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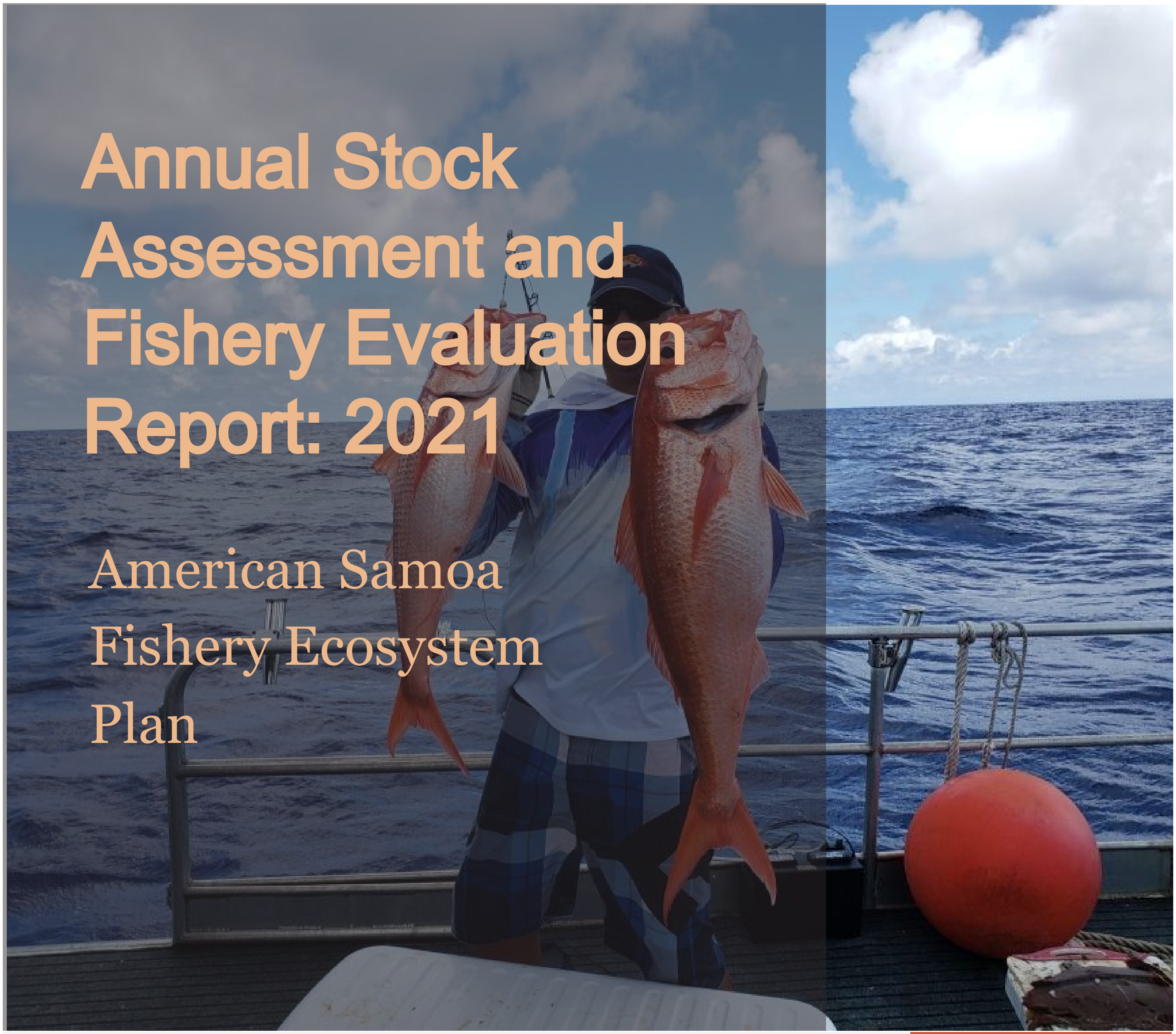
Annual Stock Assessment and Fishery Evaluation Report: 2021

American Samoa Fishery Ecosystem Plan



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The ANNUAL STOCK ASSESSMENT AND FISHERY EVALUATION REPORT for the AMERICAN SAMOA FISHERY ECOSYSTEM PLAN 2021 was drafted by the Fishery Ecosystem Plan Team. This is a collaborative effort primarily between the Western Pacific Regional Fishery Management Council (WPRFMC), National Marine Fisheries Service (NMFS)-Pacific Island Fisheries Science Center (PIFSC), Pacific Islands Regional Office (PIRO), Hawaii Division of Aquatic Resources (HDAR), American Samoa Department of Marine and Wildlife Resources (DMWR), Guam Division of Aquatic and Wildlife Resources (DAWR), and Commonwealth of the Mariana Islands (CNMI) Division of Fish and Wildlife (DFW).

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.

Additionally, in 2020 and 2021, there were notable impacts to fishery operations due to the 2019 novel coronavirus (COVID-19) outbreak and subsequent recovery. Impacts associated with the pandemic, its restrictions, and recovery are described in in Sections 2.1, 2.2, and 2.5.

Edited By: Thomas Remington, Lynker & Marlowe Sabater, Matt Seeley, and Asuka Ishizaki, WPRFMC.

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The **Western Pacific Regional Fishery Management Council** acknowledges the valuable contributions of the following Plan Team members and others for drafting sections of this report:

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NMFS Pacific Islands Regional Office: Brett Schumacher and Keith Kamikawa.

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The Council would like to thank the following individual for their contributions to the report: Ian Bertram.

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EXECUTIVE SUMMARY

As part of its five-year fishery ecosystem plan (FEP) review, the Western Pacific Regional Fishery Management Council (WPRFMC; the Council) identified its annual reports as a priority for improvement. The former annual reports have been revised to meet National Standard regulatory requirements for Stock Assessment and Fishery Evaluation (SAFE) reports. The purpose of the reports is twofold: to monitor the performance of the fishery and ecosystem to assess the effectiveness of the FEP in meeting its management objectives; and to maintain the structure of the FEP living document. The reports are comprised of three chapters: Fishery Performance, Ecosystem Considerations, and Data Integration. The Council will iteratively improve the annual SAFE reports as resources allow.

The Fishery Performance chapter of this report first presents a general description of the local fisheries within American Samoa, focusing on the management unit species (MUS), particularly bottomfish MUS (BMUS), accompanied by monitoring of ecosystem component species (ECS). The fishery data collection system is explained, encompassing creel surveys and commercial receipt books. Fishery meta-statistics for BMUS and ECS are organized into summary dashboard tables showcasing the values for the most recent fishing year and a comparison to short-term (10-year) and long-term (20-year) averages. Time series for catch and effort statistics are also provided along with implemented annual catch limits (ACLs).

In 2019, NMFS developed a stock assessment for the American Samoa BMUS stock complex and determined the complex to be both overfished and experiencing overfishing (Langseth et al. 2019). For 2020 and 2021 in American Samoa, NMFS did not implement an ACL for American Samoa BMUS, but NMFS did implement an interim catch limit (ICL) of 13,000 lb alongside an interim management measure for the American Samoa bottomfish fishery (86 FR 32361, June 21, 2021) while the Council develops a rebuilding plan to end overfishing and rebuild the stock complex from its overfished designation. The rebuilding plan will implement an ACL of 5,000 lb effective June 1, 2022 (87 FR 25590, May 2, 2022).

Total estimated catch for American Samoa BMUS in 2021 and the three-year average catch from 2019 to 2021 did not exceed the NMFS-implemented ICL of 13,000 lb. There are no other MUS in American Samoa, as an amendment to the American Samoa Archipelago FEP in early 2019 reclassified most of the MUS as ECS except for select bottomfish (84 FR 2767, February 8, 2019). ECS do not require management under ACLs or accountability measures but are still to be monitored regularly in the annual SAFE report through a one-year snapshot of the ten most-caught ECS, complete catch time series of prioritized ECS as selected by the American Samoa Department of Marine and Wildlife Resources (DMWR), as well as trophic and functional group biomass estimates from fishery-independent surveys where available.

American Samoa bottomfish fishery performance declined in 2021, which may be partially attributed to the persistence of direct and indirect impacts of the novel coronavirus (COVID-19) pandemic. Total estimated BMUS catch from creel survey data expansion was 2,215 lb, an 80% reduction from the short-term (10-year) average and 83% reduction from the long-term (20-year) average. Commercial BMUS catch from commercial purchase data were confidential in 2021 due to fewer than three dealers and/or vendors reporting fish sales. Catch-per-unit-effort (CPUE) for BMUS in 2021, measured in both pounds per trip and pounds per gear hour, was generally lower than the 10- and 20-year averages for both metrics with the exception of pounds per gear hour relative to its short-term trend. There were 21 lb/trip of BMUS harvested by bottomfish fishing, which was a 46% reduction from the short-term trend and 60% reduction from the long-term trend. The estimated 1.11 lb/gear hour of BMUS harvested by bottomfish fishing was identical to the 10-year average but represented 25% decrease from the 20-year average. There were just eight tallied fishing trips that harvested BMUS with bottomfish fishing gear in 2021, which was an 86% decrease from the 10-year trend and an 88% decrease from the 20-year trend. Tallied gear hours bottomfish fishing for BMUS were estimated to be 152, a 95% and 94% reduction from the short- and long-term trends, respectively. Participation in the bottomfish fishery also decreased in 2021, with just three unique vessels recorded as harvesting BMUS with bottomfish fishing (a decrease of 67% and 75% from the 10- and 20-year averages, respectively). There was no recorded bycatch in American Samoa boat-based bottomfish fisheries in 2021.

For the top ten landed ECS in American Samoa in 2021, available information showed that redlip parrotfish (*Scarus rubroviolaceus*) had the most catch in the creel survey data, while the blue-banded surgeonfish (*Acanthurus lineatus*) had the most catch in commercial invoice data. The second most caught species in the boat-based creel surveys was the bluespine unicornfish (*Naso unicornis*), while generic groups of unicornfish and parrotfish were the second and third highest, respectively, in the commercial purchase data. Many remaining top ten ECS from commercial purchase data were multi-species or family groups (e.g., unknown reef fishes and inshore groupers) due to how the species are organized during data collection.

For prioritized ECS in American Samoa (i.e., those selected as priorities for monitoring by DMWR), creel survey catch estimates in 2021 for two of the six species were zero. The four species with catch estimates for the year were *Panulirus penicillatus* (694 lb), *Sargocentron tiere* (42 lb), *Crenimugil crenilabis* (95 lb) and *Epinephelus melanostigma* (11 lb). In American Samoa commercial purchase data, five of the six species had zero recorded catch. The only species with catch data in 2021 was *P. penicillatus* (311 lb), whose sales data showed declines of 62% and 75% from the 10- and 20-year averages, respectively.

There were no federal permits issued for American Samoa lobster or deepwater shrimp fisheries in 2021, and no catch or effort were reported.

An Ecosystem Considerations chapter was added to the annual SAFE reports following the Council's review of its FEPs and revised management objectives. Fisher observations, fishery-independent ecosystem survey data, socioeconomics, protected species, climate and oceanographic indicators, essential fish habitat, and marine planning information are included in this chapter. A special section was added to the report in 2020 describing the impacts of COVID-19 on American Samoa archipelagic fisheries and fishing communities, and this section was updated with information on impacts and recovery for the 2021 report.

Fishery independent ecosystem data were acquired through visual surveys conducted by the National Marine Fisheries Service (NMFS) Pacific Islands Fisheries Science Center (PIFSC) Reef Assessment and Monitoring Program (RAMP) under the Ecosystem Sciences Division (ESD) in the CNMI, the Pacific Remote Island Areas (PRIA), American Samoa, Guam, the Main Hawaiian Islands (MHI), and the Northwestern Hawaiian Islands (NWHI). This report describes mean fish biomass of functional, taxonomic, and trophic groups for coral reefs as well as habitat condition using mean coral coverage per island for each of these locations. However, there were no new data reported for 2020 or 2021 due to the cancellation of surveys associated with impacts from the COVID-19 pandemic. Coral coverage at locations in American Samoa ranged from just over 3% (at South Bank) to nearly 30.5% (at Swains Island) averaged from 2010 to 2019, however there were only two surveys done at South Bank in that period. Total estimated fish biomass in American Samoa averaged from 2010 to 2019 was lowest at South Bank and highest at Ofu and Olosega, which also had the highest biomass for mid-to-large target surgeonfish, species of the family Scaridae, herbivores, and mobile invertebrate feeders. Biomass of non-planktivorous butterflyfish was highest at Tau, while Tutuila had the highest biomass for corallivores. Swains Island had the highest observed biomass for planktivores, and Rose Atoll had the highest biomass for species of the families Serranidae and Lutjanidae.

For American Samoa, 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 several species of both coral reef fish and bottomfish. Several length-derived parameters for coral reef fish and bottomfish were also summarized and included: maximum fish length, mean length, sample size, sample size for length-weight regression, and length-weight coefficients. Values for six reef-associated species and 11 species of bottomfish are presented for American Samoa where available. No new life history research on American Samoa fishery species was completed in 2021.

The socioeconomics section outlines the pertinent economic, social, and community information available for assessing the successes and impacts of management measures or the achievements of the FEP for the American Samoan Archipelago. It meets the objective "Support Fishing Communities" adopted at the 165th Council meeting; specifically, it identifies the various social and economic groups within the region's fishing communities and their interconnections. The section begins with an overview of the socioeconomic context for the region, provides a summary of relevant studies and data for American Samoa, gives summaries of relevant data and studies for American Samoan fisheries, presents available socioeconomic data (including annual data for revenue, fish price, and cost of fishing), and lists relevant studies for American Samoa. Data on pounds sold, estimated revenue, and average price per pound for catches in the American Samoan bottomfish fishery in 2021 were non-disclosed due to data confidentiality rules, as there were less than three vendors and/or dealers reporting. The top ten harvested ECS in American Samoa had 12,229 pounds sold in 2021, but revenue data were also non-disclosed due to confidentiality rules. The only priority ECS in 2021 with commercial data was the green spiny lobster, but similarly, the data were confidential and not able to be reported.

The protected species section of this report summarizes information and monitors protected species interactions in fisheries managed under the American Samoa 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 American Samoa bottomfish and coral reef ecosystem component fisheries that would affect the potential for interactions with protected species, and there is no other information to indicate that impacts to protected species in these fisheries have changed in recent years. In 2021, there were updates to the status of Endangered Species Act (ESA) ESA listing processes for several species.

The climate change section of this report includes indicators of current and changing climate and related oceanic conditions in the geographic areas for which the 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 considering changing climate, provide historical context, and identify patterns and trends.

The trend of atmospheric concentration of carbon dioxide (CO_2) is increasing exponentially with a time series maximum at 416 ppm in 2021. Since 1989, the oceanic pH at Station ALOHA in Hawaii has shown a significant linear decrease of -0.042 pH units, or roughly a 10.2% increase in acidity ([H+]) and was 8.07 in 2020. The Oceanic Niño Index, which is a measure of the El Niño – Southern Oscillation (ENSO) phase, indicated La Niña conditions for most of 2021, with two consecutive neutral seasons punctuating the year mid-year. The Pacific Decadal Oscillation (PDO) was negative in 2021. The Accumulated Cyclone Energy (ACE) Index (x 10^4 kt^2) was below average in Eastern and Central North Pacific and average in the Western North and South Pacific. Annual mean sea surface temperature (SST) was 28.78 ºC in 2021, and over the period of record, annual SST has increased at a rate of 0.022 ºC/year. The annual anomaly was 0.22 ºC hotter than average with a small area that was cooler than average in the northeast. American Samoa experienced little coral heat stress in 2021. Annual mean chlorophyll-*a* was 0.064 mg/m^3 in 2021, and the annual anomaly was 0.0062 mg/m^3 higher than average. Precipitation anomalies were relatively negative over the course of the year, especially in latter months. The local trend in sea level rise is 2.41 millimeters/year, equivalent to a change of 0.79 feet in 100 years.

The American Samoa Archipelago FEP and National Standard 2 guidelines require that this report include a report on the review of essential fish habitat (EFH) information, and the 2021 annual SAFE report addresses these requirements. The National Standard guidelines require a report on the condition of the habitat. In the 2021 report, data on benthic cover are included as indicators, pending development of habitat condition indicators for the American Samoa not otherwise represented in other sections of this report. No benthic surveys were able to be completed in 2020 or 2021, so these benthic indicators are not presented. The annual report is also meant to address any Council directives toward its Plan Team, but there were no Council recommendations specific to EFH in American Samoa in 2021.

The marine planning section of the annual report tracks activities with multi-year planning horizons and begins to monitors the impact of established facilities. No ocean activities with multi-year planning horizons were identified for American Samoa in 2021. The status of the Large Vessel Prohibited Area (LVPA) underwent litigation over the reduction of the LVPA in territorial waters. NMFS appealed Hawaii Federal District Court's 2017 decision that invalidated the 2016 LVPA reduction to the U.S. Ninth Circuit Court of Appeals. The decision was reversed in a September 2020 ruling, and on July 9, 2021, NMFS published a final rule reimplementing the 2016 regulations that the Council submitted to NMFS (86 FR 36239).

The Data Integration chapter of this report is under development. The chapter explores the potential association between fishery parameters and ecologically-associated variables that may be able to explain a portion of the variance in fishery-dependent data. A contractor completed preliminary evaluations in 2017, and results of exploratory analyses were included for the first time in the 2017 report. Going forward with the data integration analyses and presentation of results for Chapter 3 of the annual SAFE reports, the Council's Archipelagic Fishery Ecosystem

Plan Team (Plan Team) suggested several improvements to implement in the future, including standardizing and correcting values in the time series, incorporating longer stretches of phase lag, completing comparisons on the species-level and by dominant gear types, incorporating local knowledge on shifts in fishing dynamics over the course of the time series, and utilizing the exact environmental data sets presented in the Ecosystem Consideration chapter of this annual SAFE report. Many of these recommendations were applied to a revisited analysis in the Hawaii annual SAFE report in 2018 with similar plans for American Samoa data integration analyses in future report cycles. Implementation of these suggestions will allow for the preparation of a more finalized version of the data integration chapter in the future, and the chapter will be updated going forward as resources allow. For the 2021 report, several recent relevant abstracts from primary publications related to data integration were added to the chapter.

Plan Team members agreed to carry out the following recommendations, some of which are relevant to the American Samoa annual SAFE report:

Regarding American Samoa and Guam BMUS catch, the Archipelagic Plan Team:

1. Recommended the Council request PIFSC, DAWR, DMWR, and the Guam and American Samoa Advisory Panels review the reported increase and decrease, respectively, of total estimated BMUS landings in 2021 to determine whether the values are statistical and/or operational anomalies associated with data collection or if the values are indicative of the actual 2021 BMUS fishery performance.

Regarding the bycatch reporting improvements in the annual SAFE reports, the Archipelagic Plan Team:

2. Endorsed the current bycatch tables, noting that fisher-reported data may be biased downward, and recommends adding a separate table to describe the type of bycatch (e.g., a top-10 ranked species list and/or top 90 percentile) that comprises the number released for non-target species in the archipelagic bycatch tables.
3. Formed a working group comprised of Keith Bigelow, Brad Gough, Matt Seeley, Brian Ishida, and Thomas Remington to address the development of the top-10 ranked species and/or top 90 percentile list approach and the issue of reporting non-target species bycatch for MUS fisheries that are targeted by multiple gear types (e.g., uku in the main Hawaiian Islands).

Regarding the territorial non-commercial fisheries module to be included in the annual SAFE reports, the Archipelagic Plan Team:

4. Recommended the following members: Marc Nadon, Danika Kleiber, Ashley Tomita, and Keith Bigelow, finalize the configuration and content for the territorial non-commercial modules, based on the commercial catch summarization procedure presented to the APT, at the upcoming intersessional meeting for incorporation in the 2022 annual SAFE reports.
5. Recommended the following members: Bryan Ishida and Paul Murakawa, and Thomas Remington work with Hongguang Ma and Thomas Ogawa in the development of the Hawaii non-commercial module utilizing a similar approach as the NOAA Saltwater Recreational Fisheries Snapshot for Western Pacific Non-Commercial Fisheries.

Regarding the estimation of total catch, the Archipelagic Plan Team:

6. Recommended the Council request PIFSC to continue the development of scripts that would enable consistency between the catch time series used in stock assessment and the

annual SAFE reports to improve the monitoring of catch relative to implemented Annual Catch Limits.

Regarding the management of ecosystem component species, the Archipelagic Plan Team:

7. Recommended the PIFSC-ESD coordinate with the Council in the planning of the EBFM Workshop, incorporating the management of ECS as a thematic area. The APT notes that providing separate data streams together to inform the status of ECS in the context of EBFM would be useful to support the territorial management process. Further, the APT recommends PIFSC-ESD invite staff from Office of Sustainable Fisheries to provide guidance on the NS1 provision for designating and managing ECS as part of the workshop in combination with provisions of NS1 criteria 10.

Regarding the aquaculture management framework alternatives, the Archipelagic Plan Team:

8. Endorsed Alternative 3, which includes an expanded scope for the management framework, but noted concerns regarding the proposed 20-year duration for issued permits, non-native species, and ensuring there are appropriate monitoring plans implemented. However, the APT notes that at least a portion of these appropriate monitoring plans will be implicit through the permitting process.

Regarding the alternatives for the NWHI fishing regulations, the Archipelagic Plan Team:

9. Deferred the development of recommendations until the Office of National Marine Sanctuaries provides explicit boundaries for the proposed sanctuary relative to the Papahānaumokuākea Marine National Monument. When the sanctuary boundaries are further defined, the Archipelagic Plan Team will revisit this topic at a future meeting.

Regarding the CNMI BMUS hierarchical cluster analysis, the Archipelagic Plan Team:

10. Recommended the Council endorse the proposed BMUS list for CNMI and include this BMUS list for consideration by the previously established Archipelagic Plan Team MSA subgroup in the development of their MSA requirement sections for the FEP amendment associated with the BMUS revisions.

Regarding the main Hawaiian Island Uku Essential Fish Habitat modeling approaches, the Archipelagic Plan Team:

11. Recommended the Council endorse both modeling approaches to formulate the habitat module of the annual SAFE report noting concerns regarding the limitations of the data inputs. The modules should include qualitative information to supplement the model results. PIFSC and Council should work towards improving the data inputs (i.e., seasonal pattern to distribution and spawning aggregation) and include commercial fishery data and size frequency data in future EFH modeling work.

