxozonus	Labridae
36271	Mesothorax Hogfish	Bodianus mesothorax	Labridae
36243	Hogfish	Bodianus tanyokidus	Labridae
36209	Floral Wrasse	Cheilinus chlorourus	Labridae
36210	Red-Breasted Wrasse	Cheilinus fasciatus	Labridae
36211	Snooty Wrasse	Cheilinus oxycephalus	Labridae
36213	Tripletail Wrasse	Cheilinus trilobatus	Labridae
36216	Cigar Wrasse	Cheilio inermis	Labridae
36217	Yel-Cheeked Tuskfish	Choerodon anchorago	Labridae
36313	Harlequin Tuskfish	Choerodon fasciatus	Labridae
36305	Wrasse	Cirrhilabrus balteatus	Labridae
36272	Wrasse	Cirrhilabrus cyanopleura	Labridae
36273	Exquisite Wrasse	Cirrhilabrus exquisitus	Labridae
36306	Johnson'S Wrasse	Cirrhilabrus johnsoni	Labridae
36218	Wrasse	Cirrhilabrus katherinae	Labridae
36274	Yellowband Wrasse	Cirrhilabrus luteovittatus	Labridae
36307	Rhomboid Wrasse	Cirrhilabrus rhomboidalis	Labridae
36309	Red-Margined Wrasse	Cirrhilabrus rubrimarginatus	Labridae
36219	Clown Coris	Coris aygula	Labridae
36275	Dapple Coris	Coris batuensis	Labridae
36314	Pale-Barred Coris	Coris dorsomacula	Labridae
36220	Yellowtailed Coris	Coris gaimardi	Labridae
36221	Knife Razorfish	Cymolutes praetextatus	Labridae

36291	Finescale Razorfish	Cymolutes torquatus	Labridae
36300	Wandering Cleaner Wrasse	Diproctacanthus xanthurus	Labridae
36222	Sling-Jawed Wrasse	Epibulus insidiator	Labridae
36276	Sling-Jawed Wrasse	Epibulus n sp	Labridae
36223	Bird Wrasse	Gomphosus varius	Labridae
36224	2-Spotted Wrasse	Halichoeres biocellatus	Labridae
36277	Drab Wrasse	Halichoeres chloropterus	Labridae
36278	Canary Wrasse	Halichoeres chrysus	Labridae
36318	Wrasse	Halichoeres dussumieri	Labridae
36226	Checkerboard Wrasse	Halichoeres hortulanus	Labridae
36227	Weedy Surge Wrasse	Halichoeres margaritaceus	Labridae
36228	Dusky Wrasse	Halichoeres marginatus	Labridae
36279	Pinstriped Wrasse	Halichoeres melanurus	Labridae
36229	Black-Ear Wrasse	Halichoeres melasmapomus	Labridae
36311	Ornate Wrasse	Halichoeres ornatissimus	Labridae
36315	Seagrass Wrasse	Halichoeres papilionaceus	Labridae
36298	Wrasse	Halichoeres prosopeion	Labridae
36304	Wrasse	Halichoeres purpurascens	Labridae
36280	Richmond'S Wrasse	Halichoeres richmondi	Labridae
36281	Zigzag Wrasse	Halichoeres scapularis	Labridae
36312	Shwartz Wrasse	Halichoeres shwartzi	Labridae

36282	Wrasse	Halichoeres sp	Labridae
36230	3-Spot Wrasse	Halichoeres trimaculatus	Labridae
36225	Wrasse	Halichoeres zeylonicus	Labridae
36231	Striped Clown Wrasse	Hemigymnus fasciatus	Labridae
36232	1/2 &1/2 Wrasse	Hemigymnus melapterus	Labridae
36303	Wrasse	Hologymnosus annulatus	Labridae
36233	Ring Wrasse	Hologymnosus doliatus	Labridae
36234	Tubelip Wrasse	Labrichthys unilineatus	Labridae
36200	Wrasse	Labridae	Labridae
36235	Bicolor Cleaner Wrasse	Labroides bicolor	Labridae
36266	Bluestreak Cleaner Wrasse	Labroides dimidiatus	Labridae
36237	Black-Spot Cleaner Wrasse	Labroides pectoralis	Labridae
36283	Allen'S Wrasse	Labropsis alleni	Labridae
36238	Micronesian Wrasse	Labropsis micronesica	Labridae
36239	Wedge-Tailed Wrasse	Labropsis xanthonota	Labridae
36240	Leopard Wrasse	Macropharyngodon meleagris	Labridae
36284	Negros Wrasse	Macropharyngodon negrosensis	Labridae
36241	Seagrass Razorfish	Novaculichthys macrolepidotus	Labridae
36242	Dragon Wrasse	Novaculichthys taeniourus	Labridae
36207	Arenatus Wrasse	Oxycheilinus arenatus	Labridae
36264	2-Spot Wrasse	Oxycheilinus	Labridae

		bimaculatus	
36208	Celebes Wrasse	Oxycheilinus celebecus	Labridae
36263	Bandcheek Wrasse	Oxycheilinus digrammus	Labridae
36215	Oriental Wrasse	Oxycheilinus orientalis	Labridae
36212	Ringtail Wrasse	Oxycheilinus unifasciatus	Labridae
36292	Wrasse	Paracheilinus bellae	Labridae
36293	Wrasse	Paracheilinus sp	Labridae
36265	Wrasse	Polylepion russelli	Labridae
36294	Wrasse	Pseudocheilinops ataenia	Labridae
36244	Striated Wrasse	Pseudocheilinus evanidus	Labridae
36245	6 Line Wrasse	Pseudocheilinus hexataenia	Labridae
36246	8 Line Wrasse	Pseudocheilinus octotaenia	Labridae
36285	Line Wrasse	Pseudocheilinus sp	Labridae
36247	4 Line Wrasse	Pseudocheilinus tetrataenia	Labridae
36316	Rust-Banded Wrasse	Pseudocoris aurantiofasciata	Labridae
36317	Torpedo Wrasse	Pseudocoris heteroptera	Labridae
36286	Yamashiro'S Wrasse	Pseudocoris yamashiroi	Labridae
36267	Chiseltooth Wrasse	Pseudodax moluccanus	Labridae
36248	Polynesian Wrasse	Pseudojuloides atavai	Labridae
36249	Smalltail Wrasse	Pseudojuloides cerasinus	Labridae

36250	Wrasse	Pterogogus cryptus	Labridae
36296	Wrasse	Pterogogus guttatus	Labridae
36251	Red-Shoulder Wrasse	Stethojulis bandanensis	Labridae
36252	Wrasse	Stethojulis strigiventor	Labridae
36299	Wrasse	Stethojulis trilineata	Labridae
36253	2 Tone Wrasse	Thalassoma amblycephalum	Labridae
36255	6 Bar Wrasse	Thalassoma hardwickii	Labridae
36262	Jansen'S Wrasse	Thalassoma janseni	Labridae
36287	Crescent Wrasse	Thalassoma lunare	Labridae
36256	Sunset Wrasse	Thalassoma lutescens	Labridae
36257	Surge Wrasse	Thalassoma purpureum	Labridae
36258	5-Stripe Surge Wrasse	Thalassoma quinquevittatum	Labridae
36254	Xmas Wrasse	Thalassoma trilobatum	Labridae
36289	Wh-Barred Pygmy Wrasse	Wetmorella albofasciata	Labridae
36259	Bl-Spot Pygmy Wrasse	Wetmorella nigropinnata	Labridae
36290	Wrasse	Xiphocheilus sp	Labridae
36261	Yblotch Razorfish	Xyrichtys aneitensis	Labridae
36301	Celebe'S Razorfish	Xyrichtys celebecus	Labridae
36302	Razorfish	Xyrichtys geisha	Labridae
36308	Yellowpatch Razorfish	Xyrichtys melanopus	Labridae
36260	Blue Razorfish	Xyrichtys pavo	Labridae
36401	Bolbometopon muricatum	Bumphead parrotfish	
36214	Cheilius undulatus	Napoleon wrasse	

1101	Carcharhinus albimarginatus	Carcharhinidae	Carcharhinidae
1102	Carcharhinus amblyrhynchos	Carcharhinidae	Carcharhinidae
1104	Carcharhinus galapagensis	Carcharhinidae	Carcharhinidae
1106	Carcharhinus melanopterus	Carcharhinidae	Carcharhinidae
1201	Sphyrna lewini	Hammerhead	Carcharhinidae
1202	Sphyrna mokorran	Hammerhead	Carcharhinidae
1200	Sphyrnidae	Hammerhead	Carcharhinidae
44518	Starry Triggerfish	*Abalistes stellatus*	Other
20701	Barred Needlefish	*Ablennes hians*	Other
35050	Blackspot Sergeant	*Abudefduf lorenzi*	Other
35051	Yellowtail Sergeant	*Abudefduf notatus*	Other
35001	Banded Sergeant	*Abudefduf septemfasciatus*	Other
35002	Scis-Tail Sgt Major	*Abudefduf sexfasciatus*	Other
35003	Black Spot Sergeant	*Abudefduf sordidus*	Other
35004	Sergeant-Major	*Abudefduf vaigiensis*	Other
29150	Spiney Basslets	Acanthoclinidae	Other
29151	Hiatt'S Basslet	*Acathoplesiops hiatti*	Other
40537	Goby	*Acentrogobius bonti*	Other
44566	Seagrass Filefish	*Acreichthys tomentosus*	Other
25601	Shrimpfish	*Aeoliscus strigatus*	Other
2201	Spotted Eagle Ray	*Aetobatis narinari*	Other
2202	Eagle Ray	*Aetomyleaus maculatus*	Other
4801	Indo-Pacific Bonefish	*Albula glossodonta*	Other

4802	Bonefish	*Albula neoguinaica*	Other
4800	Bonefish	Albulidae	Other
17100	Lancetfishes	Alepisauidae	Other
17101	Lancetfish	*Alepisaurus ferox*	Other
40711	Dorothea'S Wriggler	*Allomicrodesmis dorotheae*	Other
39202	Blenny	*Alticus arnoldorum*	Other
44558	Unicorn Filefish	*Aluterus monoceros*	Other
44551	Filefish	*Aluterus scriptus*	Other
44552	Filefish	*Amanses scopas*	Other
28700	Glass Perch	Ambassidae	Other
28701	Glassie	*Ambassis buruensis*	Other
28702	Glassie	*Ambassis interrupta*	Other
35201	2-Spot Hawkfish	*Amblycirrhitus bimacula*	Other
40501	Goby	*Amblyeleotris faciata*	Other
40502	Goby	*Amblyeleotris fontaseni*	Other
40503	Goby	*Amblyeleotris guttata*	Other
40506	Goby	*Amblyeleotris randalli*	Other
40505	Brown-Barred Goby	*Amblyeleotris steinitzi*	Other
40507	Bluespotted Goby	*Amblyeleotris wheeleri*	Other
4306	Blue Pilchard	*Amblygaster clupeoides*	Other
4307	Spotted Pilchard	*Amblygaster sirm*	Other
35005	Damselfish	*Amblygliphidodon aureus*	Other
35006	Staghorn Damsel	*Amblygliphidodon*	Other

		curacao	
35052	White-Belly Damsel	*Amblygliphidodon leucogaster*	Other
35053	Ternate Damsel	*Amblygliphidodon ternatensis*	Other
40523	Goby	*Amblygobius decussatus*	Other
40524	Goby	*Amblygobius hectori*	Other
40670		*Amblygobius linki*	Other
40525	Goby	*Amblygobius nocturnus*	Other
40526	Goby	*Amblygobius phalaena*	Other
40527	Goby	*Amblygobius rainfordi*	Other
40662	Goby	*Amblygobius sp*	Other
44816	Evileye Puffer	*Amblyrhinchotus honckenii*	Other
40504	Prawn Goby	*Amlbyeleotris periophthalma*	Other
35007	Org-Fin Anemonefish	*Amphiprion chrysopterus*	Other
35008	Clark'S Anemonefish	*Amphiprion clarkii*	Other
35095	Tomato Anemonefish	*Amphiprion frenatus*	Other
35009	Dusky Anemonefish	*Amphiprion melanopus*	Other
35096	False Clown Anemonefish	*Amphiprion ocellaris*	Other
35010	Pink Anemonfish	*Amphiprion peridaeraion*	Other
35097	3-Banded Anemonefish	*Amphiprion tricinctus*	Other
43507	Dragonet	*Anaora tentaculata*	Other