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ACRONYMS AND ABBREVIATIONS

Acronym	Meaning
A_{50}	Age at 50% Maturity
$A\Delta_{50}$	Age at 50% Sex Reversal
ABC	Acceptable Biological Catch
ACE	Accumulated Cyclone Energy
ACL	Annual Catch Limits
ACT	Annual Catch Target
AM	Accountability Measure
AS	American Samoa
ASCA	American Samoa Code Annotated
ASG	American Samoa Government
ASOP	American Samoa Ocean Plan
AVHRR	Advanced Very High Resolution Radiometer (NOAA)
B	Biomass
B_{FLAG}	Reference point indicating low biomass
BiOp	Biological Opinion
BMUS	Bottomfish Management Unit Species
BOEM	Bureau of Ocean Energy Management
BSIA	Best Scientific Information Available
CFEAI	Commercial Fishing Economic Assessment Index
CFMP	Community-Based Fishery Management Program
CFR	Code of Federal Regulations
CMAP	Merged Analysis of Precipitation (CPC)
CMUS	Crustacean Management Unit Species
CNMI	Commonwealth of the Northern Mariana Islands
CO-OPS	Center for Operational Oceanographic Products and Services (NOAA)
CPC	Climate Prediction Center (NOAA)
CPI	Consumer Price Index
CPUE	Catch per Unit Effort
CRED	Coral Reef Ecosystem Division (PIFSC)
CREP	Coral Reef Ecosystem Program (PIFSC)
CREMUS	Coral Reef Ecosystem Management Unit Species
CRW	Coral Reef Watch (NOAA)
CV	Coefficient of Variation
DAR	Division of Aquatic Resources (Hawaii)
DAWR	Division of Aquatic and Wildlife Resources (Guam)
DFW	Division of Fish and Wildlife (CNMI)
DGI	Daily Growth Increments
DHW	Degree Heating Weeks
DIC	Dissolved Inorganic Carbon
DMWR	Department of Marine and Wildlife Resources (American Samoa)
DPS	Distinct Population Segment
E	Effort

Acronym	Meaning
EA	Environmental Assessment
ECS	Ecosystem Component Species
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
ENSO	El Niño - Southern Oscillation
EO	Executive Order
ESA	Endangered Species Act
ESRL	Earth Systems Research Laboratory (NOAA)
F	Fishing Mortality
FL	Fork Length
FR	Federal Register
FAO	Food and Agriculture Organization
FEP	Fishery Ecosystem Plan
FMP	Fishery Management Plan
FONSI	Finding of No Significant Impact
GLM	General Linear Modeling
GOES	Geostationary Operational Environmental Satellite (NOAA)
GPS	Global Positioning System
H	Harvest
HAPC	Habitat Area of Particular Concern
HOT	Hawaii Ocean Time Series (UH)
HURL	Hawaii Undersea Research Laboratory (NOAA and UH)
ICL	Interim Catch Limit
k	von Bertalanffy Growth Coefficient
L_{50}	Length at 50% Maturity
$L\Delta_{50}$	Length at 50% Sex Reversal
L_{∞}	Asymptotic Length
L_{bar}	Mean Fish Length
L_{max}	Maximum Fish Length
LAA	Likely to Adversely Affect
LOC	Letter of Concurrence
LOF	List of Fisheries
LVPA	Large Vessel Prohibited Area
M	Natural Mortality
MBTA	Migratory Bird Treaty Act
MFMT	Maximum Fishing Mortality Threshold
MHI	Main Hawaiian Islands
MMA	Marine Managed Area
MMPA	Marine Mammal Protection Act
MNM	Marine National Monument
MODIS	Moderate Resolution Imaging Spectroradiometer (NASA)
MPA	Marine Protected Area
MPCC	Marine Planning and Climate Change
MPCCC	MPCC Committee (WPRFMC)
MSA	Magnuson-Stevens Fishery Conservation and Management Act

Acronym	Meaning
MSL	Mean Sea Level
MSST	Minimum Stock Size Threshold
MSU	Microwave Sounding Unit
MSY	Maximum Sustainable Yield
MUS	Management Unit Species
n	Sample Size
N_{L-W}	Sample Size for Length-Weigh Regression
N/A	Not Applicable
NAF	No Active Fishery
NASA	National Aeronautics and Space Administration
NCADAC	National Climate Assessment and Development Advisory Committee
NCDC	National Climatic Data Center (NOAA)
ND	Not Detected
NEPA	National Environmental and Policy Act
NESDIS	National Environmental Satellite, Data, and Information Service (NOAA)
NLAA	Not Likely to Adversely Affect
NMFS	National Marine Fisheries Service (NOAA)
NMS	Non-metric Multidimensional Scaling
NMSAS	National Marine Sanctuary of American Samoa
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service (NOAA)
NS	National Standard
NWHI	Northwestern Hawaiian Islands
NWS	National Weather Service
OEO	Office of Economic Opportunity (American Samoa)
OFL	Overfishing Limits
ONI	Ocean Niño Index
OPI	OLR Precipitation Index (NOAA)
OLR	Outgoing Longwave Radiation
OY	Optimum Yield
PacIOOS	Pacific Islands Ocean Observing System
PCMUS	Precious Coral Management Unit Species
PDO	Pacific Decadal Oscillation
Pelagic FEP	Fishery Ecosystem Plan for the Pacific Pelagic Fisheries
PIBHMC	Pacific Island Benthic Habitat Mapping Center (UH)
PIFSC	Pacific Island Fisheries Science Center (NMFS)
PIRCA	Pacific Islands Regional Climate Assessment
PIRO	Pacific Islands Regional Office (NMFS)
PMEL	Pacific Marine Environmental Laboratory (NOAA)
PMUS	Pelagic Management Unit Species
POES	Polar Operational Environmental Satellite (NOAA
PRIA	Pacific Remote Island Areas
RAMP	Reef Assessment and Monitoring Program (CRED)

Acronym	Meaning
ROV	Remotely Operated Underwater Vehicle
RPB	Regional Planning Body
SAFE	Stock Assessment and Fishery Evaluation
SBRM	Standardized Bycatch Reporting Methodologies
SD	Standard Deviation
SEEM	Social, Economic, Ecological, Management (Uncertainty)
SFA	Sustainable Fisheries Act
SODA	Simple Ocean Data Assimilation
SPC	Stationary Point Count
SSC	Scientific and Statistical Committee (WPRFMC)
SSM/I	Special Sensor Microwave/Imager
SST	Sea Surface Temperature
SSBPR	Spawning Stock Biomass Proxy Ratio
t_0	Hypothetical Age at Length Zero
T_{max}	Maximum Age
TA	Total Alkalinity
TALFF	Total Allowable Level of Foreign Fishing
TBA	To Be Assigned
TBD	To Be Determined
UH	University of Hawaii
USFWS	United States Fish and Wildlife Service
VBGF	von Bertalanffy Growth Function
VFP	Visual Fox Pro
WPacFIN	Western Pacific Fishery Information Network
WPR	Western Pacific Region
WPRFMC	Western Pacific Regional Fishery Management Council
WPSAR	Western Pacific Stock Assessment Review

1 FISHERY PERFORMANCE

1.1 FISHERY DESCRIPTIONS

The Samoa Archipelago is a remote chain of 13 islands of varying sizes and an atoll, located 14° south of the equator near the International Date Line. The islands lie between 13° and 14° latitude south and 169° and 173° longitude west, about 480 km (300 mi) from west to east, covering an area of 3,030 sq. km (1,170 sq. miles). With its tropical setting and its latitudinal range lying within the known limits of coral growth, coral reefs fringe the islands and atolls in the archipelago. The archipelago is approximately 4,200 km south of Hawaii in the central South Pacific Ocean and is divided into two political entities: Independent Samoa and American Samoa. The Independent Samoa has two large islands, Upolu and Savaii, and eight islets. American Samoa is comprised of five volcanic islands (Tutuila, Aunu'u, Ofu, Olosega, and Ta'u), one low-island (Swains Island), and a coral atoll (Rose Atoll). The five volcanic islands that are part of the American Samoa territory are very steep with mountainous terrain and high sea cliffs and of various sizes. Tutuila Island, the largest (137 km^2) and most populated island, is the most eroded with the most extensive shelf area and has banks and barrier reefs. Aunu'u is a small island close to Tutuila. Ofu and Olosega (13 km^2 together) are twin volcanic islands separated by a strait which is a shallow and narrow break in the reef flat between the islands. Ta'u is the easternmost island (45 km^2) with a more steeply sloping bathymetry.

The Samoa archipelago was formed by a series of volcanic eruptions from the "Samoan hotspot" (Hart et al. 2000). Based on the classic hotspot model, Savaii Island (the westernmost) in Samoa would be the oldest and Ta'u island (the easternmost) in American Samoa the youngest of the islands in the archipelago. Geological data indicate that Savaii is about four to five million years old, Upolu in Samoa about two to three million years old, Tutuila about 1.5 million years old, Ofu-Olosega about 300,000 years old, and Ta'u about 100,000 years old. Swains and Rose are built on much older volcanoes, they but are not part of the Samoan volcanic chain (Hart et al. 2004). The geological age and formation of Rose Atoll is not well known, and Swains is part of the Tokelau hot-spot chain which is anywhere from 59 to 72 million years old (Neall and Trewick 2008; Konter et al. 2008). There are numerous banks in the archipelago, the origins of which are not well known. The South Bank near Tutuila Island, for instance, is of another geological origin.

American Samoa experiences occasional cyclones due to its geographic location in the Pacific. Cyclones occur on one- to 13-year intervals, with the six strong occurrences happening over the last 40 years (Esau in 1981; Tusi in 1987; Ofa in 1990; Val in 1991; Heta in 2004; Olaf in 2005). The Territory had two tsunamis in the last 100 years due to its proximity to the geologically active Tonga Trench.

It is in this geological and physical setting that the Samoans have established their culture over the last 3,500 years. For three millennia, the Samoans have relied on the ocean for their sustenance. Fish and fishing activities constitute an integral part of the "*fa'a Samoa*", or the Samoan culture. Fish are also used for chiefly position entitlements and other cultural activities during the "*fa*'*a lalave*", or ceremonies.

1.1.1 Bottomfish Fishery

Deep, zooxanthellate, scleractinian coral reefs that have been documented in the Pacific often occur around islands in clear tropical oceanic waters (Lang 1974; Fricke and Meischner 1985; Kahng and Maragos 2006). These mesophotic coral ecosystems are found at depths of 30-40 m up to 150 m and have been exploited by bottomfish fishermen mainly targeting snappers, emperors, and groupers. Bottomfish fishing utilizing traditional canoes by the indigenous residents of American Samoa has been a subsistence practice since the Samoans settled on the Tutuila, Manu'a, and Aunu'u islands. It was not until the early 1970s that the bottomfish fishery developed into a commercial scheme utilizing motorized boats. The bottomfish fishery of American Samoa was typically comprised of commercial overnight bottomfish handlining using skipjack as bait on 28 to 30-foot-long aluminum/plywood “alia” (a term used for larger boats in Samoa). Imported bottomfish from the independent state of Samoa help satisfy demand, however the imports weaken the local bottomfish fishery. A government-subsidized program, called the Dory Project, was initiated in 1972 to develop the offshore fisheries into a commercial venture, and resulted in an abrupt increase in the size of the fishing fleet and total landings. In 1982, a fisheries development project aimed at exporting high-priced deep-water snappers to Hawaii initiated another notable increase in bottomfish landings and revenue. Between 1982 and 1988, the bottomfish fishery accounted for as much as half of the total commercial landings (by weight).

American Samoa's bottomfish fishery was a relatively larger size between 1982 and 1985 when it was new and expanding. In 1988, a decline in the bottomfish fishery occurred as many skilled and full-time commercial fishermen converted to trolling. Additionally, profits and revenue in bottomfish fishing suffered from four separate hurricanes, Tusi in 1987, Ofa in February of 1990, Val in December of 1991, and Heta in January of 2004, as well as the 2009 tsunami. The gradual depletion of newly discovered banks and migration of many fishermen into other fishing vendors resulted in the decline of landings through the mid-1980s. Fuel prices have gradually risen in the recent years, causing yet another strain on the bottomfish fisheries. The average price of bottomfish has also declined due to the shift in demand from local to imported bottomfish that complete closely with local prices. In 2004, 60 percent of coolers imported from the independent state of Samoa on the Lady Naomi Ferry were designated for commercial sale, and data from the Commercial Invoice System show that half of these coolers were filled with bottomfish.

Beginning in 1988, the nature of American Samoa's fisheries changed dramatically with a shift in importance from bottomfish fishing to trolling. In recent years, the dominant fishing method has been longlining (by weight). Bottomfish fishing has been in decline for years, but it was dealt a final devastating blow by the impacts of the 2009 tsunami. A fishery failure was declared, and the U.S. Congress allocated $1 million to revive the fishery. This fund has been used to repair boats damaged by the tsunami, maintain the floating docks used by the alia boats, and build a boat ramp. In 2013, the American Samoan Government also implemented a subsidy program that provided financial relief associated the rising fuel prices, and the fuel price has lowered since then.

1.1.2 Ecosystem Component Fishery

Traditional coral reef fishing in the lagoons and shallow reef areas has included methods such as gleaning and using bamboo poles with lines and baits or with a multi-pronged spear attached.

The deep water and pelagic fisheries have traditionally used wooden canoes, hand-woven sennit lines with shell hooks and stone sinkers, and lures made of wood and shell pieces.

Presumably, the change from traditional to present-day fishing methods started with Western contact in the 18th century. Today the fisheries in American Samoa can be broadly categorized in terms of habitat and target species as either pelagic fisheries, bottomfish fisheries in mesophotic reefs, or nearshore coral reef fisheries. For creel monitoring program purposes, fisheries are either subsistence (i.e., primarily shore-based and mostly for personal consumption) or commercial (i.e., primarily boat-based and mostly sold). Bottomfish fishing is a combination of mesophotic reef fishing (i.e., spearfishing) and/or pelagic fishing (i.e., trolling). The coral reef fishery involves gleaning, spearfishing (snorkel or free dive from shore or using boat), rod-and-reel using nylon lines and metal hooks, bamboo pole, throw nets, and gillnets. SCUBA spearfishing was introduced in 1994, restricted for use by native American Samoans in 1998, and finally banned in 2002 following recommendations by biologists from the DMWR and local scientists.

In 2018, the Council drafted an Amendment 4 to the American Samoa FEP that reclassified a large number of MUS as Ecosystem Component Species (ECS; WPRFMC 2018). The final rule was posted in the Federal Register in early 2019 (84 FR 2767, February 8, 2019). This amendment reduces the number of MUS from 205 species/families to 11 in the American Samoa FEP. All former coral reef ecosystem management unit species (CREMUS) were reclassified as ECS that do not require ACL specifications or accountability measures but are still to be monitored regularly to prioritize conservation and management efforts and to improve efficiency of fishery management in the region. All existing management measures, including reporting and record keeping, prohibitions, and experimental fishing regulations apply to the associated ECS. If an ECS stock becomes a target of a federal fishery in the future, NMFS and the Council may consider including that stock as a MUS to actively manage it. These species are still regularly monitored via other means (see Sections 1.5.3 and 2.3).

1.2 FISHERY DATA COLLECTION SYSTEM

American Samoa has been regularly conducting fishery-dependent monitoring since 1982 for its boat-based fisheries. The boat-based fisheries mostly involve trolling for tuna, skipjacks, and trevally, and bottomfish fishing mostly targets snappers, emperors, and groupers. Boat-based data collection involve two runs: first is the participation run used to determine the number of boats/fishermen out to fish and identify the type of gear being used, and the second is the interview run where the fishermen are interviewed for effort and economic data while also measuring the length and weight of each fish identified to the species level.

1.2.1 Boat-Based Creel Survey

The boat-based data collection focuses mostly on the main docks in Fagatogo and Pago Pago. Boat-based data collection is also being conducted in Manu’a. Boat-based data collection in both Ofu-Olosega and Ta’u is opportunistic since there is no set schedule for boats to go out and land their catches.

The survey follows a random stratified design. The stratification is by survey area, weekday/weekend, and time of day. The survey is divided into two phases: 1) participation run; and 2) catch interview phase. The participation run attempts to estimate the amount of participation by counting the number of boats "not on the dock" or the presence of trailers. The catch interview phase occurs after the participation run, which documents catch composition, CPUE, length-weight information, catch disposition, and some socio-economic information. The data is transcribed weekly into the WPacFIN database. Catch expansion is done on an annual scale through a simple expansion algorithm using expanded effort and CPUE. For more details of the boat-based creel survey see Oram et al. (2011).

1.2.2 Shore-Based Creel Survey

The shore-based data collection follows the same general scheme as the boat-based creel survey, and by randomly selects eight-hour periods and locations four to five times per week to conduct necessary runs. Survey locations are western Tutuila from Vailoa to Amanave, central Tutuila from Aua to Nuuuli, eastern Tutuila from Lauli'i to Tula, while the Manu'a routes are relatively more complicated.

The following data are generated through these creel collection programs: 1) catch landings; 2) effort; 3) CPUE; 4) catch composition; 5) length (accurate to the nearest centimeter); 6) weight (lbs.). The survey follows a random stratified design. The stratification is by survey area, weekday/weekend, and time of day. The survey is divided into two phases: the participation run and the catch interview phase. The participation run attempts to estimate the amount of participation by counting the number of fishermen along the shoreline. The gear type, number of gears, and number of fishers are recorded. The catch interview phase occurs after the participation run, and documents catch composition, CPUE, length-weight information, catch disposition, and some socioeconomic information. The data is transcribed weekly into the WPacFIN database. Catch expansion is done on an annual basis through an expansion algorithm using expanded effort and CPUE values. For more details of the shore-based creel survey see Oram et al. (2011).

1.2.3 Commercial Receipt Book System

Entities that sell any seafood products are required by law to report their sales to DMWR (ASCA § 24.0305). This is done through a receipt book system collected on the 16th day of every month. Information required to be reported are: (a) the weight and number of each species of fish or shellfish received; (b) the name of the fisherman providing the fish or shellfish; (c) boat name and registration number, if applicable; (d) the name of the dealer; (e) the date of receipt; (f) the price paid per species; (g) the type of fishing gear used; (h) whether the fish or shellfish are intended for sale in fresh, frozen, or processed form; (i) which fish or shellfish were taken within/outside of territorial waters; and (j) other statistical information the department may require.

1.2.4 Boat Inventory

An annual boat inventory is being conducted to track down fishing boats and determine their ownership. This will provide information on how many boats are potentially available to engage in the fishery.

1.3 META-DATA DASHBOARD STATISTICS

The meta-data dashboard statistics describe the amount of data used or available to calculate the fishery-dependent information. Creel surveys are sampling-based systems that require random-stratified design applied to pre-scheduled surveys. The number of sampling days, participation runs, and catch interviews would determine if there were enough 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 number of invoices submitted and the number of vendors participating in the program. Variations in these meta-data affect the commercial landing and revenue estimates.

1.3.1 Creel Survey Meta-Data Statistics

Calculations:

Sample days: Count of the total number of unique dates found in the boat log sampling date data in boat-based creel surveys.

Catch Interviews: In boat-based creel surveys, 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 scheduled survey days (Regular) and opportunistic interviews (Opportunistic), which are collected on non-scheduled days.

Table 1. Summary of American Samoa boat-based creel survey meta-data

Year	# Sample Days	# Catch Interviews	
		Regular	Opportunistic
1986	186	532	1
1987	110	338	0
1988	158	366	0
1989	160	389	0
1990	160	191	0
1991	134	169	0
1992	127	137	0
1993	140	126	0
1994	209	234	0
1995	239	333	0
1996	222	389	3
1997	226	888	1
1998	229	852	1
1999	207	659	0
2000	206	457	0
2001	205	249	2
2002	194	212	0
2003	220	489	0

Year	# Sample Days	# Catch Interviews	
		Regular	Opportunistic
2004	239	485	5
2005	238	330	0
2006	238	319	7
2007	251	484	6
2008	225	303	11
2009	165	174	9
2010	188	168	2
2011	240	203	1
2012	269	285	14
2013	262	245	0
2014	236	353	27
2015	233	247	26
2016	224	165	47
2017	222	139	33
2018	215	176	11
2019	218	166	12
2020	230	164	2
2021	206	77	6
10-year avg.	**232**	**202**	**18**
10-year SD	**19**	**76**	**14**
20-year avg.	**226**	**259**	**11**
20-year SD	**24**	**118**	**12**

In summary, the number of sample days doubled from the 1980s to the 1990s, but there has been a general decline in regular interviews over the years. The number of opportunistic interviews increased from 2014 to 2019. The variability of opportunistic interviews is related to natural disasters, DMWR staff changes, the American Samoa Government's fuel subsidy program, and COVID-19 restrictions in 2020. There was a notable decline of interviews of over 50% in 2021 relative to 2019 and 2020, which can likely be attributed to the decline of bottomfishing in 2021.

1.3.2 Commercial Receipt Book Statistics

Calculations:

Vendors: Count of the number of unique buyer codes found in the commercial purchase header data from the Commercial Receipt Book, BMUS vendors are only from vendors that landed BMUS species.

Invoices: Count of the number of unique invoice numbers found in the commercial header data from the Commercial Receipt Book, BMUS vendors are only from vendors that landed BMUS species.

Table 2. Summary of American Samoa commercial receipt book meta-data

Year	# Vendors	# Invoices Collected	# BMUS Vendors	# BMUS Invoices Collected
1992	11	445	8	51
1993	17	695	11	88
1994	21	1,415	13	138
1995	39	2,403	16	187
1996	17	1,737	8	83
1997	18	1,740	n.d.	n.d.
1998	22	1,704	3	10
1999	19	1,496	7	30
2000	19	1,151	7	61
2001	33	1,331	13	158
2002	26	1,055	9	127
2003	31	1,249	13	123
2004	28	934	14	118
2005	65	970	14	93
2006	59	1,170	13	109
2007	63	1,282	10	135
2008	46	1,001	11	100
2009	45	806	14	114
2010	34	620	9	54
2011	30	776	7	28
2012	30	827	11	28
2013	35	779	4	19
2014	42	1,126	9	37
2015	45	1,577	6	53
2016	50	1,396	6	18
2017	58	1,372	6	21
2018	62	1,342	3	16
2019	64	1,491	6	41
2020	63	867	5	11
2021	57	768	n.d.	n.d.
10-year avg.	**51**	**1,155**	**6**	**25**
10-year SD	**12**	**302**	**3**	**14**
20-year avg.	**47**	**1,070**	**9**	**63**
20-year SD	**14**	**271**	**4**	**45**

In summary, the number of engaged vendors has increased over time, but the number of invoices has declined. Additionally, the number of vendors selling BMUS has declined through the years, which suggests a decline in bottomfish and BMUS commerce. Lastly, COVID-19 restrictions seem to have also negatively affected general fish and BMUS commerce. There were fewer than three vendors that sold BMUS in 2021, thus the non-disclosure of data due to confidentiality.

1.4 FISHERY SUMMARY DASHBOARD STATISTICS

The Fishery Summary Dashboard Statics section consolidates all fishery-dependent information comparing the most recent year with short-term (recent 10 years) and long-term (recent 20 years) 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 above, below, 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*
- *above 1 standard deviation*
- *below 1 standard deviation*
- *within 1 standard deviation*

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

Table 3. Annual indicators for American Samoa bottomfish fisheries describing performance and comparing 2021 estimates with short- (10-year) and long-term (20-year) averages

Fishery	Fishery statistics	Short-term (10 years)	Long-term (20 years)
Bottomfish	**Total estimated catch (lb)**		
All gears (BMUS only)	All BMUS from creel survey data	**1,739[▼80%]**	**1,739[▼83%]**
	All BMUS from commercial purchase data	**n.d.**	**n.d.**
	Catch-per-unit-effort (from boat-based creel surveys)		
Bottomfish fishing (BMUS only)	Bottomfish lb/trip	**21[▼46%]**	**21[▼60%]**
	Bottomfish lb/gr-hr	**1.11 [no change]**	**1.11[▼24%]**
	Fishing effort (from boat-based creel surveys)		
Bottomfish fishing (BMUS only)	Tallied bottomfish trips	**8[▼86%]**	**8[▼88%]**
	Tallied bottomfish gear hours	**152[▼95%]**	**152[▼94%]**
	Fishing participation (from boat-based creel surveys)		

Fishery	Fishery statistics	Short-term (10 years)	Long-term (20 years)
Bottomfish fishing (BMUS only)	Tallied number of bottomfish vessels	**3[▼67%]**	**3[▼75%]**
	Estimated average number of fishermen per bottomfish trip	**3[no change]**	**3[no change]**
	Bycatch (from boat-based creel surveys)		
Bottomfish fishing (BMUS only)	# fish caught	**124[▼90%]**	**124[▼95%]**
	# fish discarded/released	**0[no change]**	**0[no change]**
	% bycatch	**0[no change]**	**0[no change]**

Table 4. Annual indicators for American Samoa ECS fisheries describing performance and comparing 2021 estimates with short- (10-year) and long-term (20-year) averages

Fishery	Fishery statistics	Short-term (10 years)	Long-term (20 years)
ECS	**Total estimated boat-based catch (lb)**		
Prioritized ECS	*Sargocentron tiere* from creel survey data	**42[▲83%]**	**42[▲282%]**
	Sargocentron tiere from commercial purchase data	**0[no change]**	**0[no change]**
	Crenimugil crenilabis from creel survey data	**95[▲102%]**	**95[▲313%]**
	Crenimugil crenilabis from commercial purchase data	**0[no change]**	**0[no change]**
	Panulirus penicillatus from creel survey data	**694[▲42%]**	**694[▼54%]**
	Panulirus penicillatus from commercial purchase data	**311[▼62%]**	**311[▼75%]**
	Clams from creel survey data	**0[no change]**	**0[no change]**
	Clams from commercial purchase data	**0[no change]**	**0[no change]**
	Octopus cyanea from creel survey data	**0[no change]**	**0[no change]**
	Octopus cyanea from commercial purchase data	**0[no change]**	**0[no change]**
	Epinephelus malanostigma from creel survey data	**11[▼86%]**	**11[▼73%]**
	Epinephelus malanostigma from commercial purchase data	**0[no change]**	**0[no change]**

1.5 CATCH STATISTICS

The following section summarizes the catch statistics for bottomfish, a one-year snapshot of the top ten landed species, and the top six prioritized species (and species groups) in American Samoa as determined by DMWR. The six species are the bluelined squirrelfish (*Sargocentron tiere*), fringelip mullet (*Crenimugil crenilabis*), green spiny lobster (*Panulirus penicillatus*), clams, day octopus (*Octopus cyanea*), and one-blotch grouper (*Epinephelus melanostigma*).

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 levels of catch for fishing methods and the top species complexes harvested in bottomfish fisheries in addition to the top ten landed species and top six prioritized species.

1.5.1 Catch by Data Stream

This section describes the estimated total catch from the boat-based creel survey programs as well as the commercial landings from the commercial receipt book system. The difference between the creel total and the commercial landings 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. In this case, the commercial receipt books can capture fishery data better than the creel surveys.

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

Table 5. Summary of American Samoa BMUS total catch (lb) from expanded boat-based and shore-based creel surveys and the commercial purchase system for all gear types

Year	Boat-Based Creel Survey Estimates	Shore-Based Creel Survey Estimates	Total Creel Survey Estimates	Commercial Landings
1986	3,860	-	3,860	-
1987	625	-	625	-
1988	24,722	-	24,722	-
1989	26,719	-	26,719	-
1990	9,471	2,009	11,480	-
1991	11,062	345	11,407	-
1992	8,050	1,132	9,182	1,895
1993	9,675	403	10,078	3,464
1994	24,195	560	24,755	2,375
1995	22,246	262	22,508	4,855
1996	22,477	1,040	23,517	1,082
1997	26,812	0	26,812	n.d.
1998	10,501	0	10,501	492
1999	12,687	0	12,687	1,701
2000	13,850	0	13,850	3,693
2001	30,064	0	30,064	3,447
2002	23,621	0	23,621	1,448
2003	12,971	0	12,971	2,511
2004	11,000	10	11,010	3,233
2005	8,226	46	8,272	2,490
2006	3,051	343	3,394	2,203

Year	Boat-Based Creel Survey Estimates	Shore-Based Creel Survey Estimates	Total Creel Survey Estimates	Commercial Landings
2007	10,913	161	11,074	4,001
2008	22,095	256	22,351	3,171
2009	34,388	194	34,582	3,035
2010	7,044	4	7,048	1,084
2011	14,083	3	14,086	711
2012	2,099	7	2,106	1,161
2013	5,732	1	5,733	882
2014	13,984	0	13,984	3,140
2015	21,528	8	21,536	2,047
2016	19,307	6	19,313	566
2017	14,791	190	14,981	1,131
2018	11,957	283	12,240	838
2019	11,082	551	11,633	1,749
2020	7,751	289	8,040	336
2021	1,739	476	2,215	n.d.
10-year avg.	**10,997**	**201**	**11,198**	**1,222**
10-year SD	**6,382**	**202**	**6,584**	**828**
20-year avg.	**12,868**	**166**	**13,034**	**1,805**
20-year SD	**7,959**	**173**	**8,132**	**1,083**

"-" indicates no data are available.

In summary, the table indicates non-commercial BMUS landings comprise roughly 90% of total catch, and only 10% of BMUS is sold. However, this trend is being revisited as taxonomic level to which fish are identified in the commercial receipts seems to have led to the underestimation of the BMUS sold. Variability in BMUS landings is likely due to natural disturbances (e.g., the 2009 tsunami) and the government fuel subsidy (i.e., initiated in 2014 and discontinued in 2017). BMUS landings have steadily declined since 2015, with a steeper decline in 2020 due to COVID-19 restrictions. BMUS catches decreased more notably in 2021 by nearly 80%, and commercial data non-disclosed due to data confidentiality rules.

1.5.2 Expanded Catch Estimates by Fishing Method

Catch information is provided for boat-based fishing methods that contribute most of the annual catch for American Samoa.

Calculations: The creel survey catch time series are the sum of the estimated weight for selected gear in all strata for all species and all BMUS species.

Table 6. Total catch time series estimates (lb) for all species and BMUS only using American Samoa expanded boat-based creel survey data for bottomfish fishing gears

Year	Bottomfish Fishing		Bottom-Troll Mixed		Spearfishing	
	All	BMUS	All	BMUS	All	BMUS
1986	59,512	1,648	61,310	2,194	33,451	0
1987	9,161	316	35,676	309	32,884	0
1988	28,798	16,528	35,990	7,645	53,616	45
1989	20,556	12,075	42,483	14,022	40,828	584
1990	8,308	4,754	11,829	4,651	1,441	0
1991	14,439	7,328	14,004	3,734	833	0
1992	14,941	8,050	0	0	0	0
1993	18,535	7,984	5,277	1,647	734	0
1994	52,382	22,395	8,812	1,674	32,996	0
1995	20,900	11,442	37,078	10,699	6,531	2
1996	39,932	18,110	13,626	4,348	6,369	19
1997	37,784	21,621	10,131	4,870	85,169	320
1998	10,759	7,280	6,542	3,102	77,443	119
1999	15,009	9,896	8,142	2,616	63,509	176
2000	25,104	12,045	3,888	1,746	42,922	60
2001	53,374	28,692	3,756	1,373	9,841	0
2002	47,689	22,852	1,774	768	8,562	0
2003	28,119	12,364	1,599	607	5,557	0
2004	29,591	9,526	3,517	1,470	4,405	0
2005	17,911	6,723	4,066	1,500	416	2
2006	12,028	2,539	1,169	494	2,589	19
2007	36,093	10,228	1,273	580	19,249	105
2008	54,674	21,495	1,809	575	8,030	25
2009	81,909	34,113	1,175	275	17,208	0
2010	16,307	6,917	272	83	60,110	44
2011	29,834	12,973	5,355	1,091	33,210	19
2012	13,515	1,834	1,646	259	15,950	1
2013	27,126	5,240	1,853	437	31,784	51
2014	32,471	13,165	4,006	801	17,695	4
2015	43,173	20,110	5,715	1,197	25,756	203
2016	28,363	14,435	15,300	4,398	7,272	474
2017	29,940	12,697	8,594	1,980	8,759	114
2018	18,763	11,145	3,550	658	6,140	121
2019	18,426	10,507	2,773	482	8,514	47
2020	13,636	5,790	6,812	1,453	7,193	318
2021	1,190	598	5,970	1,086	6,537	55

Year	Bottomfish Fishing		Bottom-Troll Mixed		Spearfishing	
	All	BMUS	All	BMUS	All	BMUS
10-year avg.	22,660	9,552	5,622	1,275	13,560	139
10-year SD	11,321	5,781	3,861	1,153	8,583	145
20-year avg.	29,038	11,763	3,911	1,010	14,747	80
20-year SD	17,487	7,885	3,392	914	13,791	120

In summary, BMUS landings have closely tracked landings for all bottomfish and account for 40% of the total bottomfish landings. However, the mixed bottomfish-trolling gear classification showed a different trend with a decline in BMUS landings. There were hurricane impacts to the fishery in 1987, 1990, 2004, and 2005, as well as in 2009 due to the tsunami. The 26% decline in bottomfish landings and 45% decline in BMUS landings in 2020 are attributed to impacts associated with COVID-19; however, landings from bottomfish-trolling increased in 2020. The fishery decline continued, as there was a 90% decline of BMUS bottomfishing catch in 2021 and 25% decline of BMUS mixed bottomfishing-trolling catch in 2021.

1.5.3 Top and Prioritized Species in Boat-Based Fishery Catch

Catch time series can act as indicators of fishery performance. Variations in the catch can be attributed to various factors, and there is no single explanatory variable for the observed trends. A one-year reflection of the top ten harvested species (by weight) is included to monitor which ECS are being caught the most annually. Additionally, DMWR selected six species/groups that were reclassified as ECS that are still of priority for regular monitoring, and complete catch time series of these species are included in the report as well.

Calculations: Catch tallied from the boat-based expanded species composition data combining gear types for all species excluding BMUS and pelagic MUS species.

Table 7a. Top ten landed ECS in American Samoa from boat-based creel survey data in 2021

Common Name	Scientific Name	Catch (lb)
Redlip parrotfish	*Scarus rubroviolaceus*	1,098
Bluespine unicornfish	*Naso unicornis*	1,040
Humpback snapper	*Lutjanus gibbus*	741
Spiny lobster	*Panulirus pencillatus*	694
Redtail parrotfish	*Chlorurus japanensis*	631
Blue-banded surgeonfish	*Acanthurus lineatus*	630
Twinspot snapper	*Lutjanus bohar*	604
Orangespine unicornfish	*Naso lituratus*	444
Multidens snapper	*Pristipomoides multidens*	317
Dark-capped parrotfish	*Scarus oviceps*	286

Calculations: Catch tallied from commercial receipt data combining gear types for all species excluding BMUS and pelagic MUS species.

Table 7b. Top ten landed ECS in American Samoa from estimated commercial landings data in 2021

Common Name	Scientific Name	Catch (lb)
Blue-banded surgeonfish	*Acanthurus lineatus*	4,372
Unicornfishes	*Naso* spp.	2,159
Parrotfishes	*Scarus* spp.	2,000
Striped bristletooth	*Ctenochaetus striatus*	928
Squirrelfishes	*Sargocentron* spp.	785
Pacific sailfin tang	*Zebrasoma veliferum*	648
Inshore groupers	Multi-species spp.	438
Reef fishes (unknown)	Multi-genera multi-species	371
Spiny lobster	*Panulirus pencillatus*	311
Squid	Multi-genera multi-species	217

In summary, species groupings and catch are expectedly different for ECS between the creel surveys and commercial invoices. *Scarus rubroviolaceus* was the top ECS in the creel surveys but not on the top list from commercial data. *Acanthurus lineatus* was top ECS from commercial invoices but was in the middle of the list from creel surveys. It is also notable that various species are aggregated into larger taxonomic groupings in the commercial invoices, such as the surgeonfish *Naso*, the parrotfish as *Scarus* spp., and more coarsely as multi-species and multi-genera groups.

Calculations: Catch tallied from boat-based expanded species composition data for species identified as priority ECS (Appendix A).

Table 8a. Catch (lb) from boat-based creel survey expansion data for prioritized species in American Samoan ECS fisheries

Year	*Sargocentron tiere*	*Crenimugil crenilabis*	*Panulirus penicillatus*	Clams (multi-species)	*Octopus cyanea*	*Epinephelus melanostigma*
1986	0	0	1,903	0	0	0
1987	0	0	2,545	0	0	0
1988	0	0	5,973	0	0	0
1989	0	0	4,212	0	0	0
1990	0	0	186	0	0	0
1991	0	0	146	0	0	0
1992	0	0	0	0	0	0
1993	0	0	47	0	0	0
1994	0	0	1,375	0	0	0
1995	0	0	269	0	0	0
1996	0	0	379	0	0	0
1997	0	0	4,885	0	0	0
1998	0	0	3,924	0	0	0
1999	0	0	2,065	0	0	0

Year	*Sargocentron tiere*	*Crenimugil crenilabis*	*Panulirus penicillatus*	**Clams (multi-species)**	*Octopus cyanea*	*Epinephelus melanostigma*
2000	0	0	1,762	0	0	0
2001	0	0	1,544	0	0	0
2002	0	0	753	0	0	0
2003	0	0	910	0	0	0
2004	0	0	560	0	0	0
2005	0	0	29	0	0	0
2006	0	0	225	0	0	0
2007	0	3	1,618	0	0	0
2008	0	0	1,113	0	0	0
2009	0	0	2,759	0	0	0
2010	0	0	14,305	0	0	0
2011	0	0	3,135	0	0	0
2012	0	0	566	0	0	0
2013	79	4	1,727	0	0	13
2014	9	0	140	0	0	52
2015	0	0	7	0	0	52
2016	18	42	249	0	0	71
2017	32	0	1,042	0	0	174
2018	20	143	148	0	0	182
2019	29	181	0	0	0	146
2020	0	0	307	0	0	110
2021	42	95	694	0	0	11
10-yr avg.	**23**	**47**	**488**	**0**	**0**	**81**
10-yr SD	**25**	**69**	**546**	**0**	**0**	**68**
20-yr avg.	**11**	**23**	**1,514**	**0**	**0**	**41**
20-yr SD	**21**	**53**	**3,136**	**0**	**0**	**63**

Calculations: Catch tallied from commercial purchase data for species identified as priority ECS (Appendix A).

Table 8b. Catch (lb) from commercial purchase data for prioritized species in American Samoan ECS fisheries

Year	*Sargocentron tiere*	*Crenimugil crenilabis*	*Panulirus penicillatus*	**Clams (multi-species)**	*Octopus cyanea*	*Epinephelus melanostigma*
1996	0	0	3,104	0	0	0
1997	0	0	4,262	0	0	0
1998	0	0	3,088	0	0	0
1999	0	0	2,255	0	0	0

Year	*Sargocentron tiere*	*Crenimugil crenilabis*	*Panulirus penicillatus*	Clams (multi-species)	*Octopus cyanea*	*Epinephelus melanostigma*
2000	0	0	808	0	0	0
2001	0	0	1,105	0	0	0
2002	0	0	762	0	0	0
2003	0	0	779	0	0	0
2004	0	0	506	0	0	0
2005	0	0	3,238	0	0	0
2006	0	0	5,380	0	0	0
2007	0	0	1,649	0	0	0
2008	0	0	1,417	0	0	0
2009	0	0	680	0	0	0
2010	0	0	1,464	0	0	0
2011	0	0	974	0	0	0
2012	0	0	621	0	0	0
2013	0	0	899	0	0	0
2014	0	0	1,292	0	0	0
2015	0	0	989	0	0	0
2016	0	0	1,102	0	0	0
2017	0	0	767	0	0	0
2018	0	3	743	0	0	0
2019	0	0	1,256	0	0	0
2020	0	0	228	0	0	0
2021	0	0	311	0	0	0
10-yr avg.	**0**	**0**	**821**	**0**	**0**	**0**
10-yr SD	**0**	**1**	**363**	**0**	**0**	**0**
20-yr avg.	**0**	**0**	**1,253**	**0**	**0**	**0**
20-yr SD	**0**	**1**	**1,163**	**0**	**0**	**0**

In summary, the priority ECS for American Samoa are the soldierfish (*Sargocentron tiere*), the giant clams (*Tridacna* spp.), the nearshore grouper (*Epinephelus melanostigma*), the nearshore mullet (*Crenimugil crenilabis*), the octopus (*Octopus cyanea*), and the spiny lobster (*Panulirus penicillatus*). However, only the spiny lobster has substantial data throughout the years since it is caught by boat-based spearfishing. The rest of the priority ECS are primarily harvested by various nearshore fisheries.

1.6 CATCH-PER-UNIT-EFFORT (CPUE) STATISTICS

This section summarizes the estimates for CPUE in the boat-based fisheries both for all species and for BMUS only. The boat-based fisheries include bottomfish fishing (handline gear), spearfishing (snorkel), and bottom-trolling mixed that comprise a majority of the total bottomfish catch. Trolling is primarily a pelagic fishing method but also catches coral reef fishes including jacks and gray jobfish. CPUE is reported as both pounds per gear hour and pounds per trip in the boat-based methods.

Calculations**:** CPUE is calculated from interview data by gear type using ∑catch /∑ (number of gears used*number of hours fished) or ∑catch /∑trips for boat-based data. If the value is blank (i.e., zero), then there was no interview collected for that method. Landings from interviews without fishing hours or number of gears are excluded from the calculations.

All - lb/trip: All catch and trips are tallied from landings by gear level, including non-BMUS species.

All - lb/gr-hr.: All catch and trips are tallied from trips with data on the number of gears used and numbers of hours fished, including non-BMUS species.

BMUS - lb/trip: Only BMUS catch and trips that landed BMUS species are tallied from landings by gear level.

BMUS - lb/gr-hr.: Only BMUS catch and trips that landed BMUS are tallied from trips with data on the number of gears used and numbers of hours fished.

In summary, CPUE as reflected in lb/gr-hr and lb/trip has declined for bottomfish overall, BMUS, bottomfish-trolling overall, and bottomfish-trolling for BMUS over the years. There has been variability in CPUE over time, and there has been no analysis of potential variables that can account for this variability. However, CPUE has been in general decline through the years for both bottomfishing and mixed bottomfishing-trolling. However, there was an uptick in CPUE from 2017 to 2020 despite being followed by a dip in 2021.

Table 9. CPUE (lb/trip and lb/gear hour) for bottomfish fishing gears in the American Samoa boat-based fishery for all species and BMUS only

Year	Bottomfish Fishing				Bottom-Troll Mixed				Spearfishing			
	All		BMUS		All		BMUS		All		BMUS	
	lb/trip	lb/gr-hr	lb/trip	lb/gr-hr	lb/trip	lb/gr-hr	lb/trip	lb/gr-hr	lb/trip	lb/gr-hr	lb/trip	lb/gr-hr
1986	136	3.16	189	3.42	217	5.08	130	2.10	257	5.08	0	0
1987	138	4.83	13	0.58	210	5.12	61	1.20	191	5.24	0	0
1988	175	6.65	107	4.08	285	6.10	96	2.40	215	5.44	13	0.33
1989	159	6.87	103	4.21	326	4.56	107	1.50	332	7.02	66	0.94
1990	127	4.12	83	2.60	248	4.32	95	1.66	170	5.27	0	0
1991	121	2.99	69	1.58	219	5.69	81	1.99	358	6.28	0	0
1992	139	4.00	80	2.29	0	0	0	0	0	0	0	0
1993	124	2.75	62	1.39	255	4.90	100	1.93	70	0	0	0
1994	125	2.62	53	1.10	193	3.37	30	0.53	247	2.40	0	0
1995	121	3.11	67	1.50	160	3.42	49	1.00	0	0	0	0
1996	143	5.58	61	2.27	283	6.69	72	1.67	0	0	0	0
1997	139	5.07	79	2.87	151	6.42	63	2.65	294	10.47	10	0.61
1998	175	4.83	116	3.20	35	1.46	0	0	393	10.90	0	0
1999	151	5.12	103	3.44	103	8.58	0	0	186	7.16	0	0
2000	122	4.11	61	2.08	36	3.00	5	0.42	0	0	0	0
2001	140	5.58	76	2.94	0	0	0	0	164	6.24	0	0
2002	81	2.62	40	1.27	0	0	0	0	177	3.75	0	0
2003	105	5.26	50	2.53	157	6.57	61	2.01	179	5.00	0	0
2004	77	1.54	32	1.06	151	6.24	73	2.88	154	6.91	0	0
2005	97	4.72	53	2.82	138	7.64	53	2.93	30	3.00	0	0
2006	81	3.47	32	1.03	97	4.30	41	1.82	86	2.11	4	0
2007	147	4.20	50	1.41	87	3.68	49	2.09	104	2.99	4	0.10
2008	191	4.43	82	1.83	107	2.93	32	0.87	106	3.43	2	0.06

Year	Bottomfish Fishing				Bottom-Troll Mixed				Spearfishing			
	All		BMUS		All		BMUS		All		BMUS	
	lb/trip	lb/gr-hr	lb/trip	lb/gr-hr	lb/trip	lb/gr-hr	lb/trip	lb/gr-hr	lb/trip	lb/gr-hr	lb/trip	lb/gr-hr
2009	320	5.71	135	2.39	278	4.17	65	0.97	330	9.21	0	0
2010	190	3.73	94	1.61	507	7.68	308	4.67	246	6.21	17	0.52
2011	194	4.65	89	2.03	292	8.22	68	1.79	326	8.49	10	0.19
2012	54	4.66	61	2.65	227	2.87	55	2.19	123	11.93	0	0
2013	81	1.91	34	0.52	162	3.94	49	1.13	247	7.43	5	0.13
2014	118	3.50	56	1.54	153	5.25	31	1.07	124	2.88	1	0.01
2015	109	2.98	51	1.36	140	0.63	31	0.14	147	3.49	14	0.28
2016	87	0.59	41	0.28	166	3.24	46	1.03	49	1.32	9	0.26
2017	91	1.13	36	0.44	145	0.31	58	0.19	45	0.13	3	0.00
2018	65	1.73	35	0.94	75	3.52	19	0.84	32	0.92	2	0.06
2019	66	2.39	33	1.11	138	4.22	27	0.84	31	0.83	1	0.07
2020	58	2.82	26	1.15	114	5.06	25	1.07	59	1.46	4	0.07
2021	49	2.55	21	1.11	154	4.22	25	0.68	55	1.03	2	0.03
10-year avg.	**78**	**2.425**	**39**	**1.110**	**147**	**3.326**	**37**	**0.92**	**91**	**3.144**	**4**	**0.103**
10-year SD	**22**	**1.115**	**12**	**0.644**	**37**	**1.592**	**13**	**0.54**	**65**	**3.547**	**4**	**0.098**
20-year avg.	**113**	**3.229**	**53**	**1.454**	**173**	**4.457**	**59**	**1.54**	**133**	**4.127**	**5**	**0.138**
20-year SD	**65**	**1.403**	**27**	**0.711**	**96**	**2.096**	**61**	**1.07**	**92**	**3.166**	**5**	**0.139**

1.7 EFFORT STATISTICS

This section summarizes the effort trends in the American Samoa bottomfish fishery. Fishing effort trends provide insights on the level of fishing pressure through time. Effort information is provided for the top boat-based fishing methods that comprise most of the annual catch.

Calculations: Effort estimates (in both trips and gear hours) are calculated from boat-based interview data. Trips are tallied according to the interview data in boat-based creel surveys. Gear hours are generated by summing the data on number of gears used*number of hours fished collected from interviews by gear type. For the boat-based estimates, data collection started in 1982, but is reported here from 1986.

All - Trips: All trips tallied by gear type.

All - Gear-hr: Gear hours tallied by gear type.

BMUS - Trips: Trips that landed BMUS tallied by gear type.

BMUS - Gear-hr: Gear hours tallied by gear type for trips landed BMUS with data on both number of gears used and numbers of hours fished.

In summary, the number of bottomfish fishing trips continued decreasing to an all-time low, and the number of bottomfish-trolling trips has had a similar decline. Bottomfishing historically was more active than mixed bottomfishing-trolling. The fishing effort measured as number of trips have been influenced by natural disasters (hurricanes in 1987 and 1990 and tsunami in 2009) and subsidies (initiation in 2014 but discontinued in 2017). BMUS trips declined by 40% in 2020 and further declined by 80% in 2021. In contrast, mixed bottomfishing-trolling trips doubled in 2020 from 2019 but similarly declined by 75% in 2021.

Table 10. Effort (trips and gear hours) for bottomfish fishing gears in the American Samoa boat-based fishery for all species and BMUS only

Year	Bottomfish Fishing				Bottom-troll Mixed				Spearfishing			
	All		BMUS		All		BMUS		All		BMUS	
	Trips	Gr-hr	Trips	Gr-hr	Trips	Gr-hr	Trips	Gr-hr	Trips	Gr-hr	Trips	Gr-hr
1986	135	5,341	13	346	80	3,385	5	260	39	1,976	0	0
1987	19	544	4	90	57	2,337	3	152	51	1,860	0	0
1988	41	1,082	37	974	34	1,589	22	879	73	2,887	1	40
1989	30	694	28	681	34	2,435	34	2,435	40	1,893	3	210
1990	19	587	16	512	15	863	15	863	8	258	0	0
1991	32	1,300	29	1,256	19	730	14	571	2	114	0	0
1992	26	902	24	841	0	0	0	0	0	0	0	0
1993	38	1,719	33	1,475	3	156	3	156	1	0	0	0
1994	40	1,917	37	1,784	9	514	8	451	4	411	0	0
1995	23	896	19	842	25	1,165	22	1,090	0	0	0	0
1996	37	949	34	916	10	423	8	343	0	0	0	0
1997	46	1,261	45	1,241	14	330	14	330	31	871	5	83
1998	17	614	17	614	2	48	0	0	2	72	0	0
1999	15	442	14	418	1	12	0	0	4	104	0	0
2000	10	297	9	265	1	12	1	12	0	0	0	0
2001	37	886	35	878	0	0	0	0	9	237	0	0
2002	44	1,343	44	1,343	0	0	0	0	7	330	0	0
2003	83	1,103	82	1,103	10	99	10	99	7	110	0	0
2004	103	4,882	92	2,631	20	484	19	484	3	67	0	0
2005	56	743	53	687	29	455	28	455	1	10	0	0
2006	88	1,779	56	1,451	12	272	12	272	7	88	1	0
2007	127	4,147	121	4,085	13	306	11	258	71	2,282	10	366
2008	105	4,349	102	4,311	10	366	10	366	35	1,051	6	241

Year	Bottomfish Fishing				Bottom-troll Mixed				Spearfishing			
	All		BMUS		All		BMUS		All		BMUS	
	Trips	Gr-hr	Trips	Gr-hr	Trips	Gr-hr	Trips	Gr-hr	Trips	Gr-hr	Trips	Gr-hr
2009	109	6,046	107	6,032	8	534	8	534	27	961	0	0
2010	42	2,132	36	2,086	1	66	1	66	94	3,533	2	64
2011	55	2,173	52	2,135	18	608	16	569	58	2,158	1	54
2012	99	1,088	14	269	5	277	2	42	55	513	1	0
2013	75	3,160	36	2,276	11	399	8	252	68	2,171	6	202
2014	125	4,081	107	3,818	22	642	22	642	64	2,761	2	160
2015	122	4,045	116	3,997	27	5,542	25	5,498	26	1,093	4	190
2016	63	8,127	62	8,119	46	1,785	46	1,785	35	1,230	7	228
2017	73	5,650	72	5,650	18	7,420	13	3,780	35	10,195	9	7,117
2018	58	2,083	57	2,083	16	280	11	249	46	1,577	10	392
2019	58	1,469	57	1,469	7	229	7	229	41	1,446	6	115
2020	43	881	39	871	17	357	16	339	48	1,933	14	675
2021	8	152	8	152	4	146	4	146	30	1,611	5	262
10-year avg.	**72**	**3,074**	**57**	**2,870**	**17**	**1,708**	**15**	**1,296**	**45**	**2,453**	**6**	**934**
10-year SD	**34**	**2,345**	**34**	**2,419**	**12**	**2,464**	**12**	**1,778**	**13**	**2,645**	**4**	**2,068**
20-year avg.	**77**	**2,972**	**66**	**2,728**	**15**	**1,013**	**13**	**803**	**38**	**1,756**	**4**	**503**
20-year SD	**32**	**2,066**	**32**	**2,063**	**11**	**1,881**	**11**	**1,358**	**25**	**2,156**	**4**	**1,527**

"NA" = no data available.