5601	Allardice'S Moray	*Anarchias allardicei*	Other
5646	Canton Island Moray	*Anarchias cantonensis*	Other
5602	Seychelles Moray	*Anarchias seychellensis*	Other
4901	Freshwater Eel	*Anguilla bicolor*	Other
4902	Freshwater Eel	*Anguilla marmorata*	Other
4900	Freshwater Eel	Anguillidae	Other
24250	Flashlightfish	Anomalopidae	Other
24251	Flashlightfish	*Anomalops katoptron*	Other
19200	Anglerfish	*Antenariidae*	Other
19201	Pigmy Frogfish	*Antennarius analis*	Other
19202	Frogfish	*Antennarius biocellatus*	Other
19203	Freckled Frogfish	*Antennarius coccineus*	Other
19204	Giant Frogfish	*Antennarius commersonii*	Other
19205	Bandtail Frogfish	*Antennarius dorehensis*	Other
19206	Sargassumfish	*Antennarius maculatus*	Other
19207	Spotfin Frogfish	*Antennarius nummifer*	Other
19208	Painted Frogfish	*Antennarius pictus*	Other
19209	Randall'S Frogfish	*Antennarius randalli*	Other
19210	Spiney-Tufted Frogfish	*Antennarius rosaceus*	Other
19211	Bandfin Frogfish	*Antennatus tuberosus*	Other
25201	Boarfish	*Antigonia malayana*	Other
26460	Velvetfishes	*Aploactinidae*	Other
30435	Cardinalfish	*Apogon amboinensis*	Other

30401	Broad-Striped Cardinalfish	*Apogon angustatus*	Other
30402	Bigeye Cardinalfish	*Apogon bandanensis*	Other
30403	Cryptic Cardinalfish	*Apogon coccineus*	Other
30436	Ohcre-Striped Cardinalfish	*Apogon compressus*	Other
30437	Redspot Cardinalfish	*Apogon dispar*	Other
30438	Longspine Cardinalfish	*Apogon doryssa*	Other
30455	Elliot'S Cardinalfish	*Apogon ellioiti*	Other
30462	Cardinalfish	*Apogon eremeia*	Other
30439	Evermann'S Cardinalfish	*Apogon evermanni*	Other
30404	Eyeshadow Cardinalfish	*Apogon exostigma*	Other
30405	Bridled Cardinalfish	*Apogon fraenatus*	Other
30441	Cardinalfish	*Apogon fragilis*	Other
30440	Gilbert'S Cardinalfish	*Apogon gilberti*	Other
30406	Guam Cardinalfish	*Apogon guamensis*	Other
30468		*Apogon hartzfeldii*	Other
30407	Iridescent Cardinalfish	*Apogon kallopterus*	Other
30408	Inshore Cardinalfish	*Apogon lateralis*	Other
30409	Bluestreak Cardinalfish	*Apogon leptacanthus*	Other
30457	Black Cardinalfish	*Apogon melas*	Other
30463	Cardinalfish	*Apogon nigripinnis*	Other
30412	Black-Striped Cardinalfish	*Apogon nigrofasciatus*	Other
30464	Cardinalfish	*Apogon notatus*	Other
30413	7-Lined Cardinalfish	*Apogon novemfasciatus*	Other
30442	Pearly Cardinalfish	*Apogon perlitus*	Other

30465	Cardinalfish	*Apogon rhodopterus*	Other
30443	Sangi Cardinalfish	*Apogon sangiensis*	Other
30415	Gray Cardinalfish	*Apogon savayensis*	Other
30456	Seale'S Cardinalfish	*Apogon sealei*	Other
30417	Cardinalfish	*Apogon sp*	Other
30414	Bandfin Cardinalfish	*Apogon taeniophorus*	Other
30410	Bandfin Cardinalfish	*Apogon taeniopterus*	Other
30416	3-Spot Cardinalfish	*Apogon trimaculatus*	Other
30418	Ocellated Cardinalfish	*Apogonichthys ocellatus*	Other
30444	Perdix Cardinalfish	*Apogonichthys perdix*	Other
30400	Cardinalfishes	Apogonidae	Other
34377	Angelfish	*Apolemichthys griffisi*	Other
34351	Flagfin Anglefish	*Apolemichthys trimaculatus*	Other
34376	Angelfish	*Apolemichthys xanthopunctatus*	Other
29201	2-Lined Soapfish	*Aporops bilinearis*	Other
6619	Snake Eel	*Apterichtus klazingai*	Other
30419	Twinspot Cardinalfish	*Archamia biguttata*	Other
30420	Orange-Lined Cardinalfish	*Archamia fucata*	Other
30445	Blackbelted Cardinalfish	*Archamia zosterophora*	Other
6206	Scheele'S Conger	*Ariosoma scheelei*	Other
43903	Flounder	*Arnoglossus intermedius*	Other
44801	Brown Puffer	*Arothron hispidus*	Other
44802	Puffer	*Arothron manilensis*	Other

44803	Puffer	*Arothron mappa*	Other
44804	White-Spot Puffer	*Arothron meleagris*	Other
44805	Black-Spotted Puffer	*Arothron nigropunctatus*	Other
44806	Star Puffer	*Arothron stellatus*	Other
44102	Black Spotted Sole	*Aseraggodes melanostictus*	Other
44103	Smith'S Sole	*Aseraggodes smithi*	Other
44104	Whitaker'S Sole	*Aseraggodes whitakeri*	Other
39257	Lance Blenny	*Aspidontus dussumieri*	Other
39203	Cleaner Mimic	*Aspidontus taeniatus*	Other
40539		*Asteropteryx semipunctatus*	Other
43905	Intermediate Flounder	*Asterorhombus intermedius*	Other
40538	Goby	*Asterropteryx ensiferus*	Other
21800	Silverside	Atherinidae	Other
21805	Tropical Silverside	*Atherinomorus duodecimalis*	Other
21806	Striped Silverside	*Atherinomorus endrachtensis*	Other
21803	Silverside	*Atherinomorus lacunosus*	Other
21804	Hardyhead Silverside	*Atherinomorus lacunosus*	Other
21801	Bearded Silverside	*Atherion elymus*	Other
39240	Blenny	*Atrosalarius fuscus holomelas*	Other

25300	Trumpetfish	Aulostomidae	Other
25301	Trumpetfish	*Aulostomus chinensis*	Other
40540	Goby	*Austrolethops wardi*	Other
40541	Goby	*Awaous grammepomus*	Other
40542	Goby	*Awaous guamensis*	Other
44501	Undulate Triggerfish	*Balistapus undulatus*	Other
44500	Triggerfishes	Balistidae	Other
44502	Clown Triggerfish	*Balistoides conspicillum*	Other
44503	Titan Triggerfish	*Balistoides viridescens*	Other
40543	Goby	*Bathygobius cocosensis*	Other
40544	Goby	*Bathygobius cotticeps*	Other
40545	Goby	*Bathygobius fuscus*	Other
20700	Needlefish	Belonidae	Other
29001	Soapfish	*Belonoperca chaubanaudi*	Other
24200	Lantern-Eye Fish	Berycidae	Other
24201	Flashlightfish	*Beryx decadactylus*	Other
25818	Pipefish	*Bhanotia nuda*	Other
6205	Conger Eel	*Blachea xenobranchialis*	Other
39218	Blenny	*Blenniella cyanostigma*	Other
39222	Blenny	*Blenniella gibbifrons*	Other
39239		*Blenniella paula*	Other
39221	Blenny	*Blenniella periophthalmus*	Other
39200	Blennies	Blenniidae	Other

43900	Flounders	Bothidae	Other
43901	Peacock Flounder	*Bothus mancus*	Other
43902	Leopard Flounder	*Bothus pantherinus*	Other
44559	Taylor'S Inflator Filefish	*Brachaluteres taylori*	Other
6601	Snake Eel	*Brachysomophis sauropsis*	Other
18201	Codlet	*Bregmaceros nectabanus*	Other
18200	Codlets	*Bregmacerotidae*	Other
18651	Free-Tailed Brotula	*Brosmophyciops pautzkei*	Other
18601	Reef Cusk Eel	*Brotula multibarbata*	Other
18602	Townsend'S Cusk Eel	*Brotula townsendi*	Other
40546	Goby	*Bryaninops amplus*	Other
40547	Goby	*Bryaninops erythrops*	Other
40548	Goby	*Bryaninops natans*	Other
40549	Goby	*Bryaninops ridens*	Other
40550	Goby	*Bryaninops youngei*	Other
25819	Pipefish	*Bulbonaricus brauni*	Other
40402	Gudgeon	*Butis amboinensis*	Other
18650	Livebearing Brotulas	Bythitidae	Other
40551	Goby	*Cabillus tongarevae*	Other
6602	Snake Eel	*Caecula polyophthalma*	Other
32351	Scissor-Tailed Fusilier	*Caesio caerulaurea*	Other
32355	Fusilier	*Caesio cuning*	Other

32356	Lunar Fusilier	*Caesio lunaris*	Other
32352	Yellowback Caesio	*Caesio teres*	Other
32350	Fusilier	*Caesionidae*	Other
29050	Goldies	*Callanthiidae*	Other
6603	Snake Eel	*Callechelys marmorata*	Other
6604	Snake Eel	*Callechelys melanotaenia*	Other
43500	Dragonets	Callionymidae	Other
43508	Delicate Dragonet	*Callionymus delicatulus*	Other
43501	Mangrove Dragonet	*Callionymus enneactis*	Other
43502	Simple-Spined Dragonet	*Callionymus simplicicornis*	Other
40559	Goby	*Callogobious sp*	Other
40552	Goby	*Callogobius bauchotae*	Other
40553	Goby	*Callogobius centrolepis*	Other
40554	Goby	*Callogobius hasselti*	Other
40555	Goby	*Callogobius maculipinnis*	Other
40556	Goby	*Callogobius okinawae*	Other
40557	Goby	*Callogobius plumatus*	Other
40558	Goby	*Callogobius sclateri*	Other
29401	Longfin	*Calloplesiops altivelis*	Other
40403	Sleeper	*Calumia godeffroyi*	Other
44553	Gray Leatherjacket	*Cantherhines dumerilii*	Other
44565	Specktacled Filefish	*Cantherhines fronticinctus*	Other

44554	Honeycomb Filefish	*Cantherhines pardalis*	Other
44504	Rough Triggerfish	*Canthidermis maculatus*	Other
44807	Puffer	*Canthigaster amboinensis*	Other
44808	Puffer	*Canthigaster bennetti*	Other
44815	Puffer	*Canthigaster compressa*	Other
44809	Sharp Back Puffer	*Canthigaster coronata*	Other
44810	Puffer	*Canthigaster epilampra*	Other
44811	Puffer	*Canthigaster janthinoptera*	Other
44812	Puffer	*Canthigaster leoparda*	Other
44819	Circle-Barred Toby	*Canthigaster ocellicincta*	Other
44820	Papuan Toby	*Canthigaster papua*	Other
44813	Sharpnose Puffer	*Canthigaster solandri*	Other
44814	Saddle Shpns Puffer	*Canthigaster valentini*	Other
25200	Boarfishes	Caproidae	Other
26700	Coral Crouchers	*Caracanthidae*	Other
26701	Velvetfish	*Caracanthus maculatus*	Other
26702	Velvetfish	*Caracanthus unipinna*	Other
18700	Pearlfish	*Carapodidae*	Other
18702	Pearlfish	*Carapus mourlani*	Other
1109	Blackfin Shark	*Carcharhinus limbatus*	Other
902	Great White Shark	*Carcharodon carcharius*	Other
25600	Shrimpfishes	*Centriscidae*	Other