1.8 PARTICIPANTS

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

Calculations: For boat-based data, the estimated number of unique vessels is calculated by tallying the number of vessels recorded in the interview data via vessel registration or name.

All: Total unique vessels by gear type.

BMUS: Unique vessels from trips that landed BMUS by gear type.

Table 11a. Estimated number of unique vessels for bottomfish fishing gears in the American Samoa boat-based fishery for all species and BMUS only

Year	Bottomfish Fishing		Bottom-Troll Mixed		Spearfishing	
	All	BMUS	All	BMUS	All	BMUS
1986	20	5	20	3	7	0
1987	11	3	14	3	8	0
1988	12	12	11	9	9	1
1989	14	13	13	13	4	1
1990	5	4	6	6	2	0
1991	13	12	9	7	1	0
1992	9	9	0	0	0	0
1993	10	9	3	3	1	0
1994	8	7	6	6	2	0
1995	10	8	12	12	0	0
1996	15	14	8	6	0	0
1997	13	12	8	8	4	3
1998	9	9	1	0	2	0
1999	9	8	1	0	1	0
2000	8	7	1	1	0	0
2001	12	11	0	0	5	0
2002	13	13	0	0	3	0
2003	14	14	4	4	4	0
2004	21	21	7	6	3	0
2005	13	12	5	5	1	0
2006	20	14	1	1	2	1
2007	21	19	6	4	3	3
2008	18	16	8	8	3	2
2009	14	14	4	4	3	0
2010	11	8	1	1	5	1
2011	8	7	5	5	2	1

Year	Bottomfish Fishing		Bottom-Troll Mixed		Spearfishing	
	All	**BMUS**	**All**	**BMUS**	**All**	**BMUS**
2012	11	6	4	2	2	1
2013	13	10	5	3	3	2
2014	16	13	9	9	4	1
2015	14	14	10	9	4	2
2016	15	15	10	10	3	2
2017	11	11	8	7	6	3
2018	9	9	6	5	3	3
2019	6	6	3	3	5	2
2020	7	6	6	6	3	3
2021	3	3	2	2	4	2
10-year avg.	**11**	**9**	**6**	**6**	**4**	**2**
10-year SD	**4**	**4**	**3**	**3**	**1**	**1**
20-year avg.	**13**	**12**	**5**	**5**	**3**	**1**
20-year SD	**5**	**5**	**3**	**3**	**1**	**1**

"NA" = no data available.

In summary, the number of operating vessels has been affected by natural disasters and access to the government subsidy over the years in the midst of a declining trend.

Calculations: For boat-based data, the estimated number of fishermen per trip is calculated by filtering interviews that recorded the number of fishers, and then ∑fishers/∑trips. A blank cell indicates insufficient data to generate an estimate of average fishers.

All: Average fishers from all trips by gear type.

BMUS: Average fishers from trips that landed BMUS by gear type.

Table 11b. Estimated number of fishermen per trip for bottomfish fishing gears in the American Samoa boat-based fishery for all species and BMUS only

Year	Bottomfish Fishing		Bottom-Troll Mixed		Spear	
	All	**BMUS**	**All**	**BMUS**	**All**	**BMUS**
1986	3	2	2	2	5	0
1987	3	2	2	2	5	0
1988	2	2	3	3	4	4
1989	3	3	4	4	5	6
1990	2	2	3	3	4	0
1991	3	3	3	3	5	0
1992	2	2	0	0	0	0
1993	2	2	3	3	5	0
1994	2	2	3	3	4	0
1995	3	2	2	3	0	0

Year	Bottomfish Fishing		Bottom-Troll Mixed		Spear	
	All	BMUS	All	BMUS	All	BMUS
1996	3	3	3	2	0	0
1997	3	3	3	3	5	3
1998	3	3	3	0	6	0
1999	2	2	3	0	4	0
2000	3	3	3	3	0	0
2001	3	3	0	0	3	0
2002	3	3	0	0	5	0
2003	3	3	3	3	4	0
2004	3	3	3	3	6	0
2005	3	3	3	3	5	0
2006	3	4	3	3	4	6
2007	3	3	3	3	5	5
2008	3	3	3	3	4	5
2009	4	4	4	4	6	0
2010	3	4	3	3	6	5
2011	3	3	3	3	7	9
2012	2	3	5	3	5	0
2013	3	3	4	4	6	6
2014	3	3	3	3	6	7
2015	3	3	3	3	5	5
2016	3	3	3	3	5	4
2017	6	6	7	4	7	14
2018	3	3	3	2	5	5
2019	3	3	3	3	5	4
2020	2	2	2	2	5	5
2021	3	3	3	3	7	6
10-year avg.	**3**	**3**	**4**	**3**	**6**	**6**
10-year SD	**1**	**1**	**1**	**1**	**1**	**3**
20-year avg.	**3**	**3**	**3**	**3**	**5**	**4**
20-year SD	**1**	**1**	**1**	**1**	**1**	**4**

1.9 BYCATCH ESTIMATES

This section focuses on Magnuson-Stevens Fishery Conservation and Management Act (MSA) § 303(a)(11), which requires that all fishery management plans (FMPs) establish a standardized reporting methodology to assess the amount and type of bycatch occurring in the fishery. Additionally, it is required to 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: The number caught is the sum of the total number of individuals found in the raw data including bycatch. The number discarded or released is number of individuals marked as bycatch. Percent bycatch is the sum of all released divided by the number caught.

Table 12. Time series of catch and bycatch in the American Samoa boat-based BMUS and non-BMUS fisheries

Year	BMUS			Non-BMUS			BMUS + Non-BMUS		
	# Caught	# Discard or Release	% Bycatch	# Caught	# Discard or Release	% Bycatch	# Caught	# Discard or Release	% Bycatch
1992	1,803	0	0	637	0	0	2,440	0	0
1993	1,534	0	0	860	0	0	2,394	0	0
1994	5,447	0	0	2,210	0	0	7,657	0	0
1995	2,397	0	0	1,008	0	0	3,405	0	0
1996	3,940	0	0	2,059	0	0	5,999	0	0
1997	2,910	0	0	2,283	0	0	5,193	0	0
1998	998	0	0	846	0	0	1,844	0	0
1999	3,213	0	0	2,417	0	0	5,630	0	0
2000	3,386	0	0	3,052	0	0	6,438	0	0
2001	3,499	0	0	2,703	0	0	6,202	0	0
2002	3,362	0	0	3,597	0	0	6,959	0	0
2003	3,778	0	0	4,019	1	0.0249	7,797	1	0.0128
2004	2,970	0	0	3,764	0	0	6,734	0	0
2005	1,807	0	0	1,877	0	0	3,684	0	0
2006	1,573	0	0	4,260	0	0	5,833	0	0
2007	2,752	0	0	4,184	0	0	6,936	0	0
2008	4,616	0	0	3,972	0	0	8,588	0	0
2009	11,080	0	0	8,441	0	0	19,521	0	0
2010	2,902	0	0	2,119	0	0	5,021	0	0
2011	4,229	0	0	3,130	0	0	7,359	0	0
2012	775	0	0	4,362	0	0	5,137	0	0
2013	1,031	0	0	3,494	0	0	4,525	0	0
2014	3,123	0	0	3,504	0	0	6,627	0	0
2015	3,602	0	0	3,666	0	0	7,268	0	0
2016	888	0	0	1,234	0	0	2,122	0	0
2017	926	0	0	1,425	0	0	2,351	0	0
2018	630	0	0	742	0	0	1,372	0	0
2019	771	0	0	823	0	0	1,594	0	0
2020	404	0	0	632	0	0	1,036	0	0

Year	BMUS			Non-BMUS			BMUS + Non-BMUS		
	# Caught	**# Discard or Release**	**% Bycatch**	**# Caught**	**# Discard or Release**	**% Bycatch**	**# Caught**	**# Discard or Release**	**% Bycatch**
2021	124	0	0	108	0	0	232	0	0
10-yr avg.	**1,227**	**0**	**0**	**1,999**	**0**	**0**	**3,226**	**0**	**0**
10-yr SD	**1,102**	**0**	**0**	**1,489**	**0**	**0**	**2,347**	**0**	**0**
20-yr avg.	**2,567**	**0**	**0**	**2,968**	**0**	**0.0012**	**5,535**	**0**	**0.0006**
20-yr SD	**2,382**	**0**	**0**	**1,868**	**0**	**0.0054**	**4,068**	**0**	**0.0028**

1.10 FEDERAL LOGBOOK DATA

1.10.1 Number of Federal Permit Holders

In American Samoa, the following federal permits are required for fishing in the exclusive economic zone (EEZ) under the American Samoa FEP. Regulations governing fisheries under the American Samoa FEP are in the Code of Federal Regulations (CFR), Title 50, Part 665.

1.10.1.1 Special Coral Reef Ecosystem Permit

Regulations require the special coral reef ecosystem fishing permit for anyone fishing for coral reef ecosystem management unit species in a low-use marine protected area (MPA), fishing for species on the list of Potentially Harvested Coral Reef Taxa or using fishing gear not specifically allowed in the regulations. NMFS will make an exception to this permit requirement for any person issued a permit to fish under any fishery ecosystem plan who incidentally catches American Samoa coral reef ECS while fishing for bottomfish MUS, crustacean MUS or ECS, western Pacific pelagic MUS, precious coral, or seamount groundfish. Regulations require a transshipment permit for any receiving vessel used to land or transship potentially harvested coral reef taxa, or any coral reef ECS caught in a low-use MPA.

1.10.1.2 Western Pacific Precious Coral

Regulations require this permit for anyone harvesting or landing black, bamboo, pink, red, or gold corals in the EEZ in the western Pacific.

1.10.1.3 Western Pacific Crustacean Permit

Regulations require a permit for the owner of a U.S. fishing vessel used to fish for lobster (now ECS) or deepwater shrimp in the EEZ around American Samoa, Guam, Hawaii, and the Pacific Remote Islands Areas (PRIA), and in the EEZ seaward of three nautical miles of the shoreline of the Northern Mariana Islands.

There is no record of special coral reef or precious coral fishery permits issued for the EEZ around American Samoa since 2007. NMFS has issued few crustacean fishery permits as shown in Table 13. Table 13 provides the number of permits issued to American Samoa FEP fisheries between 2012 and 2021. Data are from the Pacific Islands Regional Office (PIRO) Sustainable Fisheries Division (SFD) permits program.

Table 13. Number of federal permit holders in American Samoa crustacean fisheries

Crustacean Fishery[1]	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Lobster	0	0	1	0	0	0	0	0	0	0
Shrimp	0	0	1	0	0	0	0	0	0	0

[1] Source: PIRO SFD unpublished data.

1.10.2 Summary of Catch and Effort for FEP Fisheries

The American Samoa FEP requires fishermen to obtain a federal permit to fish for certain MUS in federal waters and to report all catch and discards. While NMFS annually issues permits for various FEP fisheries, there is currently limited available data on the level of catch or effort made by federal non-longline permit holders. Determining the level of fishing activity through the required federal logbook reporting for each fishery helps establish the level of non-longline fishing occurring in federal waters to assess whether there is a continued need for active conservation and management measures (e.g., annual catch limits) for these fisheries. For each FEP fishery, the number of federal permits issued since the federal permit and logbook reporting requirement became effective as well as available catch and effort data are presented.

Federal permits are not required to fish for bottomfish in American Samoa; NMFS has never issued a federal permit for precious coral or coral reef fishing in federal waters around American Samoa. Therefore, catch and effort data is not presented for these fisheries.

1.10.2.1 Spiny and Slipper Lobster

Table 14. Summary of available federal logbook data for lobster fisheries in American Samoa

Year	No. of Federal Lobster Permits Issued[1]	No. of Federal Lobster Permits Reporting Catch	No. of Trips in AS EEZ	Total Reported Logbook Catch (lb)		Total Reported Logbook Release/Discard (#)	
				Spiny lobster ECS[2]	*Slipper lobster ECS*[2]	*Spiny lobster ECS*[2]	*Slipper lobster ECS*[2]
2004	0						
2005	0						
2006	2	0					
2007	2	0					
2008	7	0					
2009	0						
2010	0						
2011	0						
2012	0						

2013	0						
2014	1	0					
2015	0						
2016	0						
2017	0						
2018	0						
2019	0						
2020	0						
2021	0						

[1] Source: PIRO SFD unpublished data.
[2] On February 8, 2019, NMFS published a final rule (84 FR 2767) to reclassify all crustacean MUS in American Samoa as ECS.

1.10.2.2 Deepwater Shrimp

Table 15. Summary of available federal logbook data for deepwater shrimp fisheries in American Samoa

Year	No. of Federal Shrimp Permits Issued[1]	No. of Federal Shrimp Permits Reporting Catch	No. of Trips in American Samoa EEZ	Total Reported Logbook Shrimp ECS[2] Catch (lb)	Total Reported Logbook Shrimp ECS[2] Release/Discard (lb)
2009	0				
2010	0				
2011	0				
2012	0				
2013	0				
2014	1	0			
2015	0				
2016	0				
2017	0				
2018	0				
2019	0				
2020	0				
2021	0				

[1] Source: PIRO SFD unpublished data.
[2] On February 8, 2019, NMFS published a final rule (84 FR 2767) to reclassify all crustacean MUS in American Samoa as ECS.
Note: Federal permit and reporting requirements for deepwater shrimp fisheries became effective on June 29, 2009 (74 FR 25650, May 29, 2009).

1.11 STATUS DETERMINATION CRITERIA

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 used for the bottomfish multi-species stock complexes. Instead, the control rules are applied to each stock complex as a whole.

The maximum sustainable yield (MSY) control rule is used as the maximum fishing mortality threshold (MFMT). The MFMT and minimum stock size threshold (MSST) are specified based on the recommendations of Restrepo et al. (1998) and both are dependent on the natural mortality rate (M). The value of M used to determine the reference point values is not specified in this section. The latest estimate published annually in the stock assessment and fishery evaluation (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 16.

Table 16. Overfishing threshold specifications for BMUS

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 CPUE are used as proxies for fishing mortality (F) and biomass (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 would 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 is used.

Since the MSY control rule specified here applies to multi-species stock complexes, it is important to ensure that no species within the complex has a mortality rate that leads to excessive depletion. In order to accomplish this, a secondary set of reference points is specified to evaluate stock status with respect to recruitment overfishing. A secondary "recruitment overfishing" control rule is specified to control fishing mortality with respect to that status. The rule applies only to those component stocks (species) for which adequate data are available. The ratio of a current spawning stock biomass proxy ($SSBP_t$) to a given reference level ($SSBP_{REF}$) is used to determine if individual stocks are experiencing recruitment overfishing. SSBP is CPUE scaled by percent mature fish in the catch. When the ratio $SSBP_t/SSBP_{REF}$, or the "SSBP ratio" (SSBPR) for any species drops below a certain limit ($SSBPR_{MIN}$), that species is considered to be recruitment overfished and management measures will be implemented to reduce fishing mortality on that species. The rule applies only when the SSBP ratio drops below the $SSBPR_{MIN}$, but it will continue to apply until the ratio achieves the "SSBP ratio recovery target" ($SSBPR_{TARGET}$), which is set at a level no less than $SSBPR_{MIN}$. These two reference points and their associated recruitment overfishing control rule, which prescribe a target fishing mortality rate ($F_{RO\text{-}REBUILD}$) as a function of the SSBP ratio, are specified as indicated in Table 17. Again, E_{MSY} is used as a proxy for F_{MSY}.

Table 17. Recruitment overfishing control rule specifications for BMUS

$F_{RO\text{-}REBUILD}$	$SSBPR_{MIN}$	$SSBPR_{TARGET}$
F(SSBPR) = 0 for SSBPR ≤ 0.10 F(SSBPR) = 0.2 F_{MSY} for 0.10 < SSBPR ≤ $SSBPR_{MIN}$ F(SSBPR) = 0.4 F_{MSY} for $SSBPR_{MIN}$ < SSBPR ≤ $SSBPR_{TARGET}$	0.20	0.30

1.11.2 Current Stock Status

1.11.2.1 Bottomfish

Biological and other fishery data are poor for all bottomfish species in the America Samoa Archipelago. Generally, data are only available on commercial landings by species and 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 (Langseth et al. 2019) for the American Samoa bottomfish MUS complex (comprised of 11 species of shallow and deep species of snapper, grouper, jacks, and emperors) was based on estimates of total catch and an abundance index derived from the nominal CPUE generated from the creel surveys. The assessments used a state-space Bayesian surplus production model within the modeling framework Just Another Bayesian Biomass Assessment (JABBA), which included biological information and fishery-dependent data through 2017. Determinations of overfishing and overfished status can then be made by comparing current biomass and harvest rates to MSY-level reference points. The American Samoa BMUS were determined to be both undergoing overfishing and in an overfished state (Table 18).

Table 18. Stock assessment parameters for the BMUS complex (from Langseth et al. 2019)

Parameter	Value	Notes	Status
MSY	28.8 (16.4-55.9)	Expressed in 1000 lb (with 95% confidence interval)	
H_{2017}	0.15	Expressed in percentage	
H_{CR}	0.107 (0.044-0.228)	Expressed in percentage (with 95% confidence interval)	
H/H_{CR}	2.75		Overfishing occurring
B_{2017}	102.6	Expressed in 1000 lb	
B_{MSY}	272.8 (120.8-687.4)	Expressed in 1000 lb (with 95% confidence interval)	
B/B_{MSY}	0.38		Overfished

1.12 OVERFISHING LIMIT, ACCEPTABLE BIOLOGICAL CATCH, AND ANNUAL CATCH LIMITS

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 papers, reports, and/or available data. These data are categorized into the different tiers in the control rule ranging from Tier 1 (i.e., most information available, typically a stock assessment) to Tier 5 (i.e., catch-only information). The control rules are applied to the BSIA. Tiers 1 to 3 involve conducting a Risk of Overfishing Analysis (denoted by P*) to quantify the scientific uncertainties associated with the assessment to specify the Acceptable Biological Catch (ABC), lowering the MSY-based OFL to the ABC. A Social, Ecological, Economic, and Management (SEEM) Uncertainty Analysis is performed to quantify the uncertainties associated with the SEEM factors, and a buffer is used to lower the ABC to an ACL. For Tier 4, which is comprised of stocks with MSY estimates but no active fisheries, the control rule is 91 percent of MSY. For Tier 5, which has catch-only information, the control rule is a one-third reduction in the median catch depending on a qualitative evaluation of stock status via expert opinion. ACL specification can choose from a variety of methods including the above mentioned SEEM analysis or a percentage buffer (i.e., percent reduction from ABC based on expert opinion) or the use of an Annual Catch Target (ACT). ACLs can be updated on an annual basis, but the Council normally produces a multi-year ACL for implementation.

The usual AM for American Samoa bottomfish fisheries is an overage adjustment. The next ACL is downward adjusted with the amount of overage from the previous ACL based on a three-year running average.

1.12.2 Current OFL, ABC, ACL, and Recent Catch

No ACLs were implemented by NMFS for American Samoa BMUS in 2020 or 2021. However, NMFS did implement an interim catch limit (ICL) of 13,000 lb for 2020 associated with an interim management measure for the American Samoa bottomfish fishery effective through May 17, 2021 (85 FR 73003, November 16, 2020). NMFS subsequently extended the interim measure to be effective from June 21, 2021 through November 18, 2021 (86 FR 32361, June 21, 2021). Consistent with Magnuson-Stevens Act sections 304(e)(6) and 305(c), the Council requested that NMFS implement this interim measure to reduce overfishing of BMUS while the Council develops management measures to end overfishing and rebuild the American Samoa bottomfish stock complex from its overfished designation. As proposed, the rebuilding plan for the American Samoa bottomfish fishery would implement an ACL of 5,000 lb and become effective in fishing year 2022 (87 FR 6479, February 4, 2022).

The catch shown in Table 19 presents the average catch of the most recent three years against the ICL as recommended by the Council at its 160th meeting to avoid large fluctuations in catch due to high interannual variability in creel survey estimates.

Table 19. American Samoa 2021 ACL table with three-year recent average catch (lb)

Fishery	MUS	OFL*	ABC	ACL**	Catch
Bottomfish	Bottomfish multi-species complex	8,000	N.A.	13,000	7,296

* OFL derived from the stock assessment (Langseth et al. 2019) with 2025 as the terminal year.
** The catch limit for 2021 was an ICL implemented by NMFS as an interim measure in 2020 (85 FR 73003, November 16, 2020) and extended into 2021 (86 FR 32361, June 21, 2021) while the Council develops a rebuilding plan.

1.13 BEST SCIENTIFIC INFORMATION AVAILABLE

1.13.1 Bottomfish fishery

1.13.1.1 Stock Assessment Benchmark

The benchmark stock assessment for the Territory BMUS complex was developed and finalized by Langseth et al. (2019). The assessments used a state-space Bayesian surplus production model within the modeling framework Just Another Bayesian Biomass Assessment (JABBA). Estimates of harvest rate (H), annual biomass (B), the harvest rate associated with overfishing as determined by the harvest control rule (H_{CR}), maximum sustainable yield (MSY), and the biomass at maximum sustainable yield (B_{MSY}) allowed for determination of stock status relative to reference points determining overfishing ($H/H_{CR} > 1$) and overfished ($B < 0.7 \times B_{MSY}$) status. Stock projections were conducted for 2020-2025 for a range of hypothetical six-year catches, and the corresponding risk of overfishing was calculated.

1.13.1.2 Stock Assessment Updates

Updates to the 2007 benchmark stock assessment were done in 2012 (Brodziak et al. 2012) and 2015 (Yau et al. 2016). These included a two-year stock projection table used for selecting the level of risk the fishery will be managed under ACLs. Yau et al. (2016) was considered the best scientific information available for the Territory BMUS complexes after undergoing a Western Pacific Stock Assessment Review (WPSAR) Tier 3 panel review (Franklin et al. 2015) prior to the Langseth et al. (2019) benchmark stock assessment. This was the previous basis for P* and SEEM analyses that determined the risk levels to specify past ABCs and ACLs.

1.13.1.3 Other Information Available

Approximately every five years PIFSC administers a socioeconomic survey to small boat fishermen in American Samoa. 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.

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 analyses that determine the risk levels to specify ACLs. However, species targeted by coral reef fisheries in American Samoa are no longer classified as MUS.

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 that:

- Will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, and considering 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 (OY) in the 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 MUS complex is defined to be the level of harvest equal to the ACL consistent with the goals and objectives of the FEPs 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 MSY (F_{MSY}). There are situations when the long-term means around MSY are lower than ACLs especially if the stock is known to be productive or relatively pristine or lightly fished. A stock can have catch levels and catch rates exceeding that of MSY over the short-term to lower the biomass to a level around the estimated MSY and still not jeopardize the stock.

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 20 summarizes the harvest extent and harvest capacity information for American Samoa tracking annual catch against the ACL, but no ACL was implemented by NMFS for American Samoa BMUS in 2021. However, NMFS did implement an ICL of 13,000 lb for 2021 associated with an interim management measure for the American Samoa bottomfish fishery (86 FR 32361, June 21, 2021).

Table 20. American Samoa ACL proportion of harvest capacity and extent in 2021

Fishery	MUS	ACL*	Catch	Harvest extent (%)	Harvest capacity (%)
Bottomfish	Bottomfish multi-species complex	13,000	2,215	17.0	83.0

* The catch limit for 2021 was an ICL implemented by NMFS as an interim measure in 2020 (85 FR 73003, November 16, 2020) and extended into 2021 (86 FR 32361, June 21, 2021).

1.15 ADMINISTRATIVE AND REGULATORY ACTIONS

This summary describes management actions NMFS implemented for insular fisheries in American Samoa during calendar year 2021.