34379	Golden Angelfish	*Centropyge aurantia*	Other
34352	Bicolor Angelfish	*Centropyge bicolor*	Other
34353	Dusky Angelfish	*Centropyge bispinosus*	Other
34354	Colin'S Angelfish	*Centropyge colini*	Other
34367	White-Tail Angelfish	*Centropyge flavicauda*	Other
34355	Lemonpeel Anglefish	*Centropyge flavissimus*	Other
34356	Herald'S Anglefish	*Centropyge heraldi*	Other
34357	Flame Anglefish	*Centropyge loriculus*	Other
34368	Multicolor Angelfish	*Centropyge multicolor*	Other
34358	Multibarred Angelfish	*Centropyge multifasciatus*	Other
34359	Black-Spot Anglefish	*Centropyge nigriocellus*	Other
34378	Midnight Angelfish	*Centropyge nox*	Other
34360	Shepard'S Anglefish	*Centropyge shepardi*	Other
34369	Keyhole Angelfish	*Centropyge tibicen*	Other
34361	Pearlscale Anglefish	*Centropyge vrolicki*	Other
28959	Grouper	*Cephalopholis cyanostigma*	Other
39008	Triplefin	*Ceratobregma helenae*	Other
34301	Threadfin Butterflyfish	*Chaetodon auriga*	Other
34330	E Triangular Butterflyfish	*Chaetodon barronessa*	Other
34302	Bennetts Butterflyfish	*Chaetodon bennetti*	Other
34331	Burgess' Butterflyfish	*Chaetodon burgessi*	Other
34303	Speckled Butterflyfish	*Chaetodon citrinellus*	Other
34304	Saddleback Butterflyfish	*Chaetodon ephippium*	Other

34305	Ylw-Crn Butterflyfish	*Chaetodon flavocoronatus*	Other
34306	Kleins Butterflyfish	*Chaetodon kleinii*	Other
34307	Lined Butterflyfish	*Chaetodon lineolatus*	Other
34308	Racoon Butterflyfish	*Chaetodon lunula*	Other
34316	Redfinned Butterflyfish	*Chaetodon lunulatus*	Other
34309	Black-Back Butterflyfish	*Chaetodon melannotus*	Other
34310	Mertens Butterflyfish	*Chaetodon mertensii*	Other
34332	Meyer'S Butterflyfish	*Chaetodon meyeri*	Other
34311	Butterflyfish	*Chaetodon modestus*	Other
34333	Spot-Tail Butterflyfish	*Chaetodon ocellicaudus*	Other
34334	8-Banded Butterflyfish	*Chaetodon octofasciatus*	Other
34312	Ornate Butterflyfish	*Chaetodon ornatissimus*	Other
34335	Spot-Nape Butterflyfish	*Chaetodon oxycephalus*	Other
34313	Spotbnded Butterflyfish	*Chaetodon punctatofasciatus*	Other
34314	4-Spotted Butterflyfish	*Chaetodon quadrimaculatus*	Other
34336	Latticed Butterflyfish	*Chaetodon rafflesii*	Other
34315	Retculted Butterflyfish	*Chaetodon reticulatus*	Other
34337	Dotted Butterflyfish	*Chaetodon semeion*	Other
34338	Oval-Spot Butterflyfish	*Chaetodon speculum*	Other
34340	Tinker'S Butterflyfish	*Chaetodon tinkeri*	Other
34329	Chevron Butterflyfish	*Chaetodon trifascialis*	Other
34317	Pac Dblsddl Butterflyfish	*Chaetodon ulietensis*	Other

34318	Teardrop Butterflyfish	*Chaetodon unimaculatus*	Other
34319	Vagabond Butterflyfish	*Chaetodon vagabundus*	Other
34300	Butterflyfish	*Chaetodontidae*	Other
34370	Vermiculated Angelfish	*Chaetodontoplus mesoleucus*	Other
37401	Saddled Sandburrower	*Chalixodytes tauensis*	Other
36701	Gaper	*Champsodon vorax*	Other
36700	Gapers	*Champsodontidae*	Other
9800	Milkfish	*Chanidae*	Other
5647	Long-Jawed Moray	*Channomuraena vittata*	Other
9801	Milkfish	*Chanos chanos*	Other
30458	Lined Cardinalfish	*Cheilodipterus artus*	Other
30466	Intermediate Cardinalfish	*Cheilodipterus intermedius*	Other
30446	Cardinalfish	*Cheilodipterus isostigma*	Other
30422	Lg-Toothed Cardinalfish	*Cheilodipterus macrodon*	Other
30423	5-Lined Cardinalfish	*Cheilodipterus quinquelineata*	Other
30421	Truncate Cardinalfish	*Cheilodipterus singapurensis*	Other
20601	Flying Fish	*Cheilopogon spilonopterus*	Other
20602	Flying Fish	*Cheilopogon spilopterus*	Other
20603	Flying Fish	*Cheilopogon unicolor*	Other
35089	Minstrel Fish	*Cheiloprion labiatus*	Other

35907	Ceram Mullet	*Chelon macrolepis*	Other
5400	False Moray Eel	Chlopsidae	Other
25802	Pipefish	*Choeroichthys brachysoma*	Other
25801	Pipefish	*Choeroichthys sculptus*	Other
37001	Duckbill	*Chrionema squamiceps*	Other
35011	Midget Chromis	*Chromis acares*	Other
35012	Bronze Reef Chromis	*Chromis agilis*	Other
35022	Yel-Speckled Chromis	*Chromis alpha*	Other
35013	Ambon Chromis	*Chromis amboinensis*	Other
35014	Yellow Chromis	*Chromis analis*	Other
35015	Black-Axil Chromis	*Chromis atripectoralis*	Other
35054	Dark-Fin Chromis	*Chromis atripes*	Other
35059	Blue-Axil Chromis	*Chromis caudalis*	Other
35060	Deep Reef Chromis	*Chromis delta*	Other
35017	Twin-Spot Chromis	*Chromis elerae*	Other
35018	Scaly Chromis	*Chromis lepidolepis*	Other
35055	Lined Chromis	*Chromis lineata*	Other
35019	Bicolor Chromis	*Chromis margaritifer*	Other
35056	Black-Bar Chromis	*Chromis retrofasciata*	Other
35049	Ternate Chromis	*Chromis ternatensis*	Other
35020	Vanderbilt'S Chromis	*Chromis vanderbilti*	Other
35016	Blue-Green Chromis	*Chromis viridis*	Other
35057	Weber'S Chromis	*Chromis weberi*	Other

35058	Yel-Axil Chromis	*Chromis xanthochir*	Other
35021	Black Chromis	*Chromis xanthura*	Other
35024	2-Spot Demoiselle	*Chrysiptera biocellata*	Other
35027	Surge Demoiselle	*Chrysiptera brownriggii*	Other
35025	Blue-Line Demoiselle	*Chrysiptera caeruleolineata*	Other
35062	Blue Devil	*Chrysiptera cyanea*	Other
35026	Gray Demoiselle	*Chrysiptera glauca*	Other
35090	Blue-Spot Demoiselle	*Chrysiptera oxycephala*	Other
35064	King Demoiselle	*Chrysiptera rex*	Other
35065	Talbot'S Demoiselle	*Chrysiptera talboti*	Other
35028	Tracey'S Demoiselle	*Chrysiptera traceyi*	Other
35091	1-Spot Demoiselle	*Chrysiptera unimaculata*	Other
34610	Peacock Bass	*Cichla ocellaris*	Other
34600	Cichlids	Cichlidae	Other
35211	Threadfin Hawkfish	*Cirrhitichthys aprinus*	Other
35202	Falco'S Hawkfish	*Cirrhitichthys falco*	Other
35203	Pixy Hawkfish	*Cirrhitichthys oxycephalus*	Other
35200	Hawkfish	Cirrhitidae	Other
35204	Stocky Hawkfish	*Cirrhitus pinnulatus*	Other
6620	Fringelip Snake Eel	*Cirricaecula johnsoni*	Other
39242	Chestnut Blenny	*Cirripectes castaneus*	Other
39204	Spotted Blenny	*Cirripectes fuscoguttatus*	Other
39243	Blenny	*Cirripectes perustus*	Other

39206	Barred Blenny	*Cirripectes polyzona*	Other
39205	Squiggly Blenny	*Cirripectes quagga*	Other
39244	Red-Streaked Blenny	*Cirripectes stigmaticus*	Other
39207	Red-Speckled Blenny	*Cirripectes variolosus*	Other
14802	Air-Breath Catfish	*Clarias batrachus*	Other
14801	Air-Breath Catfish	*Clarias macrocephalus*	Other
14800	Air-Breath Catfish	Clariidae	Other
4300	Herring,Sprat,Sardines	Clupeidae	Other
26461	Velvetfish	*Cocotropis larvatus*	Other
6201	White Eel	*Conger cinereus cinereus*	Other
6202	Conger Eel	*Conger oligoporus*	Other
6208	Conger Eel	*Conger sp*	Other
6200	White,Conger,Garden Eel	Congridae	Other
30306	Deepwater Glasseye	*Cookeolus boops*	Other
30304	Bulleye	*Cookeolus japonicus*	Other
34339	Orangebanded Coralfish	*Coradion chrysozonus*	Other
40590	Goby	*Coryphopterus signipinnis*	Other
25803	Network Pipefish	*Corythoichthys flavofasciatus*	Other
25820	Pipefish	*Corythoichthys haematopterus*	Other
25804	Reef Pipefish	*Corythoichthys intestinalis*	Other
25805	Bl-Breasted Pipefish	*Corythoichthys*	Other

		nigripectus	
25821	Ocellated Pipefish	*Corythoichthys ocellatus*	Other
25822	Many-Spotted Pipefish	*Corythoichthys polynotatus*	Other
25823	Guilded Pipefish	*Corythoichthys schultzi*	Other
25824	Roughridge Pipefish	*Cosmocampus banneri*	Other
25806	D'Arros Pipefish	*Cosmocampus darrosanus*	Other
25825	Maxweber'S Pipefish	*Cosmocampus maxweberi*	Other
37400	Sand Burrowers	Creedidae	Other
35911	Mullet	*Crenimugil heterochilos*	Other
40560	Goby	*Cristagobius sp*	Other
40508	Goby	*Cryptocentroides insignis*	Other
40511	Goby	*Cryptocentrus cauruleomaculatus*	Other
40509	Goby	*Cryptocentrus cinctus*	Other
40510	Goby	*Cryptocentrus koumansi*	Other
40512	Goby	*Cryptocentrus leptocephalus*	Other
40514	Goby	*Cryptocentrus sp A*	Other
40513	Goby	*Cryptocentrus strigilliceps*	Other
40515	Goby	*Ctenogobiops aurocingulus*	Other
40516	Goby	*Ctenogobiops feroculus*	Other

40517	Goby	*Ctenogobiops pomastictus*	Other
40518	Long-Finned Prwn Goby	*Ctenogobiops tangarorai*	Other
27304	Flathead	*Cymbacephalus beauforti*	Other
35212	Swallowtail Hawkfish	*Cyprinocirrhites polyactis*	Other
20604	Flying Fish	*Cypselurus angusticeps*	Other
20605	Flying Fish	*Cypselurus poecilopterus*	Other
20606	Flying Fish	*Cypselurus speculiger*	Other
28501	Flying Gurnard	*Dactyloptena orientalis*	Other
28502	Flying Gurnard	*Dactyloptena petersoni*	Other
28500	Flying Gurnard	*Dactylopteridae*	Other
35029	Humbug Dascyllus	*Dascyllus aruanus*	Other
35066	Black-Tail Dascyllus	*Dascyllus melanurus*	Other
35030	Reticulated Dascyllus	*Dascyllus reticulatus*	Other
35031	3-Spot Dascyllus	*Dascyllus trimaculatus*	Other
2000	Stingray	Dasyatididae	Other
2001	Blue-Spotted Sting Ray	*Dasyatis kuhlii*	Other
26401	Scorpionfish	*Dendrochirus biocellatus*	Other
26402	Scorpionfish	*Dendrochirus brachypterus*	Other
26427	Zebra Lionfish	*Dendrochirus zebra*	Other
32701	Slatey Sweetlips	*Diagramma pictum*	Other