On June 21, 2021, NMFS published a final temporary rule (86 FR 32361) to implement an interim catch limit (ICL) of 13,000 lb. (5,897 kg) of American Samoa bottomfish in fishing year 2021. As an accountability measure, NMFS monitored catch, and would close the fishery in Federal waters through November 18, 2021 if the fishery reaches the ICL within the fishing year. This temporary rule extended the interim measures implemented by NMFS (November 16, 2020, 85 FR 56208), which expired on May 17, 2021, and was necessary to reduce overfishing of American Samoa bottomfish while the Council developed a long-term plan to address overfishing and rebuild the fishery.

On August 5, 2021, NMFS announced the approval of a three-year Marine Conservation Plan (MCP) for American Samoa (86 FR 42792). The MCP identifies priority conservation and management projects using funds from the Western Pacific Sustainable Fisheries Fund. The MCP is valid from July 25, 2021, through July 24, 2024.

2 ECOSYSTEM CONSIDERATIONS

2.1 COVID-19 IMPACTS

Fishing communities and island economies across the Pacific Islands Region continued to experience pandemic-related impacts during 2021. American Samoa was able to navigate the first 18-months of the pandemic without any confirmed evidence of COVID within the islands. A vaccination program began in late 2020 with widespread adoption during 2021. Travel restrictions and curfews enacted during 2020 were slowly relaxed during 2021, but unfortunately American Samoa reported its first confirmed positive coronavirus cases during 2021. However, community spread was minimal through the end of 2021.

Key metrics of pandemic recovery for island economies include tourism and unemployment, both of which drive seafood demand and have implications for fishing activity and markets. Unfortunately, no data are available for 2021 for either of these metrics, but it is expected, given ongoing travel restrictions and limitations during 2021, that tourism very likely failed to recover from the historic low of 890 visitors during 2020 (i.e., a 98% decline from the 10-year peak in visitors experienced in 2019 of nearly 59 thousand)[1]. Similarly, information is not available to comment on unemployment conditions during 2021.

A cost-earnings survey was implemented for American Samoa small boat fisheries during 2021, and an open-ended question solicited input from the community on pandemic-related impacts on fishing activities. Responses were mixed based on individual operations. About a third of responses highlighted economic challenges with curfews and closed stores complicating fish sales. There were comments related to travel restrictions prohibiting and limiting fishing crew travelling from Apia impacting some operations. Some reported taking fewer trips, while others indicated minimal, if any, pandemic-related impacts, with some suggesting they were able to schedule more fishing trips in 2021 relative to 2020.

Inflation-adjusted[2] revenues for American Samoa non-longline commercial fisheries for pelagic and insular fisheries in 2021 were down just over 20% relative to 2020, reflecting a nearly 50% decline relative to a five-year (2015 to 2019) pre-pandemic baseline. Specific revenue details for bottomfish and ecosystem component species are withheld in 2021 due to confidentiality considerations. Notably, fishers faced higher fuel prices in 2021, which, in turn, increased the reported costs of fishing, likely influencing fishing activities and economic performance.

Despite these challenges, the American Samoa fishing community (commercial fishers, non-commercial fishers, seafood markets and processors) played a vital role in supporting local food systems, nutrition, food security, and promoting social cohesion. This importance is amplified in the face of natural disasters and human health crises, and fishing communities across the Pacific Islands Region have adapted to continue these crucial functions in the face of this unprecedented disruption.

[1] https://www.spc.int/updates/blog/did-you-know/2021/06/stat-of-the-week-visitors-in-american-samoa-in-2020.
[2] Using GDP implicit price deflator: https://fred.stlouisfed.org/series/GDPDEF.

2.2 FISHER OBSERVATIONS

Hawaii fishermen Clay Tam and Roy Morioka started the fisher observations initiative in 2020 to add traditional and local ecological knowledge, and on-the-water observations to fishery-dependent data sources in the annual SAFE reports. Fisher observations from 2020 can be found in the pelagic and the respective archipelagic reports (WPRFMC 2021a; WPRFMC 2021b; WPRFMC 2021c; WPRFMC 2021d).

In 2021, the Council collected archipelagic fisher observations during quarterly advisory panel meetings for American Samoa. Input collected by fishers during these meetings was limited to Advisory Panel members. Data from American Samoa archipelagic fisher observations from 2021 was limited to one meeting late in the year. Available data is reported below.

Little fishing activity was reported in the last quarter of 2021, with few fish being sold to vendors. Street-side vendors primarily sold coral reef fish species. According to conversations with Council staff members, American Samoa fishers were slowed by irregular weather patterns in 2021, with fishers catching some, but not many, bottomfish.

2.3 CORAL REEF FISH ECOSYSTEM PARAMETERS

2.3.1 Regional Reef Fish Biomass and Habitat Condition

Description: 'Reef fish biomass' is mean biomass of reef fishes per unit area derived from visual survey data between 2010 and 2020. Hard Coral cover is mean cover derived from visual estimates by divers of sites where reef fish surveys occurred. No new surveys occurred in 2020 or 2021 due to COVID-19 and the numbers presented here are identical to the 2019 report.

Rationale: Reef fish biomass has been widely used as an indicator of relative ecosystem status and has repeatedly been shown to be sensitive to changes in fishing pressure, habitat quality, and oceanographic regime. Hard coral cover is an indicator of relative status of the organisms that build coral reef habitat and has been shown to be sensitive to changes in oceanographic regime, and a range of direct and indirect anthropogenic impacts. Most fundamentally, cover of hard corals has been increasingly impacted by temperature stress as a result of global heating.

Data Category: Fishery-independent

Timeframe: Triennial

Jurisdiction: American Samoa, Commonwealth of the Northern Mariana Islands (CNMI), Guam, Main Hawaiian Islands (MHI), Northwestern Hawaiian Islands (NWHI), and Pacific Remote Island Areas (PRIA)

Spatial Scale: Regional

Data Source: Data used to generate cover and biomass estimates come from visual surveys conducted by the National Marine Fisheries Service (NMFS) Pacific Island Fisheries Science Center (PIFSC) Ecosystem Sciences Division (ESD) and their partners as part of the Pacific Reef Assessment and Monitoring Program (RAMP). Survey methods are described in detail in Ayotte et al. (2015). In brief, they involve teams of divers conducting stationary point count cylinder (SPC) surveys within a target domain of < 30 meter 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 are used. At each SPC, divers record the number, size, and species of all fishes within or passing through paired 15 meter-diameter cylinders over 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 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.

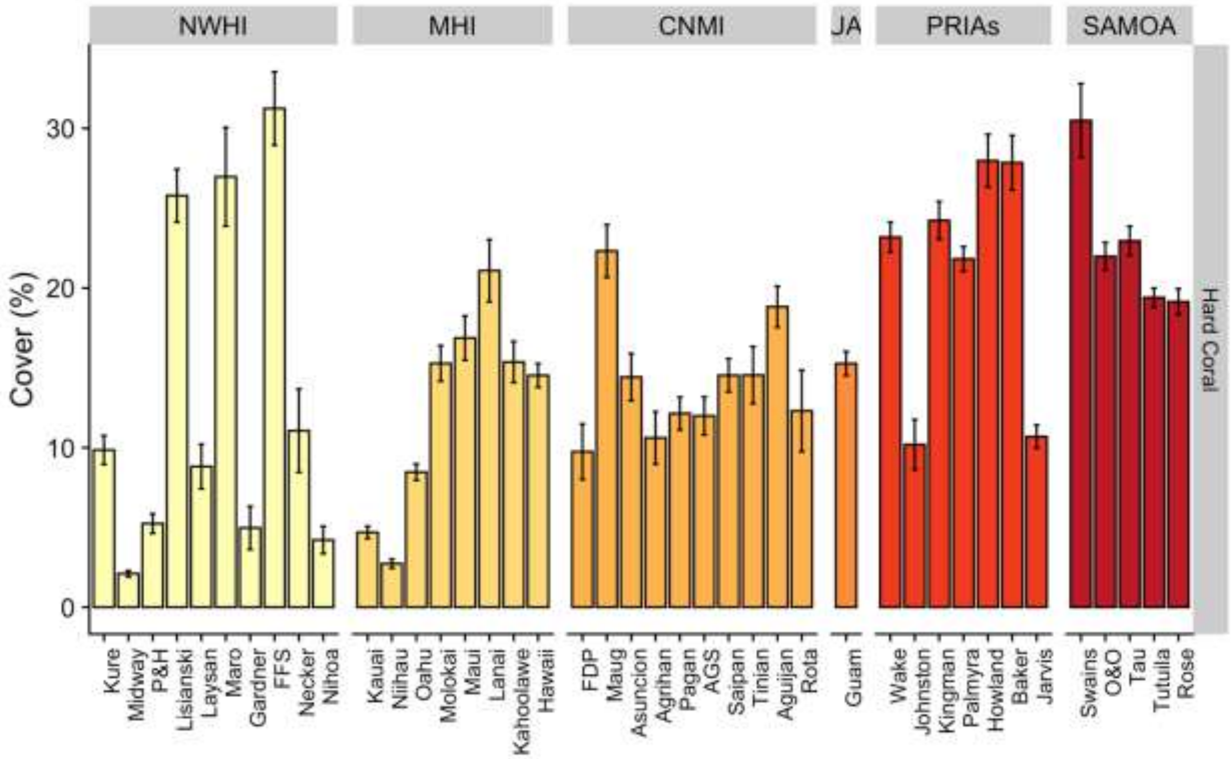

Figure 1. Mean coral cover (%) per U.S. Pacific Island averaged over the years 2010-2020 by latitude

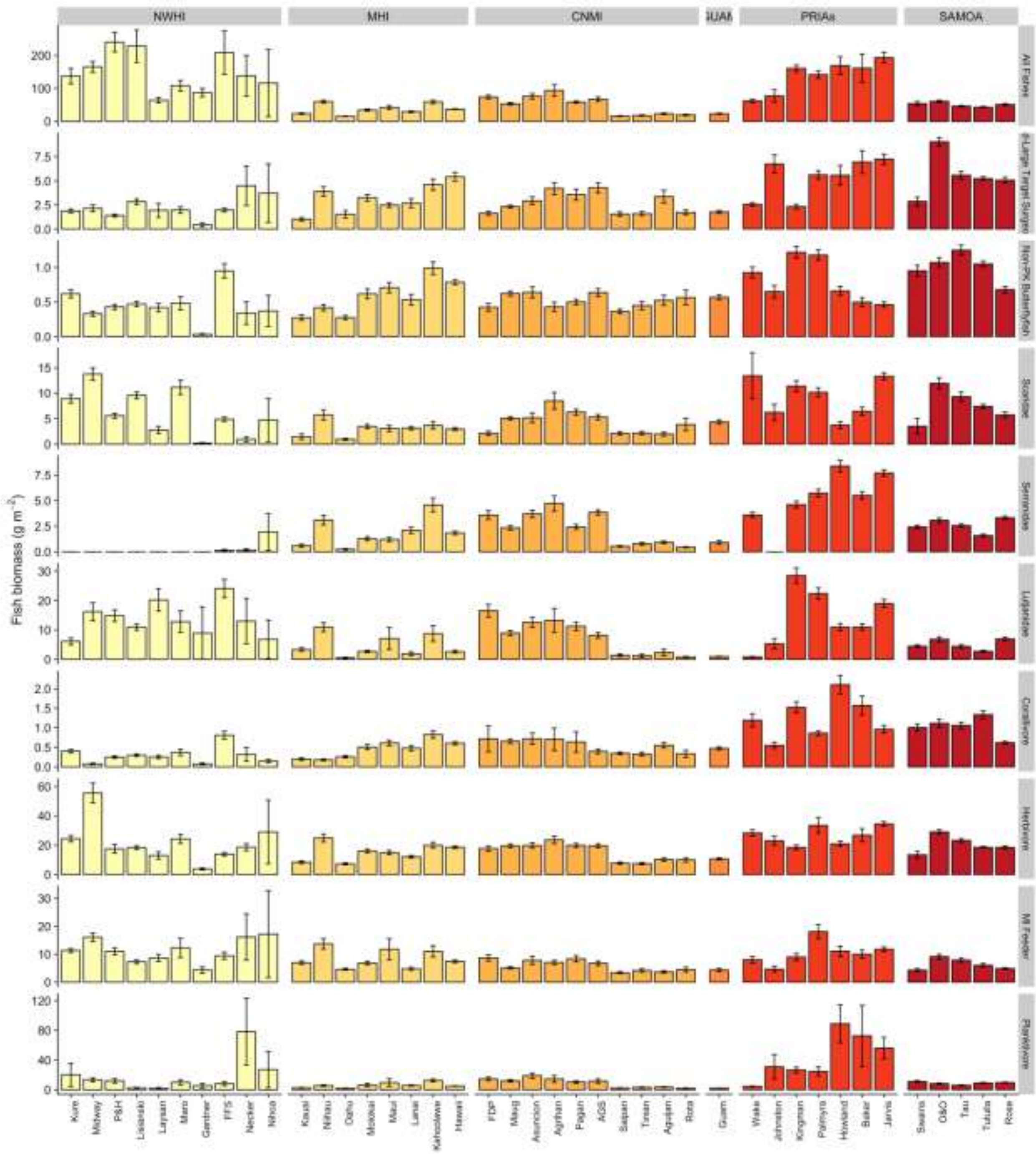

Figure 2. Mean fish biomass (g/m^2 ± standard error) of functional, taxonomic, and trophic groups by U.S. Pacific reef area from the years 2010-2020 by latitude. The group Serranidae excludes planktivorous members of that family (i.e., anthias, which can by hyper-abundant in some regions). Similarly, the bumphead parrotfish, *Bolbometopon muricatum*, has been excluded from the corallivore group – as high biomass of that species at Wake Island overwhelms corallivore biomass at all other locations. The group 'MI Feeder' consists of fishes that primarily feed on mobile invertebrates

2.3.2 Archipelagic Reef Fish Biomass and Habitat Condition

Description: 'Reef fish biomass' is mean biomass of reef fishes per unit area derived from visual survey data between 2010 and 2020. Hard Coral cover is mean cover derived from visual estimates by divers of sites where reef fish surveys occurred. No new surveys occurred in 2020 or 2021 due to COVID-19 and the numbers presented here are identical to the 2019 report.

Rationale: Reef fish biomass has been widely used as an indicator of relative ecosystem status and has repeatedly been shown to be sensitive to changes in fishing pressure, habitat quality, and oceanographic regime. Hard coral cover is an indicator of relative status of the organisms that build coral reef habitat and has been shown to be sensitive to changes in oceanographic regime, and a range of direct and indirect anthropogenic impacts. Most fundamentally, cover of hard corals has been increasingly impacted by temperature stress as a result of global heating.

Data Category: Fishery-independent

Timeframe: Triennial

Jurisdiction: American Samoa

Spatial Scale: Island

Data Source: Data used to generate biomass and cover estimates comes from visual surveys conducted by NMFS PIFSC ESD and partners, as part of the Pacific RAMP. Survey methods and sampling design, and methods to generate reef fish biomass are described in Section 2.3.1.

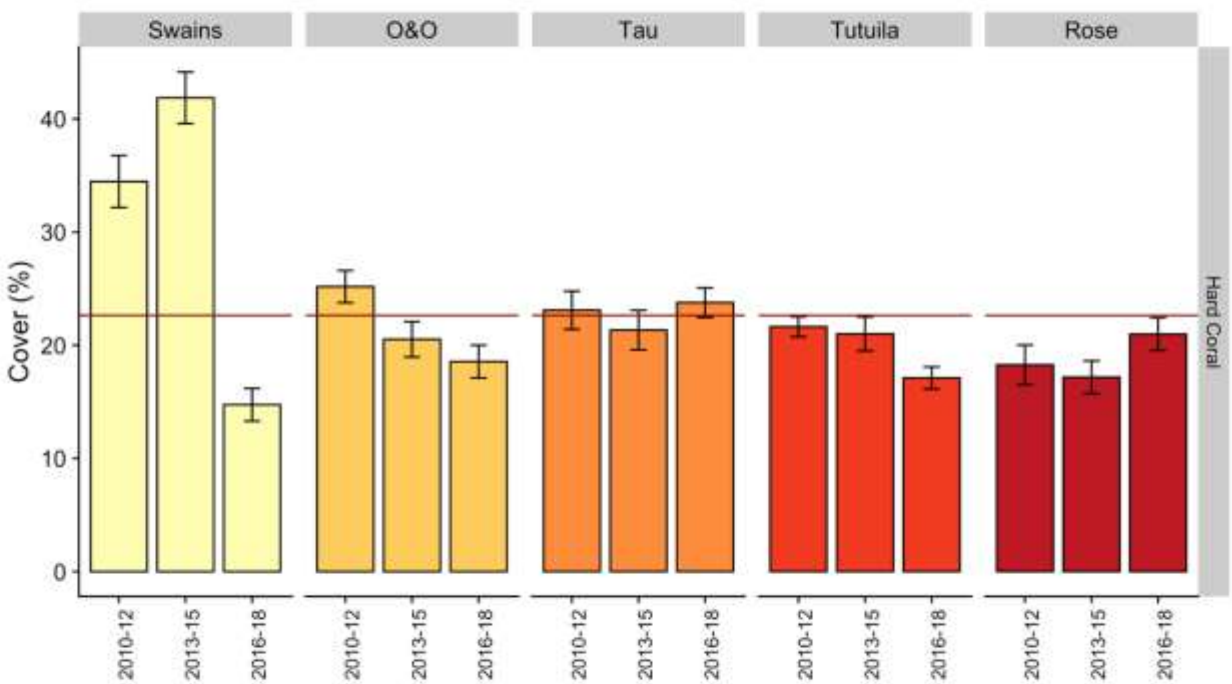

Figure 3. Mean coral cover (%) per island averaged over the years 2010-2020 by latitude with American Samoa archipelago mean estimates plotted for reference (red line)

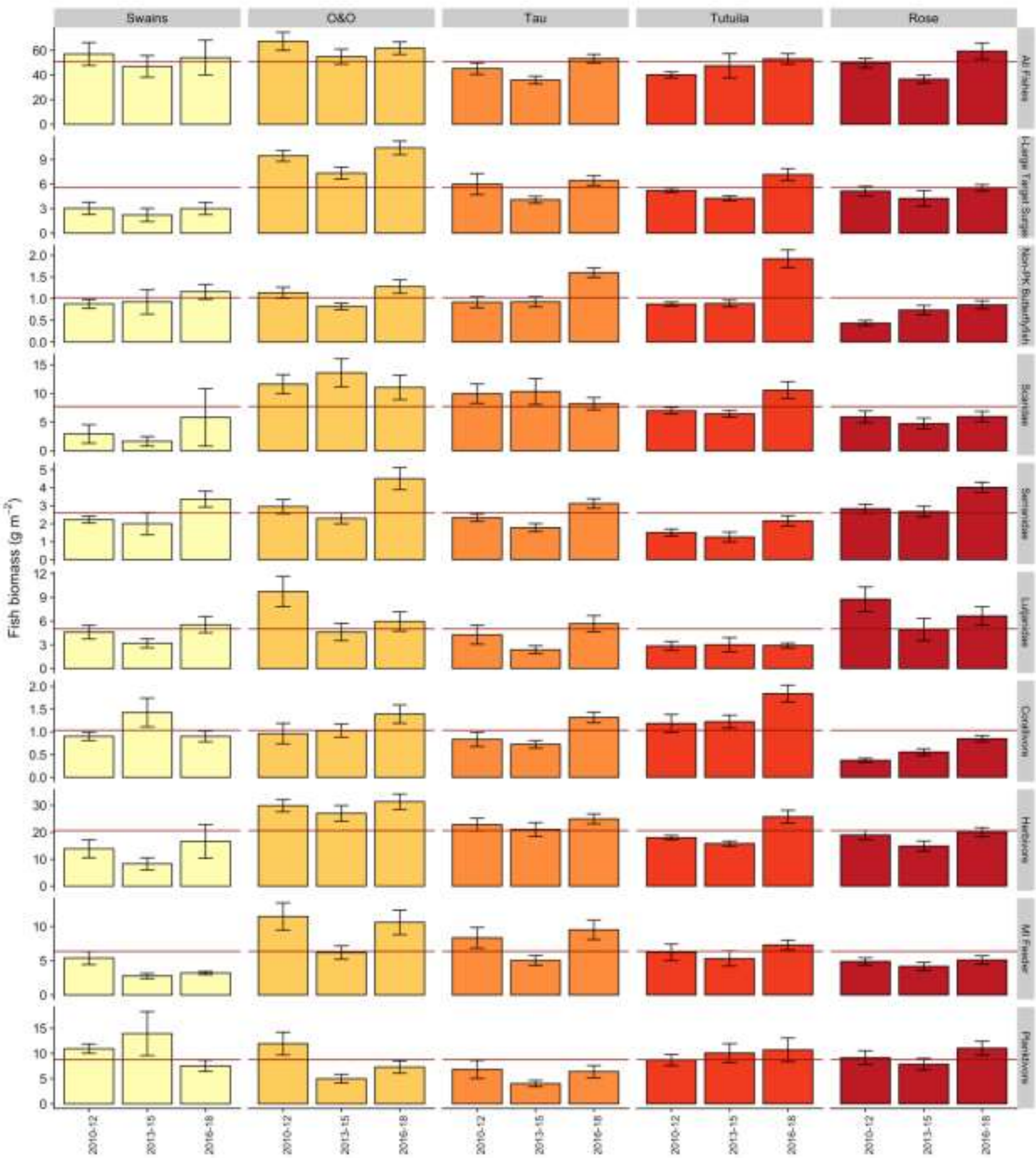

Figure 4. Mean fish biomass (g/m^2 ± standard error) of American Samoa functional, taxonomic, and trophic groups from the years 2010-2020 by island. The group Serranidae excludes planktivorous members of that family (i.e., anthias, which can by hyper-abundant in some regions). Similarly, the bumphead parrotfish, *Bolbometopon muricatum*, has been excluded from the corallivore group. The group 'MI Feeder' consists of fishes that primarily feed on mobile invertebrates; with American Samoa archipelago mean estimates plotted for reference (red line)

2.4 LIFE HISTORY INFORMATION AND LENGTH-DERIVED VARIABLES

The annual SAFE report will serve as the repository of available life history information for the Western Pacific region. Life history data, particularly age, growth, reproduction, and mortality information inform stock assessments on fish productivity and population dynamics. Some assessments, particularly for data poor stocks, utilize information from other areas that introduces biases and increases uncertainties in the population estimates. An archipelago-specific life history parameter ensures accuracy in the input parameters used in the assessment.

The NMFS PIFSC Bio-Sampling Program allows for the collection of life history samples like otoliths and gonads from priority species in the bottomfish and coral reef fisheries. A significant number of samples are also collected during research cruises. These life history samples, once processed and examined, will contribute to the body of scientific information for the two data poor fisheries in the region (coral reef fish and bottomfish). 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) prioritized coral reef ecosystem component species (ECS), and 2) bottomfish management unit species (BMUS). The prioritized coral reef species list was developed by the American Samoa Department of Marine and Wildlife Resources (DMWR) in 2019. The BMUS are the species that are listed in the federal ecosystem plan and are managed on a federal level. 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. Length-weight conversion coefficients provide area-specific values to convert length from fishery-dependent and fishery-independent data collection to weight or biomass.

2.4.1 American Samoa Coral Reef Ecosystem – Life History

2.4.1.1 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 is based on several methods including 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. Fish growth is estimated by fitting the length-at-age data to a von Bertalanffy growth function (VBGF). This function typically uses three coefficients (L_∞, k, and t_0), which together characterize the shape of the length-at-age growth relationship.

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, 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 for the data based on statistical analyses. The mid-point of the 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 age at 50% sex reversal ($A\Delta_{50}$) is typically derived by referencing the VBGF 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 and 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 (i.e., 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 species have achieved reproductive maturity (A_{50}) and sex reversal ($A\Delta_{50}$).

Data Category: Biological

Timeframe: N/A

Jurisdiction: American Samoa

Spatial Scale: Archipelagic

Data Source: Sources of data are directly derived from research cruises sampling and market samples collected by the American Samoa 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 (LHP). Refer to the “Reference” column in Table 21 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. Units are years.

L_{∞} **(asymptotic length)** – One of three coefficients of the 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 estimated mean maximum length and not the observed maximum length. Units are centimeters.

***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) are not available for age determination. This parameter can be fixed at 0. Units are years.

***M* (natural mortality)** – This is a measure of the mortality rate for a fish stock 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 the VBGF coefficients (*k* and L_∞) or 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. Units are years.

$A\Delta_{50}$ (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. Units are years.

L_{50} (length at which 50% of a fish population are capable of spawning) – 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 and growth. Units are centimeters.

$L\Delta_{50}$ (length of sex switching) – 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 and growth. Units are centimeters.