16701	Lanternfish	*Diaphus schmidti*	Other
18652	Bythitid	*Dinematichthys iluocoetenoides*	Other
44903	Porcupinefish	*Diodon eydouxi*	Other
44901	Porcupinefish	*Diodon hystrix*	Other
44902	Porcupinefish	*Diodon liturosus*	Other
44900	Porcupinefish	Diodontidae	Other
43503	Dragonet	*Diplogrammus goramensis*	Other
8801	Bristlemouth	*Diplophos sp*	Other
35067	White-Spot Damsel	*Dischistodus chrysopoecilus*	Other
35068	Black-Vent Damsel	*Dischistodus melanotus*	Other
35032	White Damsel	*Dischistodus perspicillatus*	Other
25808	Banded Pipefish	*Doryramphus dactyliophorus*	Other
25807	Bluestripe Pipefish	*Doryramphus excisus*	Other
25826	Janss' Pipefish	*Doryramphus janssi*	Other
25827	Negros Pipefish	*Doryramphus negrosensis negrsensi*	Other
4303	Sprat	*Dussumieria elopsoides*	Other
4302	Sprats	*Dussumieria sp B*	Other
31300	Diskfishes	Echeneidae	Other
31304	Remora	*Echeneis naucrates*	Other
5603	Whiteface Moray	*Echidna leucotaenia*	Other

5604	Snowflake Moray	*Echidna nebulosa*	Other
5605	Girdled Moray Eel	*Echidna polyzona*	Other
5606	Unicolor Moray	*Echidna unicolor*	Other
1350	Bramble Shark	*Echinorhinidae*	Other
1351	Bramble Shark	*Echinorhinus brucus*	Other
1352	Bramble Shark	*Echinorhinus cookei*	Other
39264	Banda Clown Blenny	*Ecsenius bandanus*	Other
39208	Blenny	*Ecsenius bicolor*	Other
39209	Blenny	*Ecsenius opsifrontalis*	Other
39245	Blenny	*Ecsenius sellifer*	Other
39246	Blenny	*Ecsenius yaeyamaensis*	Other
6621	Snake Eel	*Elapsopsis versicolor*	Other
40400	Sleepers	Eleotrididae	Other
40401	Gudgeon	*Eleotris fusca*	Other
32201	Bonnetmouth	*Emmelichthys karnellai*	Other
32200	Bonnet Mouths	*Emmelichtyidae*	Other
18703	Pearlfish	*Encheliophis boraboraensis*	Other
18705	Pearlfish	*Encheliophis gracilis*	Other
18701	Pearlfish	*Encheliophis homei*	Other
18704	Pearlfish	*Encheliophis vermicularis*	Other
5607	Bayer'S Moray	*Enchelycore bayeri*	Other
5608	Bikini Atoll Moray	*Enchelycore bikiniensis*	Other
5655	Dark-Spotted Moray	*Enchelycore kamara*	Other

5609	White-Margined Moray	*Enchelycore schismatorhynchus*	Other
5610	Viper Moray	*Enchelynassa canina*	Other
39210	Blenny	*Enchelyurus kraussi*	Other
4406	Gold Anchovy	*Enchrasicholina devisi*	Other
4405	Blue Anchovy	*Enchrasicholina heterolobus*	Other
4401	Oceanic Anchovy	*Enchrasicholina punctifer*	Other
4400	Anchovies	Engraulidae	Other
43904	Flounder	*Engyprosopon sp*	Other
39001	Triplefin	*Enneapterygius hemimelas*	Other
39002	Triplefin	*Enneapterygius minutus*	Other
39003	Triplefin	*Enneapterygius nanus*	Other
39247	Blenny	*Entomacrodus caudofasciatus*	Other
39248	Blenny	*Entomacrodus cymatobiotus*	Other
39211	Blenny	*Entomacrodus decussatus*	Other
39212	Blenny	*Entomacrodus niuafooensis*	Other
39213	Blenny	*Entomacrodus sealei*	Other
39241	Blenny	*Entomacrodus stellifer*	Other
39214	Blenny	*Entomacrodus striatus*	Other
39215	Blenny	*Entomacrodus thalassinus thalassin*	Other

34000	Batfish	Ephippidae	Other
32202	Bonnetmouth	*Erythrocles scintillans*	Other
1301	Spiny Dogfish	*Etmopterus pusillus*	Other
20757	Ribbon Halfbeak	*Euleptorhamphus viridis*	Other
28601	Dragon Fish	*Eurypegasus draconis*	Other
4304	Mantis Shrimp	*Eutremus teres*	Other
40561	Kawakawa	*Eviota afelei*	Other
40562	Herring	*Eviota albolineata*	Other
40563	Goby	*Eviota bifasciata*	Other
40564	Goby	*Eviota cometa*	Other
40565	Goby	*Eviota distigma*	Other
40566	Goby	*Eviota fasciola*	Other
40567	Goby	*Eviota herrei*	Other
40568	Goby	*Eviota infulata*	Other
40569	Goby	*Eviota lachdebrerei*	Other
40570	Goby	*Eviota latifasciata*	Other
40571	Goby	*Eviota melasma*	Other
40572	Goby	*Eviota nebulosa*	Other
40573	Goby	*Eviota pellucida*	Other
40574	Goby	*Eviota prasina*	Other
40575	Goby	*Eviota prasites*	Other
40576	Goby	*Eviota punctulata*	Other
40577	Goby	*Eviota queenslandica*	Other
40579	Goby	*Eviota saipanensis*	Other

40578	Goby	*Eviota sebreei*	Other
40580	Goby	*Eviota sigillata*	Other
40581	Goby	*Eviota smaragdus*	Other
40585	Goby	*Eviota sp*	Other
40582	Goby	*Eviota sparsa*	Other
40583	Goby	*Eviota storthynx*	Other
40584	Goby	*Eviota zonura*	Other
6622	Snake Eel	*Evipes percinctus*	Other
39216	Blenny	*Exalias brevis*	Other
20600	Flying Fish	*Exocoetidae*	Other
20611	Flying Fish	*Exocoetus volitans*	Other
40586	Goby	*Exyrias belissimus*	Other
40587	Goby	*Exyrias puntang*	Other
25401	Cornetfish	*Fistularia commersoni*	Other
25400	Cornetfish	Fistulariidae	Other
30453	Bay Cardinalfish	*Foa brachygramma*	Other
30454	Cardinalfish	*Foa sp*	Other
34320	Longnosed Butterflyfish	*Forcipiger flavissimus*	Other
34321	Big Longnose Butterflyfish	*Forcipiger longirostris*	Other
30467	Cardinalfish	*Fowleria abocellata*	Other
30426	Marbled Cardinalfish	*Fowleria marmorata*	Other
30425	Spotcheek Cardinalfish	*Fowleria punctulata*	Other
30427	Variegated Cardinalfish	*Fowleria variegatus*	Other
40588	Goby	*Fusigobius longispinus*	Other

40589	Goby	*Fusigobius neophytus*	Other
1107	Tiger Shark	*Galeocerdo cuvier*	Other
31802	Lg-Toothed Ponyfish	*Gazza achlamys*	Other
31808	Toothed Ponyfish	*Gazza minuta*	Other
34362	Ornate Angelfish	*Genicanthus bellus*	Other
34371	Black-Spot Angelfish	*Genicanthus melanospilos*	Other
34364	Watanabe'S Angelfish	*Genicanthus watanabei*	Other
32600	Mojarras	Gerreidae	Other
32602	Deep-Bodied Mojarra	*Gerres abbreviatus*	Other
32601	Common Mojarra	*Gerres acinaces*	Other
32604	Filamentous Mojarra	*Gerres filamentosus*	Other
32603	Oblong Mojarra	*Gerres oblongus*	Other
32605	Oyena Mojarra	*Gerres oyena*	Other
32606	Mojarra	*Gerres punctatus*	Other
9200	Telescopefish	*Giganturidae*	Other
40591	Goby	*Gladigobius ensifera*	Other
40592	Goby	*Glossogobius biocellatus*	Other
40593	Goby	*Glossogobius celebius*	Other
40594	Goby	*Glossogobius guirus*	Other
39249	Blenny	*Glyptoparus delicatulus*	Other
40595	Goby	*Gnatholepis anjerensis*	Other
40601		*Gnatholepis caurensis*	Other
40596	Goby	*Gnatholepis scapulostigma*	Other

40597	Goby	*Gnatholepis sp A*	Other
43400	Clingfish	Gobiesocidae	Other
40500	Goby	Gobiidae	Other
40598	Goby	*Gobiodon albofasciatus*	Other
40599	Goby	*Gobiodon citrinus*	Other
40602	Goby	*Gobiodon okinawae*	Other
40603	Goby	*Gobiodon quinquestrigatus*	Other
40604	Goby	*Gobiodon rivulatus*	Other
40605	Goby	*Gobiopsis bravoi*	Other
8802	Bristlemouth	*Gonostoma atlanticum*	Other
8803	Bristlemouth	*Gonostoma ebelingi*	Other
8800	Bristlemouths	*Gonostomatidae*	Other
6209	Orange-Barred Garden Eel	*Gorgasia preclara*	Other
6203	Conger Eel	*Gorgasia sp*	Other
29051	Goldies	*Grammatonotus sp 1*	Other
29052	Goldies	*Grammatonotus sp 2*	Other
41604	2-Lined Mackerel	*Grammatorcynos bilineatus*	Other
29002	Yellowstripe Soapfish	*Grammistes sexlineatus*	Other
29000	Soapfish	Grammistidae	Other
29003	Ocellate Soapfish	*Grammistops ocellatus*	Other
41001	Wormfish	*Gunnellichthys monostigma*	Other
41002	Onestripe Wormfish	*Gunnellichthys pleurotaenia*	Other

41011	Wormfish	*Gunnellichthys viridescens*	Other
30460	Philippine Cardinalfish	*Gymnapogon philippinus*	Other
30447	Cardinalfish	*Gymnapogon urospilotus*	Other
32361	Fusilier	*Gymnocaesio gymnopterus*	Other
5611	Zebra Moray	*Gymnomuraena zebra*	Other
5619	Moray Eel	*Gymnothorax berndti*	Other
5620	Buro Moray	*Gymnothorax buroensis*	Other
5624	Moray Eel	*Gymnothorax elegans*	Other
5635	Enigmatic Moray	*Gymnothorax enigmaticus*	Other
5621	Fimbriated Moray	*Gymnothorax fimbriatus*	Other
5622	Yellow-Margined Moray	*Gymnothorax flavimarginatus*	Other
5612	Brown Spotted Moray	*Gymnothorax fuscomaculatus*	Other
5623	Graceful-Tailed Moray	*Gymnothorax gracilicaudus*	Other
5625	Moray Eel	*Gymnothorax hepaticus*	Other
5626	Giant Moray	*Gymnothorax javanicus*	Other
5627	Blotch-Necked Moray	*Gymnothorax margaritophorus*	Other
5613	Marshall Isles Moray	*Gymnothorax marshallensis*	Other
5614	Dirty Yellow Moray	*Gymnothorax*	Other

		melatremus	
5628	Whitemouth Moray	*Gymnothorax meleagris*	Other
5648	Monochrome Moray	*Gymnothorax monochrous*	Other
5629	1-Spot Moray	*Gymnothorax monostigmus*	Other
5630	Moray Eel	*Gymnothorax neglectus*	Other
5645	Yellowmouth Moray	*Gymnothorax nudivomer*	Other
5616	Pinda Moray	*Gymnothorax pindae*	Other
5649	Moray Eel	*Gymnothorax polyuranodon*	Other
5631	Richardson'S Moray	*Gymnothorax richardsoni*	Other
5632	Yellow-Headed Moray	*Gymnothorax rueppelliae*	Other
5618	Moray Eel	*Gymnothorax sp cf Melatremus*	Other
5633	Undulated Moray	*Gymnothorax undulatus*	Other
5634	Zonipectis Moray	*Gymnothorax zonipectus*	Other
32700	Sweetlips	*Haemulidae*	Other
25811	Brock'S Pipefish	*Halicampus brocki*	Other
25828	Duncker'S Pipefish	*Halicampus dunckeri*	Other
25812	Samoan Pipefish	*Halicampus mataafae*	Other
25829	Glittering Pipefish	*Halicampus nitidus*	Other
44301	Spikefish	*Halimochirurgus alcocki*	Other
39004	Triplefin	*Helcogramma capidata*	Other

39005	Triplefin	*Helcogramma chica*	Other
39006	Triplefin	*Helcogramma hudsoni*	Other
35069	Damselfish	*Hemiglyphidodon plagiometopon*	Other
20751	Halfbeak	*Hemiramphus archipelagicus*	Other
20758	Halfbeak	*Hemiramphus far*	Other
20760	Halfbeak	*Hemiramphus lutkei*	Other
20750	Halfbeak	*Hemirhamphidae*	Other
34322	Pyrimid Butterflyfish	*Hemitaurichthys polylepis*	Other
34323	Butterflyfish	*Hemitaurichthys thompsoni*	Other
34324	Longfinned Bannerfish	*Heniochus acuminatus*	Other
34325	Pennant Bannerfish	*Heniochus chrysostomus*	Other
34341	Bannerfish	*Heniochus diphreutes*	Other
34326	Masked Bannerfish	*Heniochus monoceros*	Other
34327	Singular Butterflyfish	*Heniochus singularis*	Other
34328	Humphead Bannerfish	*Heniochus varius*	Other
4308	Gold Spot Herring	*Herklotsichthys quadrimaculatus*	Other
6204	Conger Eel	*Heteroconger hassi*	Other
40606	Goby	*Heteroeleotris sp*	Other
30301	Glasseye	*Heteropriacanthus cruentatus*	Other
2006	Whipray	*Himantura fai*	Other

2005	Wh Tail Whipray	*Himantura granulata*	Other
2003	Leopard Ray	*Himantura uarnak*	Other
25830	Pipefish	*Hippichthys cyanospilos*	Other
25831	Pipefish	*Hippichthys spicifer*	Other
25809	Pipefish	*Hippocampus histrix*	Other
25832	Pipefish	*Hippocampus kuda*	Other
19212	Sargassum Fish	*Histrio histrio*	Other
28965	Fairy Basslet	*Holanthias borbonius*	Other
28966	Fairy Basslet	*Holanthias katayamai*	Other
30801	Tilefish	*Hoplolatilus cuniculus*	Other
30802	Tilefish	*Hoplolatilus fronticinctus*	Other
30803	Tilefish	*Hoplolatilus starcki*	Other
21807	Silverside	*Hypoatherina barnesi*	Other
21808	Silverside	*Hypoatherina cylindrica*	Other
21802	Silverside	*Hypoatherina ovalaua*	Other
20753	Halfbeak	*Hyporhamphus acutus acutus*	Other
20754	Halfbeak	*Hyporhamphus affinis*	Other
20755	Halfbeak	*Hyporhamphus dussumieri*	Other
6623	Snake Eel	*Ichthyapus vulturus*	Other
26430	Spiny Devilfish	*Inimicus didactylus*	Other
21901	Keeled Silverside	*Iso hawaiiensis*	Other
35210	6-Band Hawkfish	*Isocirrhitus sexfasciatus*	Other

21900	Keeled Silversides	Isonidae	Other
39265	Beautiful Rockskipper	*Istiblennius bellus*	Other
39217	Blenny	*Istiblennius chrysospilos*	Other
39266	Streaky Rockskipper	*Istiblennius dussumieri*	Other
39219	Blenny	*Istiblennius edentulus*	Other
39267	Interrupted Rockskipper	*Istiblennius interruptus*	Other
39220	Blenny	*Istiblennius lineatus*	Other
40607	Goby	*Istigobius decoratus*	Other
40608	Goby	*Istigobius ornatus*	Other
40609	Goby	*Istigobius rigilius*	Other
40610	Goby	*Istigobius spence*	Other
41900	Billfishes	Istiophoridae	Other
901	Mackerel Shark	*Isurus oxyrhinchus*	Other
5402	Bl-Nostril False Moray	*Kaupichthys atronasus*	Other
5403	Shortfin False Moray	*Kaupichthys brachychirus*	Other
5401	Common False Moray	*Kaupichthys hyoproroides*	Other
40612	Goby	*Kellogella quindecimfasciata*	Other
40611	Goby	*Kelloggella cardinalis*	Other
40701	Sand Dart	*Kraemeria bryani*	Other
40702	Sand Dart	*Kraemeria cunicularia*	Other
40703	Sand Dart	*Kraemeria samoensis*	Other
40700	Sand Darts	Kraemeriidae	Other

30103	Dark-Margined Flagtail	*Kuhlia marginata*	Other
30101	Barred Flagtail	*Kuhlia mugil*	Other
30102	River Flagtail	*Kuhlia rupestris*	Other
30100	Flagtails	*Kuhliidae*	Other
44601	Longhorn Cowfish	*Lactoria cornuta*	Other
44602	Spiny Cowfish	*Lactoria diaphana*	Other
44605	Thornback Cowfish	*Lactoria fornasini*	Other
44817	Oceanic Blaasop	*Lagocephalus lagocephalus*	Other
44818	Silverstripe Blaasop	*Lagocephalus sceleratus*	Other
900			
6627	Oriental Snake Eel	*Lamnostoma orientalis*	Other
31800	Ponyfishes	Leiognathidae	Other
31806	Slipmouth	*Leiognathus bindus*	Other
31804	Slipmouth	*Leiognathus elongatus*	Other
31801	Common Slipmouth	*Leiognathus equulus*	Other
31805	Slipmouth	*Leiognathus smithursti*	Other
31803	Oblong Slipmouth	*Leiognathus stercorarius*	Other
6605	Saddled Snake Eel	*Leiuranus semicinctus*	Other
43401	Clingfish	*Lepadichthys caritus*	Other
43402	Clingfish	*Lepadichthys minor*	Other
35048	Fusilier Damsel	*Lepidozygus tapienosoma*	Other
16901	Barracudina	*Lestidium nudun*	Other
37402	Sand Burrower	*Limnichthys donaldsoni*	Other

43403	Clingfish	*Liobranchia stria*	Other
28991	Swissguard Basslet	*Liopropoma lunulatum*	Other
28997	Swissguard Basslet	*Liopropoma maculatum*	Other
28992	Swissguard Basslet	*Liopropoma mitratum*	Other
28993	Swissguard Basslet	*Liopropoma multilineatum*	Other
28994	Pallid Basslet	*Liopropoma pallidum*	Other
28995	Pinstripe Basslet	*Liopropoma susumi*	Other
28996	Redstripe Basslet	*Liopropoma tonstrinum*	Other
39251	Blenny	*Litobranchus fowleri*	Other
35908	Giantscale Mullet	*Liza melinoptera*	Other
32501	Triplefin	*Lobotes surinamensis*	Other
32500	Tripletails	Lobotidae	Other
40519	Goby	*Lotilia graciliosa*	Other
28981	Magenta Slender Basslet	*Luzonichthys waitei*	Other
28982	Whitley'S Slender Basslet	*Luzonichthys whitleyi*	Other
40613	Goby	*Macrodontogobius wilburi*	Other
40520	Goby	*Mahidolia mystacina*	Other
30800	Tilefishes	Malacanthidae	Other
30851	Quakerfish	*Malacanthus brevirostris*	Other
30852	Striped Blanquillo	*Malacanthus latovittatus*	Other
2301	Manta Ray	*Manta birostris*	Other
45001	Sharptail Sunfish	*Masturus lanceolatus*	Other

4700	Tarpons	*Megalopidae*	Other
4701	Indo-Pacific Tarpon	*Megalops cyprinoides*	Other
39233	Poison-Fang Blenny	*Meiacanthus anema*	Other
39223	Poison-Fang Blenny	*Meiacanthus atrodorsalis*	Other
39258	1-Stripe Poison-Fang Blenny	*Meiacanthus ditrema*	Other
39259	Striped Poison-Fang Blenny	*Meiacanthus grammistes*	Other
44505	Black Triggerfish	*Melichthys niger*	Other
44506	Pinktail Triggerfish	*Melichthys vidua*	Other
18653	Brotula	*Microbrotula sp*	Other
41000	Wormfish	*Microdesmidae*	Other
25817	Anderson'S Shrt-Nosed Pipefish	*Micrognathus andersonii*	Other
25810	Pygmy Short-Nosed Pipefish	*Micrognathus brevirostris pygmaeus*	Other
25833	Pipefish	*Microphis brachyurus brachyurus*	Other
25834	Pipefish	*Microphis brevidorsalis*	Other
25835	Pipefish	*Microphis leiaspis*	Other
25836	Pipefish	*Microphis manadensis*	Other
25837	Pipefish	*Microphis retzii*	Other
25813	Ventricose Milda	*Minyichthys myersi*	Other
2300	Myer'S Pipefish	*Mobulidae*	Other
45000	Ocean Sunfishes	*Molidae*	Other
44550	Filefishes	*Monacanthidae*	Other
33300	Monos	*Monodactylidae*	Other

33301	Mono	*Monodactylus argenteus*	Other
18000	Codlings	*Moridae*	Other
5103	Rusty Spaghetti Eel	*Moringua ferruginea*	Other
5102	Java Spaghetti Eel	*Moringua javanica*	Other
5101	Spaghetti Eel	*Moringua microchir*	Other
5100	Worm Eel	*Moringuidae*	Other
40614	Goby	*Mugilogobius tagala*	Other
40615	Goby	*Mugilogobius villa*	Other
6300	Pike Eels	*Muraenesocidae*	Other
6301	Pike Conger	*Muraenesox cinereus*	Other
6612	Snake Eel	*Muraenichthys gymnotus*	Other
6606	Snake Eel	*Muraenichthys laticaudata*	Other
6607	Snake Eel	*Muraenichthys macropterus*	Other
6613	Snake Eel	*Muraenichthys schultzi*	Other
6614	Snake Eel	*Muraenichthys sibogae*	Other
5600	Morays	*Muraenidae*	Other
16700	Lanternfishes	*Myctophidae*	Other
16702	Laternfish	*Myctophum brachygnathos*	Other
2200	Eagle Ray	*Myliobatidae*	Other
6624	Snake Eel	*Myrichthys bleekeri*	Other
6608	Banded Snake Eel	*Myrichthys colubrinus*	Other
6610	Spotted Snake Eel	*Myrichthys maculosus*	Other

6615	Snake Eel	*Myrophis uropterus*	Other
200	Hagfish	*Myxinidae*	Other
201	Hagfish	*Eptaptretus carlhubbsi*	Other
39252	Combtooth Blenny	*Nannosalarius nativitatus*	Other
701	Nurse Shark	*Nebrius ferrugineus*	Other
1110	Lemon Shark	*Negaprion acutidens*	Other
41010	Decorated Dartfish	*Nemateleotris decora*	Other
41003	Helfrichs' Dartfish	*Nemateleotris helfrichi*	Other
41004	Fire Dartfish	*Nemateleotris magnifica*	Other
32400	Threadfin Breams	*Nemipteridae*	Other
32900	Breams	*Nemipteridae*	Other
32412	Forktail Bream	*Nemipterus furcosus*	Other
32409	Butterfly Bream	*Nemipterus hexadon*	Other
32410	Notched Butterfly Bream	*Nemipterus peronii*	Other
32411	Butterfly Bream	*Nemipterus tolu*	Other
35205	Flame Hawkfish	*Neocirrhitus armatus*	Other
35072	Royal Damsel	*Neoglyphidodon melas*	Other
35073	Yellowfin Damsel	*Neoglyphidodon nigroris*	Other
35070	Coral Demoiselle	*Neopomacentrus nemurus*	Other
35071	Freshwater Demoiselle	*Neopomacentrus taeniurus*	Other
35047	Violet Demoiselle	*Neopomacentrus violascens*	Other
42200	Man-Of-War Fish	*Nomeidae*	Other

39007	Triplefin	*Norfolkia brachylepis*	Other
44507	Redtooth Triggerfish	*Odonus niger*	Other
35909	Foldlip Mullet	*Oedalechilus labiosus*	Other
39263	Mangrove Blenny	*Omobranchus obliquus*	Other
39224	Blenny	*Omobranchus rotundiceps*	Other
39256	Blenny	*Omox biporos*	Other
18706	Bivalve Pearlfish	*Onuxodon fowleri*	Other
6600	Snake Eel	*Ophichthidae*	Other
6611	Dark-Shouldered Snake Eel	*Ophichthus cephalozona*	Other
18600	Cusk Eel	*Ophidiidae*	Other
40405	Sleeper	*Ophieleotris aporos*	Other
40406	Sleeper	*Ophiocara porocephala*	Other
36600	Jawfishes	*Opisthognathidae*	Other
36601	Variable Jawfish	*Opisthognathus sp A*	Other
36602	Wass' Jawfish	*Opisthognathus sp B*	Other
34700	Knifejaws	Oplegnathidae	Other
34701	Spotted Knifejaw	*Oplegnathus punctatus*	Other
40528	Goby	*Oplopomops diacanthus*	Other
40529	Goby	*Oplopomus oplopomus*	Other
40616	Goby	*Opua nephodes*	Other
700	Nurse,Zebra,Carpet Sharks	Orectolobidae	Other
34601	Tilapia	*Oreochromis mossambicus*	Other
44600	Boxfish, Cowfish	Ostraciidae	Other