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. These parameters are also used as direct inputs into stock assessments. 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 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 21. Available age, growth, and reproductive maturity information for prioritized coral reef ecosystem component species in American Samoa

Species	Age, growth, reproductive maturity parameters									Reference
	T_{max}	L_∞	k	t_0	M	A_{50}	$A\Delta_{50}$	L_{50}	$L\Delta_{50}$	
Crenimugil crenilabis										
Epinephelus melanostigma										
Octopus cyanea										
Panulirus penicillatus										
Sargocentron tiere										
Tridacna maxima										

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 years; L_∞, L_{50}, and $L\Delta_{50}$ are in mm fork length (FL); k is in units of year^{-1}; X means the parameter estimate is too preliminary and Y means the published age and growth parameter estimates are based on DGI numerical integration technique and likely to be inaccurate. Superscript letters indicate status of parameter estimate (see footnotes below table). Published or in press publications ([d]) are shown in the "Reference" column.

2.4.1.2 Fish Length Derived Parameters

Description: The NMFS Commercial Fishery Bio-Sampling Program started in 2010 and ended in 2015. This program had two components: first was the Field/Market Sampling Program and the second was the Lab Sampling Program, details of which are described in a separate section of this report. The goals of the Field/Market Sampling Program were to:

- Broad scale looks at commercial landings (by fisher/trip, gear, and 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; and
- Develop accurate local length-weight curves.

In American Samoa, the Bio-Sampling Program 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.

Data Category: Biological

Timeframe: N/A

Jurisdiction: American Samoa

Spatial Scale: Archipelagic

Data Source: NMFS Bio-Sampling Program

Parameter Definitions:

n* – *sample size is the total number of samples accumulated for each species recorded in the Bio-Sampling Program database from the commercial spear fishery.

L_{max} – *maximum fish length* is the largest individual per species recorded in the Bio-Sampling Program database from the commercial spear fishery. This value is derived from measuring the length of individual samples for species occurring in the spear fishery. Units are centimeters.

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

a and b* – *length-weight coefficients are the coefficients derived from the regression line fitted to all length and weight measured by 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 an important component of fisheries monitoring and data poor stock assessment approaches. Maximum length (L_{max}) is used to derive missing species- and location-specific life history information (Nadon et al. 2015; Nadon and Ault 2016; Nadon 2019). The length-weight coefficients (*a* and *b* values) are used to convert length to weight for fishery-dependent and fishery-independent data collection where length is 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 American Samoa coral reef ecosystem component fisheries.

Table 22. Available length-derived information for prioritized coral reef ecosystem component species in American Samoa

Species	Length-derived parameters					Reference
	n	L_{max}	N_{L-W}	*a*	*b*	
Crenimugil crenilabis	380	48.2	380	0.0388	2.73	Matthews et al. (2019)
Epinephelus melanostigma	2,662	54.9	2,662	0.0109	3.10	Matthews et al. (2019)
Octopus cyanea						
Panulirus penicillatus	3,384	15.8	3,384	2.6004	2.41	Matthews et al. (2019)
Sargocentron tiere	3,002	25.0	3,002	0.069	2.62	Matthews et al. (2019)
Tridacna maxima						

2.4.2 American Samoa Ecosystem – Management Unit Species Life History

2.4.2.1 Age, Growth, and reproductive Maturity

Description: Age determination is based on counts of yearly growth marks (annuli) and/or DGIs internally visible within transversely cut, thin sections of sagittal otoliths. Validated age determination is based on several methods including 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. Fish growth is estimated by fitting the length-at-age data to a VBGF. This function typically uses three coefficients (L_∞, k, and t_0), which together characterize the shape of the length-at-age growth relationship.

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, 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 for the data based on statistical analyses. The mid-point of the 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 age at 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 and 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 (i.e., 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 species have achieved reproductive maturity (A_{50}) and sex reversal ($A\Delta_{50}$).

Category: Biological

Timeframe: N/A

Jurisdiction: American Samoa

Spatial Scale: Archipelagic

Data Source: Sources of data are directly derived from field samples collected at sea on NOAA research vessels and from the American Samoa 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 LHP. Refer to the "Reference" column in Table 23 for specific details on data sources by species.

Parameter definitions: Identical to Section 2.4.1.1.

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 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 multi-species assessments.

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 years; L_∞, L_{50}, and $L\Delta_{50}$ are in mm FL; k is in units of year^{-1}; X means the parameter estimate is too preliminary and Y means the published age and growth parameter estimates are 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 shown in the "Reference" column.

Table 23. Available age, growth, and reproductive maturity information for BMUS targeted for otoliths and gonads sampling in American Samoa

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	
Caranx lugubris							NA		NA	
Etelis carbunculus[1]							NA		NA	
Etelis coruscans							NA		NA	
Lethrinus rubrioperculatus	f=10[d] m=10[d]	f=27.3[d] m=29.1[d]	f=0.74[d] m=0.71[d]	f=-0.16[d] m=-0.15[d]				f=21.2[d,e]		Pardee et al. (2020)
Lutjanus kasmira							NA		NA	
Pristipomoides filamentosus							NA		NA	
Pristipomoides flavipinnis	28[d]	41.15[d]	0.47[d]		0.22[d]		NA		NA	O'Malley et al. (2019)
Pristipomoides zonatus							NA		NA	
Variola louti										

[1] *E. carbunculus* is now known to be comprised of two distinct, non-interbreeding lineages (Andrews et al. 2016). Both species occur in the Samoa Archipelago and were likely both captured by fishermen in the 1980s but reported as one species.
[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).
[e] L_{50} was derived from the published literature based on the relationship between L_∞ and L_{50}

2.4.2.2 Fish Length Derived Parameters

Description: The NMFS Commercial Fishery Bio-Sampling Program started in 2010 and ended in 2015. This program had two components: first was the Field/Market Sampling Program and the second was the Lab Sampling Program, details of which are described in a separate section of this report. The goals of the Field/Market Sampling Program were:

- Broad scale looks at commercial landings (by fisher/trip, gear, and 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; and
- Develop accurate local length-weight curves.

In American Samoa, the Bio-Sampling 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 was 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.

Category: Biological

Timeframe: N/A

Jurisdiction: American Samoa

Spatial Scale: Archipelagic

Data Source: NMFS Bio-Sampling Program

Parameter Definition: Identical to Section 2.4.1.2

Rationale: Length-derived information is an important component of fisheries monitoring and data poor stock assessment approaches. Maximum length (L_{max}) is used to derive missing species- and location-specific life history information (Nadon et al. 2015; Nadon and Ault 2016; Nadon 2019). The length-weight coefficients (*a* and *b* values) are used to convert length to weight for fishery-dependent and fishery-independent data collection where length is 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 American Samoa BMUS fishery.

Table 24. Available length-derived information for BMUS in American Samoa

Species	Length derived parameters					Reference
	n	L_{max}	N_{L-W}	a	b	
Aphareus rutilans	173	85.0	173	0.0395	2.73	Matthews et al. (2019)
Aprion virescens	952	73.4	952	0.0157	2.99	Matthews et al. (2019)
Caranx lugubris	164	86.0	164	0.0404	2.80	Matthews et al. (2019)
Etelis carbunculus[1]						
Etelis coruscans	106	89.5	106	0.0322	2.81	Matthews et al. (2019)
Lethrinus rubrioperculatus	2,349	57.0	2,349	0.0287	2.86	Matthews et al. (2019)
Lutjanus kasmira	461	35.0	461	0.0176	3.01	Matthews et al. (2019)

Species	Length derived parameters					Reference
	n	***L_{max}***	***N_{L-W}***	***a***	***b***	
Pristipomoides flavipinnis	262	56.5	262	0.0249	2.90	Matthews et al. (2019)
Pristipomoides zonatus						
Pristipomoides filamentosus						
Variola louti		50.5	365	0.0135	3.08	Matthews et al. (2019)

[1] *E. carbunculus* is now known to be comprised of two distinct, non-interbreeding lineages (Andrews et al. 2016). Both species occur in the Samoa Archipelago and were likely both captured by fishermen in the 1980s but reported as one species.

2.5 SOCIOECONOMICS

This section outlines the pertinent economic, social, and community information available for assessing the successes and impacts of management measures or the achievements of the Fishery Ecosystem Plan for the American Samoan Archipelago (WPRFMC 2009). It meets the objective "Support Fishing Communities" adopted at the 165th Council meeting; specifically, it identifies the various social and economic groups within the region's fishing communities and their interconnections. The section begins with an overview of the socioeconomic context for the region, then provides a summary of relevant studies and data for American Samoa, followed by summaries of relevant studies and data for each fishery within American Samoa.

In 1996, the Magnuson-Stevens Fishery Conservation and Management Act's National Standard 8 (NS8) specified that conservation and management measures nee to account for the importance of fishery resources in fishing communities, to support sustained participation in the fisheries, and to minimize adverse economic impacts, provided that these considerations do not compromise conservation. Unlike other regions of the U.S., the settlement of the Western Pacific region was intimately tied to the ocean, which is reflected in local culture, customs, and traditions (Figure 5).

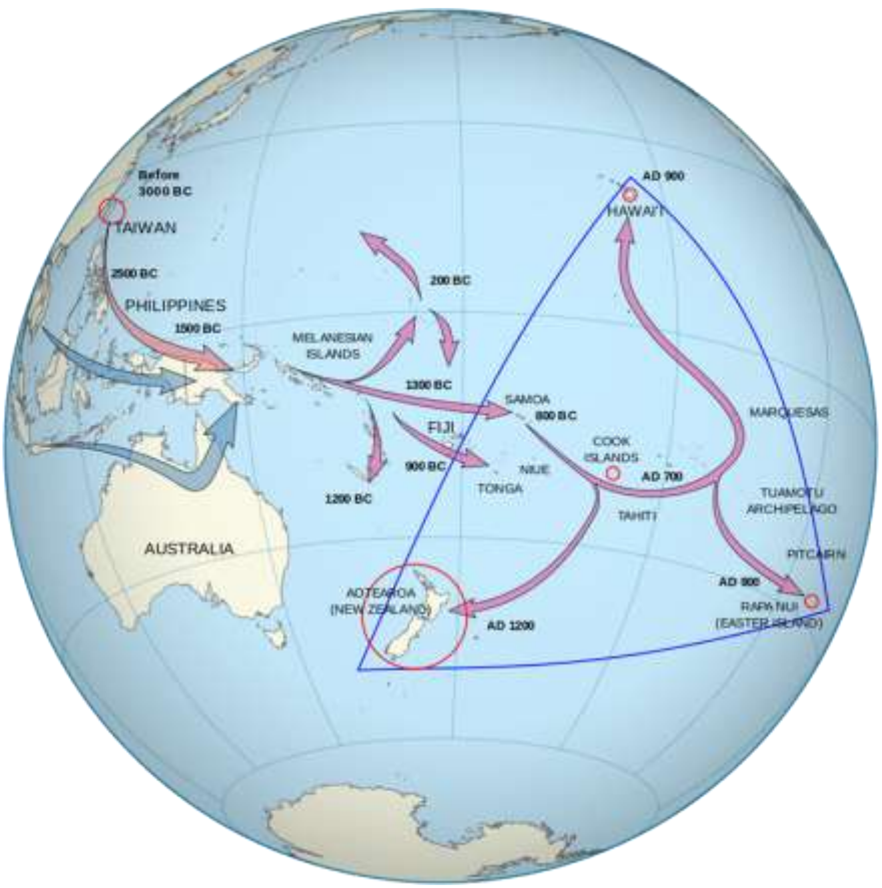

Figure 5. Settlement of the Pacific Islands, courtesy Wikimedia Commons, https://commons.wikimedia.org/wiki/File:Polynesian_Migration.svg.

Polynesian voyagers relied on the ocean and marine resources on their long voyages in search of new islands, as well as in sustaining established island communities. Today, the population of the region also represents many Asian cultures from Pacific Rim countries, which reflect similar importance of marine resources. Thus, fishing and seafood are integral local community ways of life. This is reflected in the amount of seafood eaten in the region in comparison to the rest of the United States, as well as the language, customs, ceremonies, and community events. It can also affect seasonality in prices of fish. Because fishing is such an integral part of the culture, it is difficult to cleanly separate commercial from non-commercial fishing, with most trips involving multiple motivations and multiple uses of the fish caught. While the economic perspective is an important consideration, fishermen report other motivations such as customary exchange as being equally, if not more, important. Due to changing economies and westernization, recruitment of younger fishermen is becoming a concern for the sustainability of fishing and fishing traditions in the region.

2.5.1 Response to Previous Council Recommendations

At its 185th meeting held via web conference in March 2021, the Council directed staff to review and analyze EO 13985 to Advance Racial Equity and Support Underserved Communities through the Federal Government. PIFSC staff are involved in the development of the NOAA strategy and are including concerns from the Pacific Islands Region into the national strategy.

Also at the 185th meeting, the Council directed staff to work with the SSC subgroup to finalize the plan incorporating PIFSC recommendations and the socioeconomic priorities identified by the SSPC in April 2021. These recommendations were included in the revised SSC plan.

In addition, the Council directed staff to work with the Social Science Planning Committee (SSPC) to review the socio-cultural-economic information for American Samoa to provide additional context in interpreting the results of the stock assessment prior to the data workshop in 2021. PIFSC Social-Ecological and Economic Systems (SEES) Program staff members helped guide stock assessment staff in the development of the data workshop.

At its 186th meeting held via web conference in June 2021, the Council directed the SSPC to work with the Advisory Panels to explore conducting periodic check-ins with the fishing communities to provide information for the fishery observations section of the SAFE report. The AP and SSPC formed a small working group that developed a framework for systematic gathering of fisher observations as part of the regular AP meetings for a new section of the SAFE report. The first set of meetings following this format will be held in 2022.

At its 187th meeting held via web conference in September 2021, PIFSC SEES staff presented efforts for gathering stakeholder perspectives to inform stock assessments and guild a structure for the upcoming data workshops. The Council directed staff to coordinate with the DMWR and PIFSC Stock Assessment Program to identify community members to participate in the data workshop and increase their communication and engagement with the fishing communities. PIFSC SEES Program staff continued to work with the Stock Assessment Program in design of engagement for the data workshops.

At its 189th meeting held via web conference in December 2021, PIFSC SEES staff presented the results of a cooperative project to develop a stakeholder engagement strategy in support of the territory bottomfish stock assessments, using Guam as a study site. The project is intended to be replicated in the other territories. The Council recommended the PIFSC SEES Program, in collaboration with the Council's Education and Outreach Program, develop a stakeholder engagement framework for American Samoa, CNMI, and Hawaii to improve collaboration between stakeholders for the territorial bottomfish stock assessment. SEES staff have continued to work with the stock assessment program on stakeholder engagement and recently hired a staff member to focus on this type of engagement.

2.5.2 Introduction

Fishing has played a crucial role in American Samoan culture and society since the Samoan archipelago was settled. An overview of American Samoa history, culture, geography, and relationship with the U.S. is described in Section 1.3 of the Fishery Ecosystem Plan for American Samoa (WPRFMC 2009). Over the past decade, a number of studies have synthesized details about the role of fishing and marine resources in American Samoa, as well as information about the people who engage in the fisheries or use fishery resources (e.g., Armstrong et al. 2011; Grace-McCaskey 2015; Kleiber and Leong 2018; Levine and Allen 2009; Richmond and Levine 2012). These studies describe the importance of marine resources in cultural, economics, and subsistence aspects of American Samoan village life. Fishing was held in high esteem in traditional Samoan culture, with fishing skill bringing high social status and fishing activities figuring prominently in mythology. The basic components of Samoan social structure are the family and village, with the family acting as the central unit. The village leadership decides, according to season, what sort of community fishing should take place. The tautai, or master fishermen, of the village were key decision makers who were awarded higher status than others who might otherwise outrank him when it came to matters of fishing. Village-level systems of governance and resource tenure are still largely intact, and American Samoan cultural systems and representation are formally incorporated into the Territorial Government. Reciprocity is emphasized over individual accumulation. Gifts of food, especially fish and other marine resources, mark every occasion and are a pivotal part of American Samoan social structure to this day.

Recent studies have found that American Samoa is homogeneous both ethnically and culturally (Levine et al., 2016; Richmond and Levine, 2012). Polynesians account for the vast majority of the territory's people (93%), and the primary language spoken at home is Samoan (91%) though English is often spoken in school and business settings. Contemporary American Samoan culture is characterized by a combination of traditional Samoan values and systems of social organization with a strong influence from Christianity. Maintaining "*fa'a samoa*", or "the Samoan way", was considered a priority under the Territorial constitution. Given the cultural homogeneity, nearly everyone in American Samoa accepts and complies with Samoan traditions of land and resource tenure.

However, over the last half century or so, fishing has become less prominent as a central and organized community force. During this time, modern fishing gears and technologies were introduced, tuna canneries became a major economic force in Pago Pago, the population more than tripled, and the gradual but continuous introduction of Western cultural norms and practices altered American Samoans' relationship with the sea. While many traditions and village-based systems of governance have been maintained, the islands have experienced a shift from a subsistence-oriented economy, where sharing of fish catch was extremely important, to a cash-based economy, where fishing is often viewed as a more commercial venture.

A recent study by Levine et al. (2016) found that American Samoans still consume seafood frequently, with 78% of respondents stating that they eat fish or seafood once a week or more. Most American Samoans purchase seafood from stores or restaurants, with 65% of survey respondents listing these sellers as their first or second choice for obtaining seafood. Other common means for obtaining fish include markets and roadside vendors (45%) and fish caught by household members (37%). These results corroborate Levine and Allen's (2009) observation that American Samoans largely rely on, and in many cases prefer, store-bought food to locally caught fish, with the majority of fish consumed in American Samoa imported from neighboring Samoa.

The introduction of outboard engines and other technology in the 1950s and 1960s allowed American Samoan boats to go farther and faster, but also made it necessary for boat owners and operators to sell a portion of their catch to pay for fuel and engine maintenance. The disruption of other traditional values, as well as the introduction of a cash economy based primarily on government jobs and cannery employment, also decreased reliance on traditional, subsistence fishing; this allowed commercial fishing to develop on the islands (Levine and Allen 2009).

Unlike other areas of the Western Pacific region, American Samoa also experienced the development of domestic industrial-scale fisheries, including tuna processing, transshipment, and home port industries. These domestic industrial fisheries came about due to the harbor at Pago Pago, 390,000 km^2 of EEZ, and certain special provisions of U.S. law, which allowed the development of American Samoa's decades-old fish processing industry. For example, the Territory is exempt from the Nicholson Act, which prohibits foreign ships from landing their catch in U.S. ports, and American Samoan products with less than 50% market value from foreign sources enter the U.S. duty-free.

The two most important economic sectors are the American Samoa Government (ASG), which receives income and capital subsidies from the Federal Government, and tuna canning. According to the last published Statistical Yearbook, main imports include fish brought in for processing (American Samoa Government 2021). Exports are primarily canned tuna. In 2019, domestic exports (including re-exports) from American Samoa were valued at $353,215,000, of which $351, 470,000 (over 99%) came from canned tuna sale (American Samoa Government, 2021). Private business and commerce comprise a third sector. Unlike some of their neighbors in the South Pacific, American Samoa has never been known for having a robust tourist industry.

In 2019, the ASG employed 6,195 people accounting for 37% of the total workforce in the Territory (American Samoa Government, 2021), and the private sector employed 8,055 people (Figure 6). The canneries employed 2,533 people, accounting 15% of the workforce. Ancillary businesses involved in re-provisioning the fishing fleet also generated a notable number of jobs and income for residents.

The canneries in American Samoa have been operating since 1954, represent the largest private-sector source of employment in the region, and, until recently, were the principal industry in the Territory. Although as many as 90% of cannery workers are not American Samoa citizens, the canneries play a large role in the American Samoa economy (e.g., delivering goods or services to tuna processors and improving buying patterns of cannery workers). Trends in world trade, specifically reductions in tariffs, have been reducing the competitive advantage of American Samoa's duty-free access to the U.S. canned tuna market, and the viability of the canneries has been in question for nearly the past decade. In 2009, the Chicken of the Sea cannery closed, resulting in a loss of approximately 2,000 jobs. It was bought by Tri Marine International, which invested $70 million in rebuilding and expansion, and reopened in 2015. In October 2016, Sunkist Co. suspended operations due to lack of fish, in part due to Effort Limit Area for Purse Seine (ELAPS) closures (Pacific Islands Report 2016). That same month, Tri Marine International announced that it would suspend production indefinitely in December 2016 (Honolulu Star Advertiser 2016), and there are currently no plans to reopen (Pacific Islands Report 2017). Starkist Samoa is currently the only cannery operating in American Samoa and is the largest private employer with about 2,000 workers.

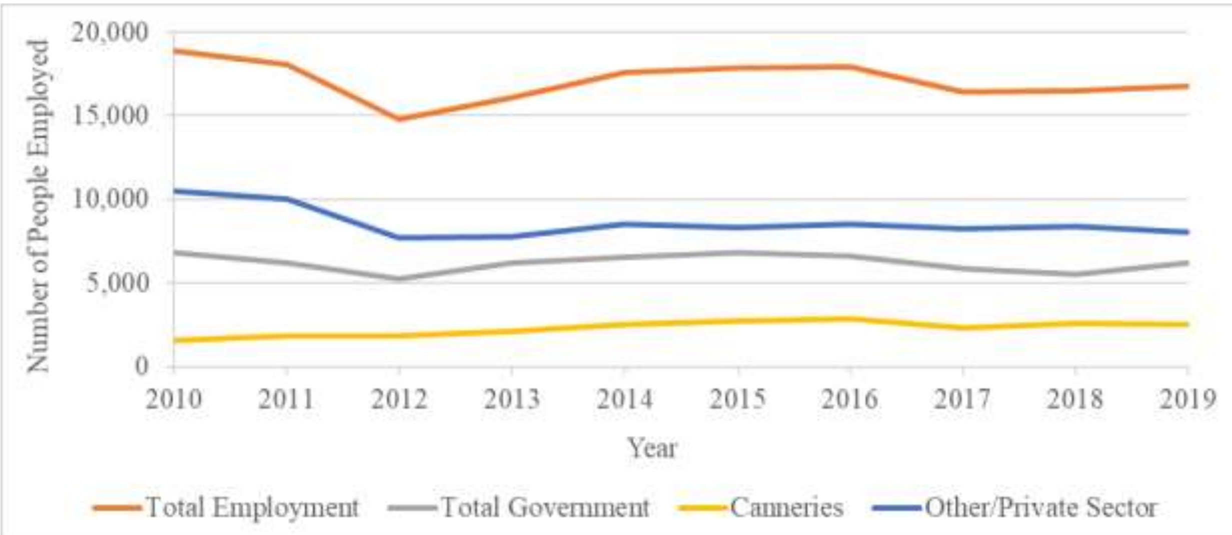

Figure 6. American Samoa Employment Estimates from 2010-2019; sourced from the American Samoa Statistical Yearbook 2018 & 2019, American Samoa Government (2021)

Even before Tri Marine International's closure, American Samoa's economy was identified as being in a highly transitional state that should be monitored closely (Grace McCaskey, 2015). It will be important to monitor any changes and developments related to the tuna industry, given the historically close connection between the tuna canneries, employment levels, population trends, and the economic welfare of the Territory. It is also possible that increased federal aid in recent years has obfuscated the full extent of the economic recession.

Members of the American Samoa fishing community had also expressed concerns about the impact of National Marine Sanctuary of American Samoa (NMSAS) expansion in 2012 and management of the Rose Atoll Marine National Monument, which was established in 2009. In both of these cases, the local communities have been concerned about the impacts on fishing practices as well as broader social and cultural issues, such as traditional marine tenure and the ability of villages to manage their own resources.

While pelagic fisheries play a larger role in the broader economy, insular fisheries are fundamentally important from a socio-cultural and dietary standpoint (Levine and Allen 2009). Village leaders still have a significant degree of control over the nearshore waters, enforcing their own village rules and regulations despite the waning strength of many of these village-based management systems. The American Samoa Department of Marine and Wildlife Resources (DMWR) is the primary agency for fisheries management. The DMWR also monitors the status of nearshore fish and marine habitats through the collection of fishery independent data, however it has limited patrolling and enforcement capacity. In 2000, the DMWR initiated the Community-based Fisheries Management Program (CFMP) to assist villages in managing and conserving their inshore fishery resources through a voluntary scheme of co-management with the government. In general, villages manage their marine areas through establishment of village marine protected areas (MPAs) sometimes called VMPAs to distinguish this program from federal or territorial MPAs. Because VMPAs are managed by local communities that have a direct interest in their success, compliance with fishing bans is generally high, and most villages with MPAs actively enforce their own rules.