44603	Cube Trunkfish	*Ostracion cubicus*	Other
44604	Spotted Trunkfish	*Ostracion meleagris meleagris*	Other
44606	Reticulate Boxfish	*Ostracion solorensis*	Other
35206	Longnose Hawkfish	*Oxycirrhitus typus*	Other
40407	Sleeper	*Oxyleotris lineolatus*	Other
44555	Longnose Filefish	*Oxymonacanthus longirostris*	Other
20759	Smallwing Flying Fish	*Oxyporhamphus micropterus micropter*	Other
40617	Goby	*Oxyurichthys guibei*	Other
40618	Goby	*Oxyurichthys microlepis*	Other
40619	Goby	*Oxyurichthys ophthalmonema*	Other
40620	Goby	*Oxyurichthys papuensis*	Other
40621	Goby	*Oxyurichthys tentacularis*	Other
40622	Goby	*Padanka sp*	Other
40623	Goby	*Palutris pruinosa*	Other
40624	Goby	*Palutris reticularis*	Other
35207	Arc-Eyed Hawkfish	*Paracirrhitus arcatus*	Other
35208	Freckeled Hawkfish	*Paracirrhitus forsteri*	Other
35209	Whitespot Hawkfish	*Paracirrhitus hemistictus*	Other
40625	Goby	*Paragobiodon echinocephalus*	Other
40626	Goby	*Paragobiodon*	Other

		lacunicolus	
40627	Goby	*Paragobiodon melanosoma*	Other
40628	Goby	*Paragobiodon modestus*	Other
40629	Goby	*Paragobiodon xanthosoma*	Other
41012	Seychelle'S Wormfish	*Paragunnellichthy seychellensis*	Other
16900	Barracudinas	Paralepididae	Other
44556	Blacksaddle Mimic	*Paraluteres prionurus*	Other
44560	Filefish	*Paramonacanthus cryptodon*	Other
44561	Filefish	*Paramonacanthus japonicus*	Other
37102	Latticed Sandperch	*Parapercis clathrata*	Other
37103	Cylindrical Sandperch	*Parapercis cylindrica*	Other
37101	Blk-Dotted Sandperch	*Parapercis millipunctata*	Other
37105	Red-Barred Sandperch	*Parapercis multiplicata*	Other
37106	Black-Banded Sandperch	*Parapercis tetracantha*	Other
37104	Blotchlip Sandperch	*Parapercis xanthozona*	Other
33402	Sandperch	*Parapriacanthus ransonneti*	Other
26433	Mcadam'S Scorpionfish	*Parascorpaena mcadamsi*	Other
26426	Mozambique Scorpionfish	*Parascorpaena mossambica*	Other
44105	Peacock Sole	*Pardachirus pavoninus*	Other

39225	Blenny	*Parenchelyurus hepburni*	Other
20607	Flying Fish	*Parexocoetus brachypterus*	Other
20608	Flying Fish	*Parexocoetus mento*	Other
41013	Beautiful Hover Goby	*Parioglossus formosus*	Other
41014	Lined Hover Goby	*Parioglossus lineatus*	Other
41015	Naked Hover Goby	*Parioglossus nudus*	Other
41016	Palustris Hover Goby	*Parioglossus palustris*	Other
41017	Rainford'S Hover Goby	*Parioglossus rainfordi*	Other
41018	Rao'S Hover Goby	*Parioglossus raoi*	Other
41019	Taeniatus Hover Goby	*Parioglossus taeniatus*	Other
41020	Vertical Hover Goby	*Parioglossus verticalis*	Other
2007	Shortsnouted Ray	*Pasinachus sephen*	Other
28600	Dragonfish	Pegasidae	Other
33400	Sweepers	*Pempherididae*	Other
33401	Bronze Sweeper	*Pempheris oualensis*	Other
34500	Armourheads	*Pentacerotidae*	Other
32901	Smalltooth Whiptail	*Pentapodus caninus*	Other
32902	3-Striped Whiptail	*Pentapodus trivittatus*	Other
37000	Duckbills	Percophidae	Other
40630	Goby	*Periophthalmus argentilineatus*	Other
40631	Goby	*Periophthalmus kalolo*	Other
44567	Yelloweye Filefish	*Pervagor alternans*	Other

44562	Orangetail Filefish	*Pervagor aspricaudatus*	Other
44557	Blackbar Filefish	*Pervagor janthinosoma*	Other
44563	Blackheaded Filefish	*Pervagor melanocephalus*	Other
44564	Blacklined Filefish	*Pervagor nigrolineatus*	Other
39260	Blenny	*Petroscirtes breviceps*	Other
39226	Blenny	*Petroscirtes mitratus*	Other
39261	Blenny	*Petroscirtes thepassi*	Other
39262	Blenny	*Petroscirtes variabilis*	Other
39227	Blenny	*Petroscirtes xestus*	Other
6625	Snake Eel	*Phenamonas cooperi*	Other
24202	Flashlightfish	*Photoblepheron palpebratus*	Other
25814	Pipefish	*Phoxocampus diacanthus*	Other
6626	Snake Eel	*Phyllophichthus xenodontus*	Other
18001	Codling	*Physiculus sp*	Other
37100	Sand Perch	Pinguipedidae	Other
39228	Blenny	*Plagiotremus laudandus*	Other
39229	Red Sabbertooth Blenny	*Plagiotremus rhynorhynchus*	Other
39230	Blenny	*Plagiotremus tapienosoma*	Other
34001	Batfish	*Platax orbicularis*	Other
34002	Pinnate Spadefish	*Platax pinnatus*	Other

34003	Longfin Spadefish	*Platax teira*	Other
20702	Keeled Needlefish	*Platybelone argalus platyura*	Other
27300	Flathead	Platycephalidae	Other
32710	2-Lined Sweetlips	*Plectorhinchus albovittatus*	Other
32706	Celebes Sweetlips	*Plectorhinchus celebecus*	Other
32707	Harlequin Sweetlips	*Plectorhinchus chaetodonoides*	Other
32712	Sweetlip	*Plectorhinchus flavomaculatus*	Other
32703	Gibbus Sweetlips	*Plectorhinchus gibbosus*	Other
32708	Lined Sweetlips	*Plectorhinchus lessonii*	Other
32709	Goldman'S Sweetlips	*Plectorhinchus lineatus*	Other
32705	Giant Sweetlips	*Plectorhinchus obscurus*	Other
32704	Spotted Sweetlips	*Plectorhinchus picus*	Other
32713	Sweetlip	*Plectorhinchus sp*	Other
32702	Oriental Sweetlips	*Plectorhinchus vittatus*	Other
28987	Fourmanoir'S Basslet	*Plectranthias fourmanoiri*	Other
28968	Basslet	*Plectranthias kamii*	Other
28985	Long-Finned Basslet	*Plectranthias longimanus*	Other
28969	Pygmy Basslet	*Plectranthias nanus*	Other
28990	Basslet	*Plectranthias rubrifasciatus*	Other

28986	Basslet	*Plectranthias winniensis*	Other
35033	Dick'S Damsel	*Plectroglyphidodo dickii*	Other
35034	Bright-Eye Damsel	*Plectroglyphidodo imparipennis*	Other
35035	Johnston Isle Damsel	*Plectroglyphidodo johnstonianus*	Other
35036	Jewel Damsel	*Plectroglyphidodo lacrymatus*	Other
35037	White-Band Damsel	*Plectroglyphidodo leucozonus*	Other
35038	Phoenix Isle Damsel	*Plectroglyphidodo phoenixensis*	Other
29400	Longfins	Plesiopidae	Other
29402	Red-Tipped Longfin	*Plesiops caeruleolineatus*	Other
29403	Bluegill Longfin	*Plesiops corallicola*	Other
29405	Sharp-Nosed Longfin	*Plesiops oxycephalus*	Other
40632	Goby	*Pleurosicya bilobatus*	Other
40664	Caroline Ghost Goby	*Pleurosicya carolinensis*	Other
40665	Blue Coral Ghost Goby	*Pleurosicya coerulea*	Other
40666	Fringed Ghost Goby	*Pleurosicya fringella*	Other
40667	Michael'S Ghost Goby	*Pleurosicya micheli*	Other
40668	Common Ghost Goby	*Pleurosicya mossambica*	Other
40633	Goby	*Pleurosicya muscarum*	Other
40669	Plicata Ghost Goby	*Pleurosicya plicata*	Other
14900	Eel Catfishes	Plotosidae	Other

14901	Striped Eel Catfish	*Plotosus lineatus*	Other
6207	Barred Sand Conger	*Poeciloconger fasciatus*	Other
29004	Spotted Soapfish	*Pogonoperca punctata*	Other
36101	6 Feeler Threadfin	*Polydactylus sexfilis*	Other
17501	Beardfish	*Polymixia japonica*	Other
17500	Beardfish	Polymixiidae	Other
36100	Threadfins	Polynemidae	Other
34350	Angelfishes	Pomacanthidae	Other
34365	Emperor Anglefish	*Pomacanthus imperator*	Other
34372	Blue-Girdled Angelfish	*Pomacanthus navarchus*	Other
34375	Semicircle Angelfish	*Pomacanthus semicirculatus*	Other
34373	6-Banded Angelfish	*Pomacanthus sexstriatus*	Other
34374	Blue-Faced Angelfish	*Pomacanthus xanthometopon*	Other
35000	Damselfishes	Pomacentridae	Other
35087	Damselfish	*Pomacentrus adelus*	Other
35039	Ambon Damsel	*Pomacentrus amboinensis*	Other
35094	Goldbelly Damsel	*Pomacentrus auriventris*	Other
35074	Speckled Damsel	*Pomacentrus bankanensis*	Other
35081	Charcoal Damsel	*Pomacentrus brachialis*	Other
35075	Burrough'S Damsel	*Pomacentrus burroughi*	Other
35084	White-Tail Damsel	*Pomacentrus chrysurus*	Other
35076	Neon Damsel	*Pomacentrus coelestis*	Other

35077	Outer Reef Damsel	*Pomacentrus emarginatus*	Other
35078	Blue-Spot Damsel	*Pomacentrus grammorhynchus*	Other
35092	Lemon Damsel	*Pomacentrus moluccensis*	Other
35086	Nagasaki Damsel	*Pomacentrus nagasakiensis*	Other
35093	Black-Axil Damsel	*Pomacentrus nigromanus*	Other
35040	Sapphire Damsel	*Pomacentrus pavo*	Other
35082	Philappine Damsel	*Pomacentrus philippinus*	Other
35083	Reid'S Damsel	*Pomacentrus reidi*	Other
35085	Blueback Damsel	*Pomacentrus simsiang*	Other
35041	Princess Damsel	*Pomacentrus vaiuli*	Other
35088	Slender Reef-Damsel	*Pomachromis exilis*	Other
35042	Guam Damsel	*Pomachromis guamensis*	Other
32711	Common Javelinefish	*Pomadasyus kaakan*	Other
26404	Lg-Headed Scorpionfish	*Pontinus macrocephalus*	Other
26431	Scorpionfish	*Pontinus sp*	Other
26452	Scopionfish	*Pontinus tentacularis*	Other
39231	Blenny	*Prealticus amboinensis*	Other
39232	Blenny	*Prealticus natalis*	Other
30300	Bigeyes	Priacanthidae	Other
30305	Bigeye	*Priacanthus alalaua*	Other
30302	Goggle-Eye	*Priacanthus hamrur*	Other

40634	Goby	*Priolepis cincta*	Other
40635	Goby	*Priolepis farcimen*	Other
40636	Goby	*Priolepis inhaca*	Other
40637	Goby	*Priolepis semidoliatus*	Other
30303	Bigeye	*Pristigenys meyeri*	Other
20609	Flying Fish	*Prognichthys albimaculatus*	Other
20610	Flying Fish	*Prognichthys sealei*	Other
42201	Freckeled Driftfish	*Psenes cyanophrys*	Other
44568	Rhino Leatherjacket	*Pseudalutarias nasicornis*	Other
30448	Cardinalfish	*Pseudamia amblyuroptera*	Other
30449	Cardinalfish	*Pseudamia gelatinosa*	Other
30450	Cardinalfish	*Pseudamia hayashii*	Other
30461	Cardinalfish	*Pseudamia zonata*	Other
30428	Cardinalfish	*Pseudamiops gracilicauda*	Other
28971	Bartlet'S Fairy Basslet	*Pseudanthias bartlettorum*	Other
28972	Bicolor Fairy Basslet	*Pseudanthias bicolor*	Other
28961	Red-Bar Fairy Basslet	*Pseudanthias cooperi*	Other
28973	Peach Fairy Basslet	*Pseudanthias dispar*	Other
28979	Fairy Basslet	*Pseudanthias huchtii*	Other
28974	Lori'S Anthias	*Pseudanthias lori*	Other
28962	Purple Queen	*Pseudanthias pascalus*	Other

28963	Sq-Spot Fairy Basslet	*Pseudanthias pleurotaenia*	Other
28975	Randall'S Fairy Basslet	*Pseudanthias randalli*	Other
28977	Smithvaniz' Fairy Basslet	*Pseudanthias smithvanizi*	Other
28964	Fairy Basslet	*Pseudanthias sp*	Other
28980	Fairy Basslet	*Pseudanthias squammipinnis*	Other
28976	Y Striped Fairy Basslet	*Pseudanthias tuka*	Other
28978	L-Finned Fairy Basslet	*Pseudanthias ventralis*	Other
5637	White Ribbon Eel	*Pseudechidna brummeri*	Other
44508	Ymargin Triggerfish	*Pseudobalistes flavimarginatus*	Other
44509	Blue Triggerfish	*Pseudobalistes fuscus*	Other
29100	Dottybacks	*Pseudochromidae*	Other
29101	Surge Dottyback	*Pseudochromis cyanotaenia*	Other
29102	Dusky Dottyback	*Pseudochromis fuscus*	Other
29103	Marshall Is Dottyback	*Pseudochromis marshallensis*	Other
29404	Dottyback	*Pseudochromis melanotaenia*	Other
29105	Long-Finned Dottyback	*Pseudochromis polynemus*	Other
29106	Magenta Dottyback	*Pseudochromis porphyreus*	Other
40638	Goby	*Pseudogobius javanicus*	Other
29202	Soapfish	*Pseudogramma*	Other

		polyacantha	
29203	Soapfish	*Pseudogramma sp*	Other
29200	Soapfishes	*Pseudogrammidae*	Other
34501	Amourhead	*Pseudopentaceros pectoralis*	Other
29111	Robust Dottyback	*Pseudoplesiops multisquamatus*	Other
29107	Revelle'S Basslet	*Pseudoplesiops revellei*	Other
29108	Rose Island Basslet	*Pseudoplesiops rosae*	Other
29110	Basslet	*Pseudoplesiops sp*	Other
29109	Hidden Basslet	*Pseudoplesiops typus*	Other
41005	Blackfin Dartfish	*Ptereleotris evides*	Other
41021	Filament Dartfish	*Ptereleotris hanae*	Other
41006	Spot-Tail Dartfish	*Ptereleotris heteroptera*	Other
41009	Dartfish	*Ptereleotris lineopinnis*	Other
41007	Pearly Dartfish	*Ptereleotris microlepis*	Other
41008	Zebra Dartfish	*Ptereleotris zebra*	Other
32357	Yellowstreak Fusilier	*Pterocaesio lativittata*	Other
32353	Twinstripe Fusilier	*Pterocaesio marri*	Other
32360	Ruddy Fusilier	*Pterocaesio pisang*	Other
32362	Mosaic Fusilier	*Pterocaesio tesselatata*	Other
32354	Bluestreak Fusilier	*Pterocaesio tile*	Other
32358	3-Striped Fusilier	*Pterocaesio trilineata*	Other
26405	Spotfin Lionfish	*Pterois antennata*	Other
26406	Clearfin Lionfish	*Pterois radiata*	Other

26407	Turkeyfish	*Pterois volitans*	Other
26602	Ocellated Gurnard	*Pterygiotrigla multiocellata*	Other
26601	Gurnard	*Pterygiotrigla sp*	Other
31301	Slender Suckerfish	*Ptheirichthys lineatus*	Other
34366	Regal Anglefish	*Pygoplites diacanthus*	Other
28989	Fairy Basslet	*Rabaulichthys sp*	Other
45003	Trunkfish	*Ranzania laevis*	Other
41612	Mackerel	*Rastrelliger brachysoma*	Other
41610	Striped Mackerel	*Rastrelliger kanagurta*	Other
40639	Goby	*Redigobius bikolanus*	Other
40640	Goby	*Redigobius horiae*	Other
40641	Goby	*Redigobius sapangus*	Other
31302	Remora	*Remora remora*	Other
30451	Cardinalfish	*Rhabdamia cypselurus*	Other
30452	Cardinalfish	*Rhabdamia gracilis*	Other
39234	Blenny	*Rhabdoblenius rhabdotrachelus*	Other
39250		*Rhabdoblennius ellipes*	Other
39235	Blenny	*Rhabdoblennius snowi*	Other
1701	Guitarfish	*Rhinchobatus djiddensis*	Other
44510	Picassofish	*Rhinecanthus aculeatus*	Other
44511	Wedge Picassofish	*Rhinecanthus rectangulus*	Other
44520	Blackbelly Picassofish	*Rhinecanthus verrucosa*	Other

1700	Guitarfish	Rhinobatidae	Other
5636	Ribbon Eel	*Rhinomuraena quaesita*	Other
26428	Weedy Scorpionfish	*Rhinopias frondosa*	Other
31303	Remora	*Rhombochirus osteochir*	Other
44607	Smallnose Boxfish	*Rhynchostracion nasus*	Other
44608	Largenose Boxfish	*Rhynchostracion rhynorhynchus*	Other
9201	Telescopefish	*Rosaura indica*	Other
44569	Minute Filefish	*Rudarius minutus*	Other
39253		*Salarius alboguttatus*	Other
39236	Spotted Rock Blenny	*Salarius fasciatus*	Other
39255	Blenny	*Salarius luctuosus*	Other
39254	Blenny	*Salarius segmentatus*	Other
44000	Righteye Flounders	Samaridae	Other
44001	3 Spot Flounder	*Samariscus triocellatus*	Other
16001	Graceful Lizardfish	*Saurida gracilis*	Other
16002	Nebulous Lizardfish	*Saurida nebulosa*	Other
34100	Scats	*Scatophagidae*	Other
34101	Scat	*Scatophagus argus*	Other
40101	Schindleriid	*Schindleria praematurus*	Other
40100	Shindleriid	*Schindleriidae*	Other
6616	Snake Eel	*Schismorhinchus labialis*	Other
6617	Snake Eel	*Schultzidia johnstonensis*	Other
6618	Snake Eel	*Schultzidia retropinnis*	Other

32404	Spinecheek	*Scolopsis affinis*	Other
32402	2 Line Spinecheek	*Scolopsis bilineatus*	Other
32406	Ciliate Spinecheek	*Scolopsis ciliatus*	Other
32401	Bl And Wh Spinecheek	*Scolopsis lineatus*	Other
32403	Margarite'S Spinecheek	*Scolopsis margaritifer*	Other
32407	Spinecheek	*Scolopsis taeniopterus*	Other
32405	3 Line Spinecheek	*Scolopsis trilineatus*	Other
32408	Spinecheek	*Scolopsis xenochrous*	Other
41611	Narrow-Barred King Mackerel	*Scomberomorus commerson*	Other
26400	Scorpionfish	Scorpaenidae	Other
26413	Guam Scorpionfish	*Scorpaenodes guamensis*	Other
26429	Hairy Scorpionfish	*Scorpaenodes hirsutus*	Other
26414	Kellogg'S Scorpionfish	*Scorpaenodes kelloggi*	Other
26412	Minor Scorpionfish	*Scorpaenodes minor*	Other
26415	Coral Scorpionfish	*Scorpaenodes parvipinnis*	Other
26420	Blotchfin Scorpionfish	*Scorpaenodes varipinis*	Other
26417	Devil Scorpionfish	*Scorpaenopsis diabolus*	Other
26421	Pygmy Scorpionfish	*Scorpaenopsis fowleri*	Other
26422	Flasher Scorpionfish	*Scorpaenopsis macrochir*	Other
26416	Tassled Scorpionfish	*Scorpaenopsis oxycephala*	Other
26434	Papuan Scorpionfish	*Scorpaenopsis papuensis*	Other
26432	Scorpionfish	*Scorpaenopsis sp*	Other

5654	Tiger Snake Moray	*Scuticaria tigrinis*	Other
26408	Yellowspotted Scorpionfish	*Sebastapistes cyanostigma*	Other
26409	Galactacma Scorpionfish	*Sebastapistes galactacma*	Other
26410	Mauritius Scorpionfish	*Sebastapistes mauritiana*	Other
26425	Barchin Scorpionfish	*Sebastapistes strongia*	Other
31807	Pugnose Soapy	*Secutor ruconius*	Other
28970	Basslet	*Selenanthias myersi*	Other
28988	Hawkfish Anthias	*Serranocirrhitus latus*	Other
40645	Goby	*Sicyopterus macrostetholepis*	Other
40646	Goby	*Sicyopterus micrurus*	Other
40647	Goby	*Sicyopterus sp*	Other
40642	Goby	*Sicyopus leprurus*	Other
40644	Goby	*Sicyopus sp*	Other
40643	Goby	*Sicyopus zosterophorum*	Other
5615	Peppered Moray	*Sideria picta*	Other
5617	White-Eyed Moray	*Sideria prosopeion*	Other
40530	Goby	*Signigobius biocellatus*	Other
40531	Goby	*Silhouettea sp*	Other
30700	Sillagos	*Sillaginidae*	Other
30701	Cardinalfish	*Sillago sihama*	Other
30431	Cardinalfish	*Siphamia fistulosa*	Other
30459	Cardinalfish	*Siphamia fuscolineata*	Other

30430	Cardinalfish	*Siphamia versicolor*	Other
44101	Banded Sole	*Soleichthys heterohinos*	Other
44100	Soles	Soleidae	Other
25700	Ghost Pipefish	*Solenostomidae*	Other
25701	Ghost Pipefish	*Solenostomus cyanopterus*	Other
25702	Ornate Ghost Pipefish	*Solenostomus paradoxus*	Other
27305	Flathead	*Sorsogona welanderi*	Other
30434	Cardinalfish	*Sphaeramia nematoptera*	Other
30432	Cardinalfish	*Sphaeramia orbicularis*	Other
36004	Sharpfin Barracuda	*Sphyraena acutipinnis*	Other
36001	Great Barracuda	*Sphyraena barracuda*	Other
36008	Yellowtail Barracuda	*Sphyraena flavicauda*	Other
36003	Blackspot Barracuda	*Sphyraena forsteri*	Other
36007	Arrow Barracuda	*Sphyraena novaehollandiae*	Other
36002	Pygmy Barracuda	*Sphyraena obtusata*	Other
36006	Slender Barracuda	*Sphyraena putnamiae*	Other
36005	Blackfin Barracuda	*Sphyraena qenie*	Other
36000	Barracudas	Sphyraenidae	Other
4301	Blue Sprat	*Spratelloides delicatulus*	Other
4305	Silver Sprat	*Spratelloides gracilis*	Other
39237	Blenny	*Stanulus seychellensis*	Other
35043	White-Bar Gregory	*Stegastes albifasciatus*	Other