Richmond and Levine (2012) described the role of community-based marine resource management in American Samoa. Organized trips for specialized fishing are marked by considerable ceremony and tradition. While more frequent in the past, organized fishing efforts continue to take place in a few villages in American Samoa. Village-wide fish drives are timed with the tides and the spawning of certain species, and after these efforts, the fish are traditionally distributed to all village families who participated in the fishing.

In 2017, understanding the relationship of pelagic fisheries to cultural fishing practices typically associated with insular fisheries has taken on greater importance. During the peak of longline landings in 2002, NMFS created a Large Vessel Prohibited Area (LVPA) to prevent gear conflicts and catch competition between large and small vessels, and to preserve opportunities for fishing by American Samoa's small boat ("alia") fleet (NOAA 2017). Since the creation of the LVPA in 2002, both large and small vessels have experienced declining catch rates, fish prices, and increasing fuel and operating costs. In 2016, NMFS published an exemption to the LVPA rule to allow large U.S. vessels holding a federal American Samoa longline limited entry permit to fish in portions of the LVPA (NOAA 2016). NMFS and the WPRFMC were then sued by the American Samoa Government, who claimed that the 1900 and 1904 Deeds of Cession were not considered in the rulemaking process. The U.S. District Court ruled in favor of American Samoa in March 2017, requiring NMFS to preserve American Samoan cultural fishing practices as part of the obligations of the Deeds of Cession. A study examining dimensions of cultural fishing for the small and large longline fleets found that these fisheries play an important role in maintaining cultural practices, primarily through sharing of catch (Kleiber and Leong 2018). The Council took action to provide a four-year exemption for vessels permitted under the American Samoa Longline Limited Entry permit, which reduced the area closed to large vessels from 25.5 to 11.5%. In September 2020 the Ninth Circuit Court of Appeals reversed the District Court decision in favor of NMFS. In February 2021, the ASG appealed to the Supreme Court of the United States, but the writ of certiorari was denied June 21, 2021. NMFS published the original 2016 LVPA exemption as a final rule, effective July 6, 2021.

2.5.3 People Who Fish

Few studies have been conducted that include demographics or other information about people who fish in American Samoa. Information at the fishery level will be reported in the fishery specific sections below. Qualitative research has resulted in some general observations about trends in fishing by American Samoans.

One household survey by Levine et al. (2016) found that over half of residents participate in fishing or gathering of marine resources. Approximately 15% reported fishing once a week or more and over 30% of households stated that they engaged in fishing or gathering at least once a month. Commercial fishing is very uncommon in American Samoa, with only 3% of those who fish stated that they frequently did so to sell their catch and 62% never selling their catch. More commonly, people fish to feed themselves and their family or to give to extended friends, family, pastors, and village leaders.

While fishing and marine resources are universally considered to be important aspects of *fa'a samoa*, limited income has made American Samoans less inclined to engage in strenuous fishing activities when food imports are relatively more available (Levine and Allen 2009). Only a small number of American Samoans engage in boat-based or commercial fishing. Although unemployment in the Territory has increased, the percentage of individuals participating in subsistence activities (including fishing for food or home use) decreased between 2000 and 2013 (Grace McCaskey 2015). However, many island residents have been employed by the canneries in Pago Pago, which facilitated the availability of low-cost fish for many residents and ensured that the livelihood of American Samoans is still tightly tied to fishing activities.

As described in the Fishery Ecosystem Plan (FEP), American Samoans have been discouraged from working on foreign longline vessels delivering tuna to the canneries for several reasons, including harsh working conditions, low wages, and long fishing trips. While American Samoans prefer employment on the U.S. purse seine vessels, the capital-intensive nature of purse seine operations limits the number of job opportunities for locals in that sector.

Local fishermen have indicated an interest in participating in the more lucrative overseas markets for fresh fish. However, they are limited by inadequate shore-side ice and cold storage facilities, as well as infrequent and expensive air transportation.

As noted by Levine and Allen (2009), the trend of decreasing reliance on local fish as a food source is reflective of a society that has been undergoing a shift from a subsistence-oriented economy to a cash economy. Changes such as a decrease in leisure time, a shift in dietary preferences towards store-bought foods, a preference to buy fish at the market rather than expend effort in fishing, and an increased availability of inexpensive imported reef fish from Western Samoa and Tonga are also likely contributing to decreasing rates of subsistence fishing in the region (Richmond and Levine 2012).

2.5.3.1 Bottomfish

Levine and Allen (2009) described the bottomfish fishery as part of their review of American Samoa as a fishing community. Prior to the arrival of Europeans in Samoa, the indigenous people had developed specialized techniques for catching bottomfish from outrigger canoes (paopao). Some of the bottomfish, such as trevally (malauli), held a particular social significance and were reserved for the matai chiefs.

In the early 1970s, the American Samoa Office of Economic Opportunity (OEO) funded the Dory Project, which provided easy credit and loans to fishermen to develop offshore fisheries. Records indicate that 70% of these dories were engaged in bottomfish fishing activities, conducted primarily at night on the shallow reef area around Tutuila. The result was an abrupt increase in the fishing fleet and total landings, but the limited nearshore bottomfish habitat meant that catch rates there declined rapidly and fishermen began to venture farther offshore to previously unexploited seamounts and banks to maintain profitable catch rates.

In the 1980s, dories were replaced by alia catamarans, larger, more powerful boats that could stay multiple days at sea. Alias primarily engaged in trolling and bottomfish fishing, and spearfishing, netting, and vertical longlining were used on occasion. Bottomfish fishing peaked between 1982 and 1988, with landings comprised as much as half of the total catch of the commercial fishery in American Samoa. In December 1980, a fish market opened in Fagatogo, which allowed fishermen to market their catch at a centralized, relatively sanitary location. Although the price for bottomfish rose between the 1970s and 1980s, it was still difficult for fishermen to make a profit from bottomfish sales due to competition with sales of inexpensive incidental catch from longline and purse seine vessels landing at the canneries.

Since 1988, there has been with a steady decrease in the importance of bottomfish fishing, as people converted to trolling and longlining for pelagic species, increasing fuel prices forced others out of the fishery, and imported fish from Western Samoa and Tonga became more available. Markrich and Hawkins (2016) noted that recently there have been fewer than 20 boats active in the bottomfish fishery. The demand for bottomfish varies depending on the need for fish at government and cultural events, though alia fishermen do return to bottomfish fishing during periods when longline catches or prices are low.

2.5.3.2 Reef Fish

American Samoa's nearshore fishing is focused on the narrow fringing coral reef that partially surrounds the islands (Levine and Allen 2009; Richmond and Levine 2012). A diverse array of fish and shellfish is harvested by residents on an almost daily basis. Most fishing is accomplished by individuals on foot in areas adjacent to their village. While the gender division in fishing is not as strict as it was in the past, women, and children still predominantly engage in gathering shellfish and small fish in the intertidal zone, while men fish farther offshore. Traditionally, women were not permitted by Samoan custom to fish outside the reef. Common fishing techniques included intertidal gleaning, diving, rod and reel, netting and trapping (including communal fish drives), and boat-based fishing.

There are several traditional fisheries associated with seasonal runs of certain species. Atule, or bigeye scad (Selar crumenophthalmus), is a coastal migratory species that spawns in mass near shore. Atule are caught through a village-wide effort in some areas where they spawn, with villagers driving the fish to a central location to be harvested. I'asina (juvenile goatfish) are caught in hand-woven funnel traps called enu. Thousands of i'asina may appear along sandy shorelines during the months of October–April. The palolo worm (Palola viridis), a coral-dwelling polychaete worm, is another unique species that is caught in large numbers in the Samoa Islands during spawning events. Palolo generally emerge once a year, one week after the full moon in October or November, to release their reproductive segments (epitokes) into nearshore waters. These epitokes are a local delicacy, and Samoans will gather in the thousands at midnight on the predicted spawning event to collect them in hand nets and screens.

Despite increasing levels of participation in the commercial fishing industry in American Samoa, most nearshore fishermen do not sell their catch. Traditionally, fish in American Samoa are not sold, but shared with others or distributed amongst the community. Many American Samoans still believe that some species, such as the palolo, should not be sold at the risk of ruining catch in future years. Sharing fish amongst the wider village community is still an important cultural practice. For example, atule are divided equally amongst village members after a group harvesting event, and palolo are still distributed to family members with a portion reserved for village pastors. However, since the advent of refrigeration, people are more likely to catch more fish during mass spawning events and share fewer, as they can be stored for longer periods for personal use.

The American Samoa DMWR has conducted inshore creel surveys along the southern shore of Tutuila Island since 1990. They documented a significant decrease in the level of shoreline fishing effort over the past three decades despite the increase in the human population over the same time period.

Studies that have examined how residents value coral reef resources found that most people perceive coral reefs as an important food source that also provides passive benefits associated with culture, biodiversity, and community (Levine and Allen 2009; Levine et al. 2016). Less importance was placed on the ecosystem, recreational benefits, shoreline protection, or other direct-use benefits. Because there is relatively little tourism, the economic value of American Samoa's coral reefs has been estimated to be relatively lower than other islands in the Western Pacific region; an analysis in 2004 estimated their value at $5 million per year (Grace-McCaskey 2014).

2.5.3.3 Crustaceans

In American Samoa, spiny lobsters constitute the bulk of the crustacean fishery (description available in Markrich and Hawkins 2016). Lobsters are often present at important meals in American Samoa such as weddings, funerals, and holidays. In the past, lobsters were typically harvested and consumed on the family and village level. They are now primarily caught by commercial fishermen in territorial waters and purchased by the public at market. Crustaceans harvested in American Samoa are processed at sea on the vessel and marketed as fresh product or as frozen lobster tails.

2.5.3.4 Precious Corals

There is currently no socioeconomics information specific to this fishery. Subsequent reports will include new data as resources allow.

2.5.4 Fishery Economic Performance

2.5.4.1 Bottomfish Fishery Commercial Landings, Revenues, Price

This section will describe trends in commercial pounds sold, revenues and prices, for the American Samoa bottomfish fishery. Figure 7 presents the trends of commercial pounds sold and revenues of bottomfish fishery (for BMUS only) during 2012-2021 and Figure 8 presents the trend of fish price for bottomfish sold during 2012-2021. Supporting data for Figure 7 and Figure 8 are shown in Table 25. The table also includes the percentage of pounds sold relative to estimates of total pounds landed for the bottomfish fishery. Both nominal and adjusted values are included.

Commercial landings data in 2021 are confidential due to fewer than 3 participating vendors, thus no detailed figures are presented. The total pounds sold and revenue of bottomfish reported in 2021 were lower than the 10 year average. The percentage of commercial landings to the total landings was also lower than 10 years average. Revenue trends follow a similar pattern as pounds sold. The BMUS commercial bottomfish landings and revenue have fluctuated during the period of 2012-2019, but in 2020 both revenue and pounds sold went down considerably and this downward trend continued in 2021. Bottomfish (BMUS) price was steady over most of the time period, but it went up substantially in 2017 then decreased in the years following. The bottomfish price in 2020 ($3.48) was down from $4.24 in 2019. Low commercial landings and low fish prices resulted in a historical low for bottomfish revenue in 2020. In 2021, BMUS price rose to 2019 levels, but revenue in 2021 was still lower than 2020 because of lower landings.

It is worth noting that the data for pounds caught and pounds sold are collected by two different data collection methods. The data of pounds sold are collected through the "Commercial Sales Receipt Books" Program, while the data of pounds caught are collected through Boat- and Shore-Based Creel Surveys. Both data series are generated from an expansion algorithm built on a non-census data collection program, and the survey coverage rates of two data collection methods may change independently across individual years. Therefore, the two time series may not move coherently to each other. For example, the low percentage of pounds sold compared to pounds caught could be due to low coverage of dealer participation in the Commercial Receipt Books Program.

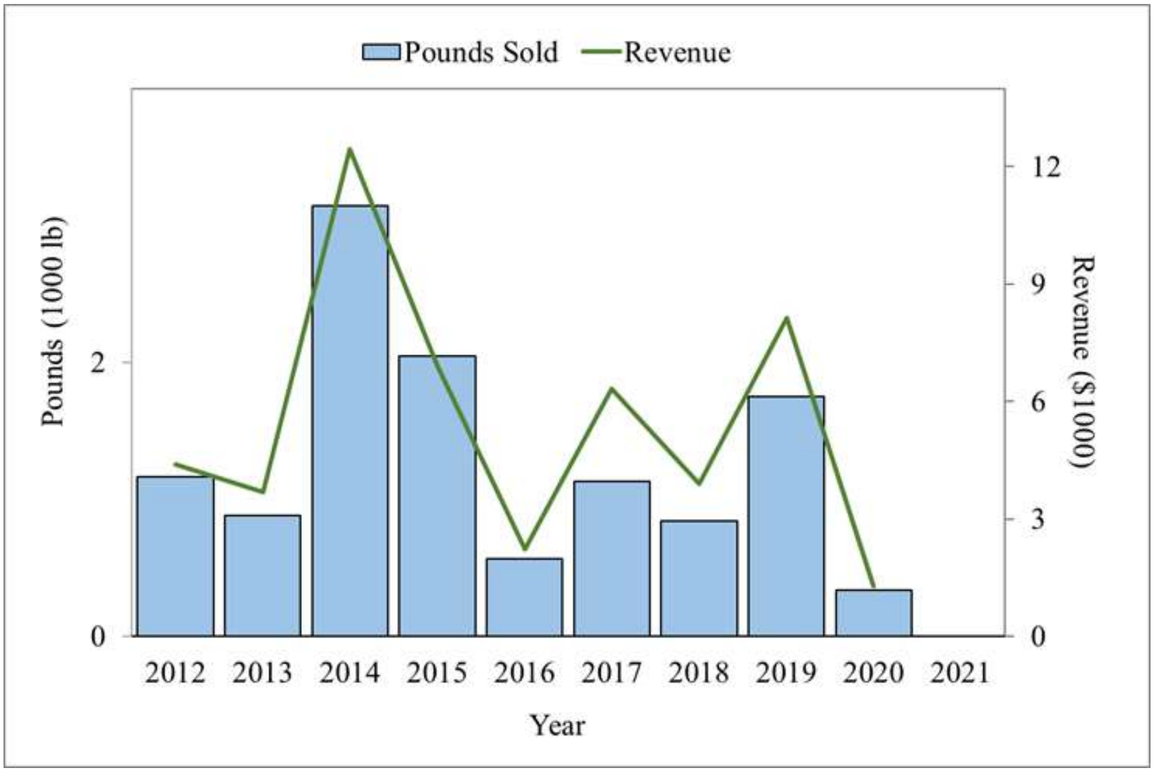

Figure 7. The pounds sold and revenues, for the American Samoa bottomfish fishery, 2012-2021*

* Confidential in 2021 due to less than 3 participating vendors.

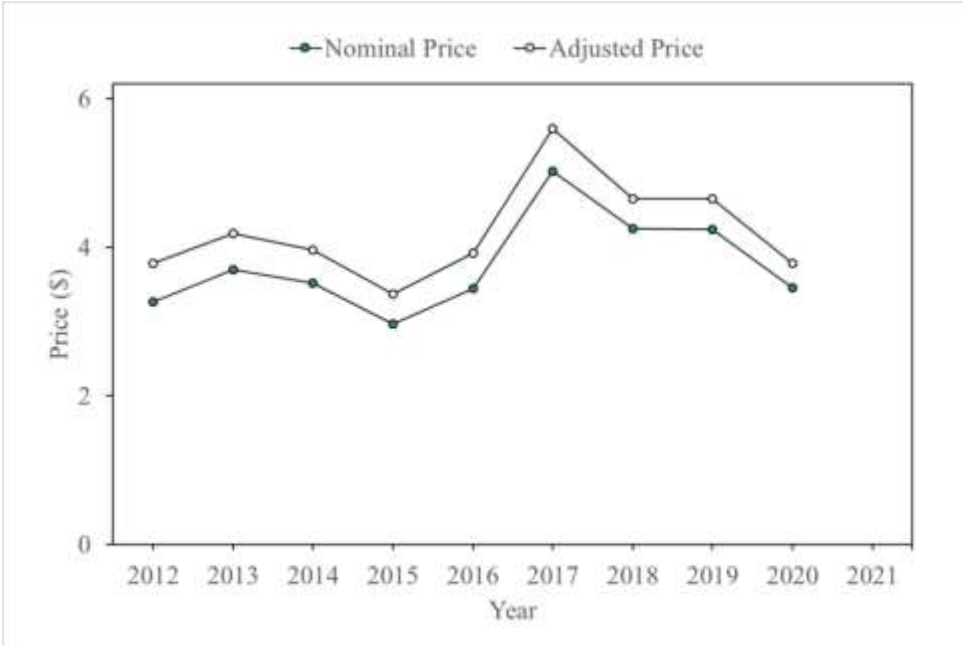

Figure 8. The prices of BMUS for the American Samoa bottomfish fishery, 2012-2021

* Confidential in 2021 due to less than 3 participating vendors.

Table 25. The commercial landings and revenue from bottomfish fishery for American Samoa, 2012-2021

Year	Estimated pounds caught (lb)	Estimated pounds sold (lb)	Estimated revenue ($)	Estimated revenue ($ adj.)	% of pounds sold	Fish price ($)	Fish price ($ adj.)	CPI adjustor
2012	2,099	1,162	3,797	4,393	55%	3.27	3.78	1.157
2013	5,731	882	3,258	3,695	15%	3.69	4.19	1.134
2014	13,982	3,140	11,051	12,454	22%	3.52	3.97	1.127
2015	21,528	2,048	6,073	6,905	10%	2.97	3.37	1.137
2016	19,308	565	1,948	2,217	3%	3.45	3.92	1.138
2017	14,790	1,130	5,676	6,329	8%	5.02	5.60	1.115
2018	11,958	838	3,558	3,903	7%	4.25	4.66	1.097
2019	11,082	1,749	7,423	8,128	16%	4.24	4.65	1.095
2020	7,750	336	1,160	1,273	4%	3.45	3.79	1.097
2021	1,738	*	*	*	*	*	*	1

*Confidential due to less than 3 participating vendors.

2.5.4.2 Bottomfish Costs of Fishing

Since 2009, PIFSC economists have maintained a continuous economic data collection program in American Samoa through collaboration with the PIFSC Western Pacific Fisheries Information Network (WPacFIN). The economic data collection gathers fishing expenditure data for boat-based reef fish, bottomfish, and pelagic fishing trips on an ongoing basis. Data for fishing trip expenses include gallons of fuel used, price per gallon of fuel, cost of ice used, cost of bait and chum used, cost of fishing gear lost, and the engine type of the boat. These economic data are collected from same subset of fishing trips as the boat-based creel survey carried out by the local fisheries management agencies and WPacFIN.

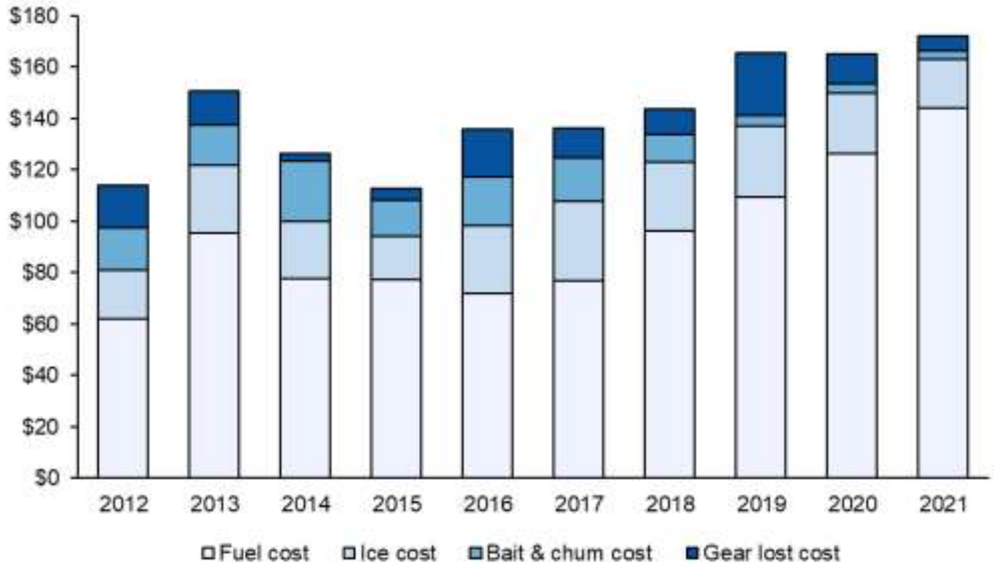

Figure **9** shows the average trip costs for American Samoa bottomfish trips during 2012–2021. In 2021, the average trip costs of bottomfish trips were $172, higher than 2020, as fuel cost were key cost item and the fuel price in 2021 was higher than 2020. Supporting data for

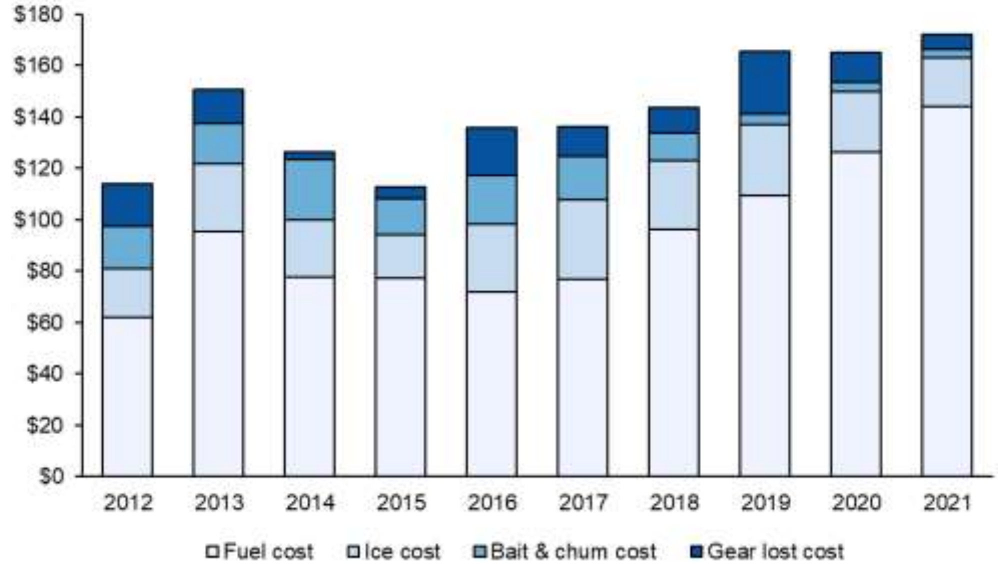

Figure **9** are presented in Table 26. The cost data summaries were generated by excluding outliners (the cases with >10 gallons/hour fished).

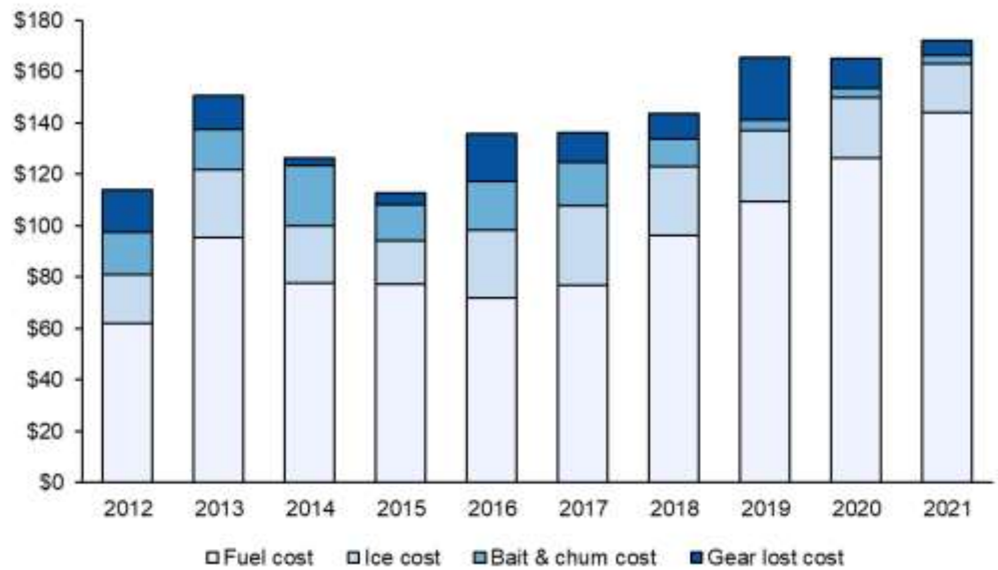

Figure 9. Average costs adjusted for American Samoa bottomfish trips from 2012–2021 adjusted to 2021 dollars

Table 26. Average and itemized costs for American Samoa bottomfish trips from 2012–2021 adjusted to 2021 dollars

Year	Total trip costs ($)	Total trip cost adj. ($)	Fuel cost adj. ($)	Ice cost adj. ($)	Bait cost adj. ($)	Gear losted adj. ($)	Fuel price adj. ($/gallon)	CPI Adjustor
2012	99	114	62	19	17	16	4.85	1.157
2013	133	151	95	26	16	13	4.87	1.134
2014	112	126	78	22	24	3	2.87	1.127
2015	99	113	77	17	14	5	2.26	1.137
2016	119	136	72	27	19	19	2.51	1.138
2017	122	136	77	31	17	12	2.56	1.115
2018	131	144	96	27	10	10	3.50	1.097
2019	151	165	109	28	4	24	3.57	1.095
2020	150	165	126	23	4	11	3.45	1.097
2021	172	172	144	19	3	6	3.46	1

Data source: PIFSC Continuous Cost Data Collection Program (Chan and Pan 2019).