35044	Pacific Gregory	*Stegastes fasciolatus*	Other
35045	Farmerfish	*Stegastes lividus*	Other
35046	Dusky Farmerfish	*Stegastes nigricans*	Other
702	Leopard Shark	*Stegastoma varium*	Other
21809	Panatella Silverside	*Stenatherina panatella*	Other
40648	Goby	*Stenogobius genivittatus*	Other
40649	Goby	*Stenogobius sp*	Other
8900	Hatchetfishes	*Sternoptichidae*	Other
40650	Goby	*Stiphodon elegans*	Other
40651	Goby	*Stiphodon sp*	Other
4408	Samoan Anchovy	*Stolephorus apiensis*	Other
4404	Indian Anchovy	*Stolephorus indicus*	Other
4407	Gold Esurine Anchovy	*Stolephorus insularis*	Other
4409	Caroline Islands Anchovy	*Stolephorus multibranchus*	Other
4403	West Pacific Anchovy	*Stolephorus pacificus*	Other
4499	Anchovy	*Stolephorus sp*	Other
20703	Reef Needlefish	*Strongylura incisa*	Other
20705	Littoral Needlefish	*Strongylura leiura leiura*	Other
5638	Giant Esturine Moray	*Strophidon sathete*	Other
44512	Scythe Triggerfish	*Sufflamen bursa*	Other
44513	Halfmoon Triggerfish	*Sufflamen chrysoptera*	Other
44514	Bridle Triggerfish	*Sufflamen freanatus*	Other
32371	Symphysanid	*Symphysanodon typus*	Other

32370	Sympysanodon	*Symphysanodontidae*	Other
26418	Stonefish	*Synanceia verrucosa*	Other
5700	Cutthroat Eel	*Synaphobranchidae*	Other
5701	Cutthroat Eel	*Synaphobranchus sp*	Other
43504	Cirlcled Dragonet	*Synchiropus circularis*	Other
43511	Ladd'S Dragonet	*Synchiropus laddi*	Other
45308	Morrison'S Dragonet	*Synchiropus morrisoni*	Other
43505	Ocellated Dragonet	*Synchiropus ocellatus*	Other
43510	Dragonet	*Synchiropus sp*	Other
43506	Mandarin Fish	*Synchiropus splendidus*	Other
43509	Pipefish, Seahorse	*Syngnathidae*	Other
25800	Alligator Pipefish	*Syngnathoides biaculeatus*	Other
25815	Lizardfish	Synodontidae	Other
16000	2-Spot Lizardfish	*Synodus binotatus*	Other
16003	Clearfin Lizardfish	*Synodus dermatogenys*	Other
16007	Reef Lizardfish	*Synodus englemanni*	Other
16004	Blackblotch Lizardfish	*Synodus jaculum*	Other
16005	Variegatus Lizardfish	*Synodus variegatus*	Other
16006	Leaf Fish	*Taenianotus triacanthus*	Other
26419	Goby	*Taenioides limicola*	Other
40652	Giant Reef Ray	*Taeniura meyeni*	Other
2002	Crescent-Banded Grunter	*Terapon jarbua*	Other
29901	Thornfishes	*Teraponidae*	Other

29900	Smooth Puffers	*Tetraodontidae*	Other
26451	Mangrove Waspfish	*Tetraroge barbata*	Other
26450	Waspfishes	*Tetrarogidae*	Other
4402	Little Priest	*Thryssa baelama*	Other
27302	Broadhead Flathead	*Thysanophrys arenicola*	Other
27303	Longsnout Flathead	*Thysanophrys chiltonae*	Other
27301	Fringlip Flathead	*Thysanophrys otaitensis*	Other
34602	Tilapia	*Tilapia zillii*	Other
33701	Banded Archerfish	*Toxotes jaculator*	Other
33700	Archerfishes	Toxotidae	Other
25816	Double-Ended Pipefish	*Trachyramphus bicoarctata*	Other
44300	Spikefishes	*Triacanthodidae*	Other
1108	Reef Whitetip Shark	*Triaenodon obesus*	Other
37200	Sand Divers	Trichonotidae	Other
37201	Micronesian Sand-Diver	*Trichonotus sp*	Other
26600	Gurnards	Triglidae	Other
40653	Goby	*Trimma caesiura*	Other
40654	Goby	*Trimma naudei*	Other
40655	Goby	*Trimma okinawae*	Other
40658	Goby	*Trimma sp A*	Other
40659	Goby	*Trimma sp B*	Other
40656	Goby	*Trimma taylori*	Other
40657	Goby	*Trimma tevegae*	Other

40660	Goby	*Trimmatom eviotops*	Other
44702	3 Tooth Puffer	*Triodon bursarius*	Other
44701	3 Tooth Puffer	*Triodon macropterus*	Other
44700	Tripletooth Puffers	*Triodontidae*	Other
39000	Triplefins	*Tripterygiidae*	Other
20706	Keeled Houndfish	*Tylosurus acus melanotus*	Other
20704	Houndfish	*Tylosurus crocodilis crocodilis*	Other
39009	Longjaw Triplefin	*Ucla xenogrammus*	Other
37800	Stargazers	*Uranoscopidae*	Other
37801	Stargazer	*Uranoscopus sp*	Other
2004	Porcupine Ray	*Urogymnus africanus*	Other
5639	Unicolor Snake Moray	*Uropterygius concolor*	Other
5660	Fiji Moray Eel	*Uropterygius fijiensis*	Other
5650	Brown-Spotted Snake Eel	*Uropterygius fuscoguttatus*	Other
5651	Gosline'S Snake Moray	*Uropterygius goslinei*	Other
5652	Moon Moray	*Uropterygius kamar*	Other
5642	Lg-Headed Snake Moray	*Uropterygius macrocephalus*	Other
5640	Marbled Snake Moray	*Uropterygius marmoratus*	Other
5641	Tidepool Snake Moray	*Uropterygius micropterus*	Other
5653	Lg-Spotted Snake Moray	*Uropterygius polyspilus*	Other

5643	Moray Eel	*Uropterygius supraforatus*	Other
5644	Moray Eel	*Uropterygius xanthopterus*	Other
2008	Roundray	*Urotrygon daviesi*	Other
40532	Glass Goby	*Valenciennea muralis*	Other
40663	Parva Goby	*Valenciennea parva*	Other
40533	Goby	*Valenciennea puellaris*	Other
40534	Goby	*Valenciennea sexguttatus*	Other
40536	Goby	*Valenciennea sp*	Other
40535	Goby	*Valenciennea strigatus*	Other
40521	Goby	*Vanderhorstia ambanoro*	Other
40661	Goby	*Vanderhorstia lanceolata*	Other
40522	Goby	*Vanderhorstia ornatissima*	Other
44515	Guilded Triggerfish	*Xanthichthys auromarginatus*	Other
44516	Bluelined Triggerfish	*Xanthichthys careuleolineatus*	Other
44521	Crosshatch Triggerfish	*Xanthichthys mento*	Other
40713	Wriggler	*Xenishthmus sp*	Other
40710	Flathead Wriggler	Xenisthmidae	Other
40712	Barred Wriggler	*Xenisthmus polyzonatus*	Other
44517	Triggerfish	*Xenobalistes tumidipectoris*	Other

39238	Blenny	*Xiphasia matsubarai*	Other
41250	Moorish Idols	*Zanclidae*	Other
41251	Moorish Idol	*Zanclus cornutus*	Other
20756	Esturine Halfbeak	*Zenarchopterus dispar*	Other
49400	ASSORTED REEF FISH	Misc. Reeffish	Misc. Reeffish
49110	SHALLOW BOTTOMFISH	Misc. Shallow bottomfish	Misc. Shallow bottomfish
49100	ASSORTED BOTTOMFISH	Misc. Bottomfish	Misc. Bottomfish
72600	Acanthaster planci	Crown-Of-Thorns	Other Invertebrates
79301	Actinopyga lecanora	Stonefish	Other Invertebrates
79302	Actinopyga miliaris	Blackfish	Other Invertebrates
79303	Actinopyga obesa	Sea Cucumber	Other Invertebrates
79304	Actinopyga sp	Sea Cucumber	Other Invertebrates
72500	Asterinidae	Starfish	Other Invertebrates
72400	Asteropidae	Starfish	Other Invertebrates
72100	Astropectinidae	Starfish	Other Invertebrates
79801	Bohadschia argus	Sea Cucumber	Other Invertebrates
79802	Bohadschia graeffei	Sea Cucumber	Other Invertebrates
79803	Bohadschia marmorata	Brown Sandfish	Other Invertebrates
79804	Bohadschia paradoxa	Sea Cucumber	Other Invertebrates
79805	Bohadschia sp	Sea Cucumber	Other Invertebrates
78900	Brissidae	Irregular Urchins	Other Invertebrates
97100	Cephea sp	Jellyfish	Other Invertebrates
78100	Cidaridae	Cidarians	Other Invertebrates

71000	Class Crinoidea	Crinoids	Other Invertebrates
78000	Class Echinoidea	Sea Urchins	Other Invertebrates
78800	Clypeasteridae		Other Invertebrates
79400	Cucumariidae	Sea Cucumbers	Other Invertebrates
78301	Diadema savignyi	Longspine Urchin	Other Invertebrates
78302	Diadema setosum	Longspine Urchin	Other Invertebrates
78300	Diadematidae	Sea Urchins	Other Invertebrates
78700	Echinoidea	Sea Urchins	Other Invertebrates
78600	Echinometridae	Sea Urchins	Other Invertebrates
72800	Echinosteridae	Reef Starfish	Other Invertebrates
78304	Echinothrix calamaris	Longspine Urchin	Other Invertebrates
78303	Echinothrix diadema	Longspine Urchin	Other Invertebrates
78200	Echinothuriidae	Sea Urchins	Other Invertebrates
78605	Heterocentrotus mammillatus	Slate Pencil Urchin	Other Invertebrates
79201	Holothuria atra	Lollyfish	Other Invertebrates
79202	Holothuria edulis	Pinkfish	Other Invertebrates
79203	Holothuria fuscogilva	White Teatfish	Other Invertebrates
79204	Holothuria fuscopunctata	Elephant'S Trunkfish	Other Invertebrates
79205	Holothuria hilla	Sea Cucumber	Other Invertebrates
79206	Holothuria impatiens	Sea Cucumber	Other Invertebrates
79207	Holothuria leucospilota	Sea Cucumber	Other Invertebrates
79208	Holothuria sp	Sea Cucumber	Other Invertebrates
79200	Holothuriidae	Sea Cucumber	Other Invertebrates
79000	Holothuroidea	Sea Cucumbers	Other Invertebrates

72700	Mithrodia bradleyi	Spiney-Armed Starfish	Other Invertebrates
72300	Ophidiaster confertus	Orange Starfish	Other Invertebrates
72200	Oreasteridae	Starfish	Other Invertebrates
79500	Phyllophoridae	Sea Cucumbers	Other Invertebrates
78503	Pseudoboletia maculata	Common Urchin	Other Invertebrates
72000	Sc Asteroidea	Starfish	Other Invertebrates
75000	Sc Ophiuroidea	Basket,Brittle, Serpentstars	Other Invertebrates
72900	Sphaerasteridae	Starfish	Other Invertebrates
79100	Stichopodidae	Sea Cucumbers	Other Invertebrates
79101	Stichopus chloronotus	Greenfish	Other Invertebrates
79102	Stichopus horrens	Sea Cucumber	Other Invertebrates
79103	Stichopus noctivatus	Sea Cucumber	Other Invertebrates
79105	Stichopus sp	Sea Cucumber	Other Invertebrates
79104	Stichopus variegatus	Curryfish	Other Invertebrates
79601	Synapta maculata	Sea Cucumber	Other Invertebrates
79602	Synapta media	Sea Cucumber	Other Invertebrates
79603	Synapta sp	Sea Cucumber	Other Invertebrates
79600	Synaptidae	Sea Cucumbers	Other Invertebrates
78400	Temnopleuridae	Sea Urchins	Other Invertebrates
79901	Thelenota ananas	Prickly Redfish	Other Invertebrates
79902	Thelenota anax	Amberfish	Other Invertebrates
79903	Thelenota sp	Sea Cucumber	Other Invertebrates
78502	Toxopneustes pileolus	Flower Urchin	Other Invertebrates

78500	Toxopneustidae	Shortspine Urchins	Other Invertebrates
78501	Tripneustes gratilla	Shortspine Urchin	Other Invertebrates