2.5.4.3 Ecosystem Component Species

Based on new guidelines for the archipelagic SAFE report from the Council, this section highlights the top 10 ECS (sorted by landings) and the priority ECS (recommended by the local fishery management agency) caught by small boats or shoreline fishing. Please note the top 10 species list and the priority species list reported in the socioeconomic module may not be consistent with the lists reported in the fishery module in the previous sections. The inconsistences result from several factors: 1) differences in data sources, 2) differences in level of species groupings, 3) differences in commercial landing and total landings.

Firstly, the data for pounds caught and pounds sold are collected by two different data collection methods, as mentioned in the earlier section. The data for “pounds sold” (commercial landings) reported in this socioeconomics module were collected through the “Commercial Sales Receipt Books” Program, while the data for pounds caught were collected through “Boat-based Creel Survey”. The survey coverage rates of two data collection methods may change independently in individual years. Secondly, the species groups used in the two data collection programs were different, as the species in the commercial receipt books usually were lumped into family levels or species groups while the species reported in the Creel Survey were more detailed at the species level. Third, fish species with higher total pounds caught may not necessarily lead to higher pounds sold in the markets. Therefore, the two series may not move coherently with each other.

Table 27 shows the commercial landings and revenue of the top 10 ECS in American Samoa. The total pounds sold of the top 10 species/species groups was 14,516 pounds (valued at $45,666) in 2020. Data in 2021 only show the species names of the top 10 ECS because of confidentiality considerations as there were less than 3 participating vendors. While the commercial landings of the top 10 species in 2020 dropped substantially (only 22% of the 2019 level), these trends continued in 2021. Revenue in 2021 also went down significantly. In terms of commercial landing ratio, it was difficult to estimate because the commercial landings (pounds sold) were collected through the commercial receipt book program where species were often lumped into species group or family and the data of pounds caught were collected through creel survey where species was more specifically defined. Table 28 shows the priority ECS. Six fish species are suggested as priority species (species of interest) for the area. Only one species (green spiny lobster) of the six showed up in the commercial receipt books in 2020 and 2021.

Table 27. Top 10 ECS commercial landings, revenue, and price 2020 and 2021

	2021			2020		
Top 10 ECS Species	**Estimated Pounds Sold**	**Estimated Revenue**	**Price per Pound**	**Estimated Pounds Sold (lbs)**	**Estimated Revenue ($)**	**Price per Pound ($/lb)**
Blue-banded	*	*	*	8,351	25,459	3.05
Reef fishes	*	*	*	3,264	9,926	3.04
Striped bristletooth	*	*	*	4,277	12,924	3.02
Parrotfishes	*	*	*	2,641	8,918	3.38
Unicornfishes	*	*	*	3,074	9,338	3.04
Pacific sailfin tang	*	*	*	694	2,803	
Squirrelfishes	*	*	*	664	2,040	3.07
Squid	*	*	*			
Inshore groupers	*	*	*	264	813	3.08
Spiny Lobster	*	*	*			
Total	*	*	*	23,229	72,221	3.10

Data source: WPacFIN, commercial receipt books (confidential in 2021 due to less than 3 participating vendors)

Table 28. Priority ECS commercial landings, revenue, and price 2020 and 2021

	2021			2020		
Priority Species	**Pounds Sold**	**Revenue ($)**	**Price $/lb**	**Pounds Sold**	**Revenue ($)**	**Price $/lb**
Green spiny lobster	*	*	*	228	969	4.25

Data source: WPacFIN commercial receipt books (confidential in 2021 due to less than 3 participating vendors)

2.5.5 Ongoing Research and Information Collection

Each year, the PIFSC reports on the status of economic data collections for select regional commercial fisheries. This supports a national economic data monitoring effort known as the Commercial Fishing Economic Assessment Index (CFEAI). Details on the CFEAI and access to data from other regions is available at: https://www.st.nmfs.noaa.gov/data-and-tools/CFEAI-RFEAI/.

The table below represents the most recent data available for CFEAI metrics for select regional commercial fisheries for 2021. Entries for American Samoa insular fisheries are bolded in red. These values represent the most recent year of data for key economic data monitoring parameters (fishing revenues, operating costs, and fixed costs). The assessment column indicates the most recent publication year for specific economic assessments (returns above operating cost, profit), where available.

Table 29. Pacific Islands Region 2021 Commercial Fishing Economic Assessment Index

	2021 CFEAI				
	2021 Reporting Year (e.g. 1/2021-12/2021)				
	Data			Assessment	
Pacific Islands Fisheries	Fishing Revenue Most Recent Year	Operating Cost Most Recent Year	Fixed Cost Most Recent Year	Returns Above Operating Costs (Quasi Rent) Assessment Most Recent Year	Profit Assessment Most Recent Year
HI Longline	2021	2021	2013	2021	2016
ASam Longline	2021	2021	2016	2021	2019
HI Offshore Handline	2021	2014	2014	2019	2019
HI Small Boat (pelagic)	2021	2021	2021	2017	2019
HI Small Boat (bottomfish)	2021	2021	2021	2017	2019
HI Small Boat (reef)	2021	2021	2021	2017	2019
Guam Small boat	2021	2021	2019	2019	
CNMI Small boat	2021	2021	2019	2019	
ASam Small boat	**2021**	**2021**	**2021**	**2019**	

PIFSC maintained the ongoing economic data collection in American Samoa for small boat fisheries (Chan and Pan, 2019) during 2021. Additionally, a cost-earnings survey of the American Samoa small boat fishery was completed during 2021. This survey provides updated data on fishing revenues, operating costs, and fixed costs, as well as numerous elements related to fishing behavior, market participation, and fishery demographics for American Samoa boat-based fisheries. PIFSC hopes to have survey results published by the end of 2022.

PIFSC also generates projections for upcoming fiscal years, and the table below provides the projected CFEAI report for 2022 (*all projected activities and analyses are subject to funding*). Based on early projections PIFSC intends to maintain ongoing economic data collections in American Samoa for small boat fisheries (Chan and Pan, 2019) during 2022.

Table 30. Pacific Islands Region 2022 Commercial Fishing Economic Assessment Index

	2022 Projected CFEAI				
	2022 Reporting Year (e.g. 1/2022-12/2022)				
	Data			Assessment	
Pacific Islands Fisheries	Fishing Revenue Most Recent Year	Operating Cost Most Recent Year	Fixed Cost Most Recent Year	Returns Above Operating Costs (Quasi Rent) Assessment Most Recent Year	Profit Assessment Most Recent Year
HI Longline	2022	2022	2022	2022	2022
ASam Longline	2022	2022	2016	2022	2016
HI Offshore Handline	2022	2014	2014	2019	2019
HI Small Boat (pelagic)	2022	2021	2021	2022	2022
HI Small Boat (bottomfish)	2022	2021	2021	2022	2022
HI Small Boat (reef)	2022	2021	2021	2022	2022
Guam Small boat	2022	2022	2019	2019	
CNMI Small boat	2022	2022	2019	2019	
ASam Small boat	**2022**	**2022**	**2021**	**2022**	

Community social indicators have been generated for American Samoa (Kleiber *et al*., 2018) in accordance with a national project to describe and evaluate community well-being in terms of environmental justice, economic vulnerability, and gentrification pressure (https://www.fisheries.noaa.gov/national/socioeconomics/social-indicators-coastal-communities). However, these indicators rely on Census data, and cannot be updated until 2020 Census data becomes available, perhaps sometime in 2022.

2.5.6 Relevant PIFSC Economics and Human Dimensions Publications: 2021

Publication	**MSRA priority**
Hedelin B, Gray S, Woehlke S, BenDor TK, Singer A, Jordan R, Zellner M, Giabbanelli P, Glynn P, Jenni K, Jetter A, Kolagani N, Laursen B, Leong KM, et al. 2021. What's left before participatory modeling can fully support real-world environmental planning processes: A case study review. Environmental Modelling & Software. 143:105073.https://doi.org/10.1016/j.envsoft.2021.105073	HC2.1.2 HC2.2.1 HC2.2.2 IF8.1.1
Hospital J, Leong K, Sweeney J. 2021. Pacific Islands Fisheries Impacts from COVID-19. 10p. (in: NOAA Fisheries National COVID-19 Preliminary Baseline Impact Assessment). https://media.fisheries.noaa.gov/2021-02/Initial-COVID-19-Impact-Assessment-webready.pdf	HC1.1.1 HC2.1.3 HC2.2.1
Hospital J, Iwane M, Kleiber D, Leong K, Sweeney J. 2021. Pacific Islands Fisheries Impacts from COVID-19 – Pacific Islands Snapshot March – July 2020. 10p. https://media.fisheries.noaa.gov/2021-02/Pacific-Islands-COVID-19-Impact-Snapshot-webready.pdf	HC1.1.1 HC2.1.3 HC2.2.1
Hospital J, Iwane M, Kleiber D, Leong K, Sweeney J. 2021. Pacific Islands Fisheries Impacts from COVID-19 (in NMFS. 2021. U.S. Seafood Industry and For-hire Sector Impacts from COVID-19: 2020 in Perspective. NOAA Tech. Memo. NMFS-SPO-221, 88 p. https://spo.nmfs.noaa.gov/sites/default/files/TM221.pdf	HC1.1.1 HC2.1.3 HC2.2.1
Johnson E, Champ JG, Leong K, Melena S. 2021. Content evaluation of the response to the centennial Find Your Park Campaign. Natural Resource Report. NPS/NRSS/NROC/NRR-2021/2242. National Park Service. Fort Collins, Colorado. https://doi.org/10.36967/nrr-2284970	HC3.2.4
Kasperski S, DePiper GS, Blake S, Colburn LL, Jepson M, Haynie AC, Karnauskas M, Leong KM, Lipton D, Masi M, et al. 2021. Assessing the State of Coupled Social-Ecological Modeling in Support of Ecosystem Based Fisheries Management in the U.S. Front. Mar. Sci. https://doi.org/10.3389/fmars.2021.631400	HC2.1.1 HC2.1.2 HC2.1.4 IF8.1.1
Pan M. 2021. Maximum Economic Yield and Non-Linear Catchability. North American Journal of Fisheries Management. http://doi.org/10.1002/nafm.10661	IF3.1.2

Tommasi D, deReynier YL, Townsend H, Harvey CJ, Satterthwaite W, Marshall KN, Kaplan IC, Brodie S, Field J, Hazen E, et al. 2021. A Case Study in Connecting Fisheries Management Challenges With Models and Analysis to Support Ecosystem-Based Management in the California Current Ecosystem. Frontiers in Marine Science. 8:776. https://doi.org/10.3389/fmars.2021.624161	IF8.1.1 IF8.1.6 HC2.1.2
Williams GD, Andrews KS, Brown JA, Gove JM, Hazen EL, Leong KM, Montenero KA, Moss JH, Rosellon-Druker JM, Schroeder ID, Siddon E. 2021. Place-Based Ecosystem Management: Adapting Integrated Ecosystem Assessment Processes for Developing Scientifically and Socially Relevant Indicator Portfolios. Coastal Management. 49(1):46-71. https://doi.org/10.1080/08920753.2021.1846154	IF8.1.1 HC2.2.1 HC3.1.3

2.6 PROTECTED SPECIES

This section of the report summarizes information on protected species interactions in fisheries managed under the American Samoa FEP. Protected species covered in this report include sea turtles, seabirds, marine mammals, sharks, and corals. Most of these species are protected under the Endangered Species Act (ESA), Marine Mammal Protection Act (MMPA), and/or Migratory Bird Treaty Act (MBTA). A list of protected species found in or near American Samoa waters and a list of critical habitat designations in the Pacific Ocean are included in Appendix B.

2.6.1 Indicators for Monitoring Protected Species Interactions in the American Samoa FEP Fisheries

This report monitors the status of protected species interactions in the American Samoa FEP fisheries using proxy indicators such as fishing effort and changes in gear types as these fisheries do not have observer coverage. Creel surveys and logbook programs are not expected to provide reliable data about protected species interactions. Discussion of protected species interactions is focused on fishing operations in federal waters and associated transit through territorial waters.

2.6.1.1 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 prohibitions benefit protected species by preventing potential interactions with non-selective fishing gear.

2.6.1.2 ESA Consultations

ESA consultations were conducted by NMFS and the U.S. Fish and Wildlife Service (USFWS; for species under their jurisdiction including seabirds) to ensure ongoing fisheries operations managed under the American Samoa FEP are not jeopardizing the continued existence of any ESA-listed species or adversely modifying critical habitat. The results of these consultations conducted under section 7 of the ESA are briefly described below and summarized in Table 31.

NMFS concluded in an informal consultation dated April 9, 2015 that all fisheries managed under the American Samoa FEP are not likely to adversely affect the Indo-West Pacific distinct population segment (DPS) of scalloped hammerhead shark or ESA-listed reef-building corals.

Table 31. Summary of ESA consultations for American Samoa FEP Fisheries

Fishery	Consultation date	Consultation type[a]	Outcome[b]	Species
Bottomfish	3/3/2002	BiOp	NLAA	Blue whale, fin whale, green sea turtle, hawksbill sea turtle, humpback whale, leatherback sea turtle, loggerhead sea turtle, olive ridley sea turtle, sei whale, sperm whale
	Initiated 6/5/2019	*Consultation ongoing*		Oceanic whitetip shark, giant manta ray, chambered nautilus
Coral reef ecosystem	3/7/2002	LOC	NLAA	Blue whale, fin whale, green sea turtle, hawksbill sea turtle, humpback whale, leatherback sea turtle, loggerhead sea turtle, olive ridley sea turtle, sei whale, sperm whale
	5/22/2002	LOC (USFWS)	NLAA	Green, hawksbill, leatherback, loggerhead, and olive ridley turtles, Newell's shearwater, short-tailed albatross, Laysan duck, Laysan finch, Nihoa finch, Nihoa millerbird, Micronesian megapode, 6 terrestrial plants.
	9/18/2018	No effect memo	No effect	Oceanic whitetip shark, giant manta ray
Crustaceans	9/28/2007	LOC	NLAA	Blue whale, fin whale, green sea turtle, hawksbill sea turtle, humpback whale, leatherback sea turtle, loggerhead sea turtle, olive ridley sea turtle, sei whale, sperm whale
	9/18/2018	No effect memo	No effect	Oceanic whitetip shark, giant manta ray
Precious corals	10/4/1978	BiOp	Does not constitute threat	Leatherback sea turtle, sperm whale
	12/20/2000	LOC	NLAA	Green sea turtle, hawksbill sea turtle, humpback whale
	9/18/2018	No effect memo	No effect	Oceanic whitetip shark, giant manta ray
All fisheries	4/9/2015	LOC	NLAA	Reef-building corals, scalloped hammerhead shark (Indo-West Pacific DPS)

[a] BiOp = Biological Opinion; LOC = Letter of Concurrence

[b] LAA = likely to adversely affect; NLAA = not likely to adversely affect.

Bottomfish Fishery

In a biological opinion issued on March 3, 2002, NMFS concluded that the ongoing operation of the Western Pacific Region’s bottomfish and seamount groundfish fisheries is not likely to jeopardize the continued existence of five sea turtle species (loggerhead, leatherback, olive ridley, green and hawksbill turtles) and five marine mammal species (humpback, blue, fin, sei and sperm whales).

On June 5, 2019, NMFS reinitiated consultation for the American Samoa bottomfish fisheries due to the listing of the oceanic whitetip shark, giant manta ray, and chambered nautilus under the ESA. On June 6, 2019 (extended on August 11, 2020, December 15, 2020, and February 9, 2022), NMFS determined that the conduct of the American Samoa bottomfish fisheries during the period of consultation will not violate ESA Section 7(a)(2) and 7(d).

Crustacean Fishery

In an informal consultation completed on September 28, 2007, NMFS concluded that American Samoa 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).

On September 18, 2018, NMFS concluded the American Samoa crustacean fisheries will have no effect on the oceanic whitetip shark and giant manta ray.

Coral Reef Ecosystem Fishery

In an informal consultation completed on March 7, 2002, NMFS concluded that the American Samoa coral reef ecosystem 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).

On May 22, 2002, the USFWS concurred with the determination of NMFS that the activities conducted under the Coral Reef Ecosystems FMP are not likely to adversely affect listed species under USFWS's exclusive jurisdiction (i.e., seabirds) and listed species shared with NMFS (i.e., sea turtles).

On September 18, 2018, NMFS concluded the American Samoa coral reef ecosystem fisheries will have no effect on the oceanic whitetip shark and giant manta ray.

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. In an informal consultation completed on December 20, 2000, NMFS concluded that American Samoa precious coral fisheries are not likely to adversely affect humpback whales, green turtles, or hawksbill turtles.

On September 18, 2018, NMFS concluded the American Samoa precious coral fisheries will have no effect on the oceanic whitetip shark and giant manta ray.

2.6.1.3 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 2022 LOF (87 FR 23122, April 19, 2022) the American Samoa bottomfish fishery is classified as a Category III fishery (i.e., a remote likelihood of or no known incidental mortality and serious injury of marine mammals).

2.6.2 Status of Protected Species Interactions in the American Samoa FEP Fisheries

Bottomfish and Coral Reef Fisheries

There are no observer data available for the American Samoa bottomfish or coral reef fisheries. However, based on the information in the 2002 BiOp for fisheries operating under the American Samoa FEP, bottomfish fisheries are not expected to interact with any ESA-listed species in federal waters around American Samoa. Based on current ESA consultations, coral reef fisheries are not expected to interact with any ESA-listed species in federal waters around American Samoa. NMFS has also concluded that the American Samoa bottomfish and coral reef commercial fisheries will not affect marine mammals in any manner not considered or authorized under the MMPA.

As described in Section 2.6.1.2, ESA consultation for newly listed elasmobranch species in the American Samoa bottomfish fishery is ongoing. There are no known interactions with oceanic whitetip shark or giant manta rays in this fishery.

Based on fishing effort and other characteristics described in Chapter 1 of this report, 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 and Precious Coral Fisheries

There are currently no crustacean or precious coral fisheries operating in federal waters around American Samoa. However, based on current ESA consultations, crustacean fisheries are not expected to interact with any ESA-listed species in federal waters around American Samoa. NMFS has also concluded that the American Samoa crustacean and precious coral commercial fisheries will not affect marine mammals in any manner not considered or authorized under the MMPA.

2.6.3 Identification of Emerging Issues

Table 32 summarizes current candidate ESA species, recent listing status, and post-listing activity (critical habitat designation and recovery plan development). Impacts from FEP-managed fisheries on any new listings and critical habitat designations will be considered in future versions of this report.

Table 32. Status of candidate ESA species, recent ESA listing processes, and post-listing activities

Species		Listing Process			Post-Listing Activity	
Common Name	**Scientific Name**	**90-Day Finding**	**12-Month Finding / Proposed Rule**	**Final Rule**	**Critical Habitat**	**Recovery Plan**
Oceanic whitetip shark	*Carcharhinus longimanus*	Positive (81 FR 1376, 1/12/2016)	Positive, threatened (81 FR 96304, 12/29/2016)	Listed as threatened (83 FR 4153, 1/30/2018)	Designation not prudent; no areas within U.S. jurisdiction that meet definition of critical habitat (85 FR 12898, 3/5/2020)	In development; recovery planning workshops convened in 2019.
Chambered nautilus	*Nautilus pompilius*	Positive (81 FR 58895, 8/26/2016)	Positive, threatened (82 FR 48948, 10/23/2017)	Listed as threatened (83 FR 48876, 9/28/2018)	Designation not prudent; no areas within U.S. jurisdiction that meet definition of critical habitat (85 FR 5197, 01/29/2020)	TBA
Giant manta ray	*Manta birostris*	Positive (81 FR 8874, 2/23/2016)	Positive, threatened (82 FR 3694, 1/12/2017)	Listed as threatened (83 FR 2916, 1/22/2018)	Designation not prudent; no areas within U.S. jurisdiction that meet definition of critical habitat (84 FR 66652, 12/5/2019)	Recovery outline published 12/4/19 to serve as interim guidance until full recovery plan is developed; recovery planning workshop planned for 2021.
Corals	N/A	Positive for 82 species (75 FR 6616, 2/10/2010)	Positive for 66 species (77 FR 73219, 12/7/2012)	20 species listed as threatened (79 FR 53851, 9/10/2014)	Critical habitat proposed (85 FR 76262, 11/27/2020), comment period extended through 5/26/2021 (86 FR 16325)	In development, interim recovery outline in place; recovery workshops convened in May 2021.

Species		Listing Process			Post-Listing Activity	
Common Name	**Scientific Name**	**90-Day Finding**	**12-Month Finding / Proposed Rule**	**Final Rule**	**Critical Habitat**	**Recovery Plan**
Giant clams	*Hippopus, H. porcellanus, Tridacna costata, T. derasa, T. gigas, T. Squamosa,* and *T. tevoroa*	Positive (82 FR 28946, 06/26/2017)	TBA (status review ongoing)	TBA	N/A	N/A
Green sea turtle	*Chelonia mydas*	Positive (77 FR 45571, 8/1/2012)	Identification of 11 DPSs, endangered and threatened (80 FR 15271, 3/23/2015)	11 DPSs listed as endangered and threatened (81 FR 20057, 4/6/2016)	In development, proposal expected TBA	TBA
Shortfin Mako Shark	*Isurus oxyrinchus*	Positive (86 FR 19863. 4/15/2021)	TBA (status review ongoing)	TBA	N/A	N/A

[a] NMFS and USFWS have been tasked with higher priorities regarding sea turtle listings under the ESA, and do not anticipate proposing green turtle critical habitat designations in the immediate future.

2.6.4 Identification of Research, Data, and Assessment Needs

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

- Improve species identification of commercial and non-commercial fisheries data (e.g., outreach, use FAO species codes) to improve understanding of potential protected species impacts.
- Define and evaluate innovative approaches to derive robust estimates of protected species interactions in insular fisheries.
- Conduct genetic and telemetry research to improve understanding of population structure and movement patterns for listed elasmobranchs.
- Estimates of post release survival for incidental protected species.

2.7 CLIMATE AND OCEANIC INDICATORS

2.7.1 Introduction

Over the past few years, the Council has incorporated climate change into the overall management of the fisheries over which it has jurisdiction. This 2020 annual SAFE report includes a now standard chapter on indicators of climate and oceanic conditions in the Western Pacific region. These indicators reflect global climate variability and change as well as trends in local oceanographic conditions.

The 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 are numerous:

- 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 as well as the development of a Climate Science Strategy by NMFS in 2015 and the subsequent development of the Pacific Islands Regional Action Plan for climate science; and
- The Council's own engagement with NOAA as well as jurisdictional fishery management agencies in American Samoa, CNMI, Guam, and Hawaii as well as fishing industry representatives and local communities in those jurisdictions.

In 2013, the Council began restructuring its Marine Protected Area/Coastal and Marine Spatial Planning Committee to include a focus on climate change, and the committee was renamed as the Marine Planning and Climate Change Committee (MPCCC). In 2015, based on recommendations from the committee, the Council adopted its Marine Planning and Climate Change Policy and Action Plan, which provided guidance to the Council on implementing climate change measures, including climate change research and data needs. The revised Pelagic FEP (February 2016) included a discussion on climate change data and research as well as a new objective (Objective 9) that states the Council should consider the implications of climate change in decision-making, with the following sub-objectives:

a) To identify and prioritize research that examines the effects of climate change on Council-managed fisheries and fishing communities.
b) To ensure climate change considerations are incorporated into the analysis of management alternatives.
c) To monitor climate change related variables via the Council's Annual Reports.
d) To engage in climate change outreach with U.S. Pacific Islands communities.

Beginning with the 2015 report, the Council and its partners began providing continuing descriptions of changes in a series of climate and oceanic indicators. The MPCCC was disbanded in early 2019, re-allocating its responsibilities among its members already on other committees or teams, such as the Fishery Ecosystem Plan Teams.

This annual report focuses previous years' efforts by refining existing indicators and improving communication of their relevance and status. Future reports will include additional indicators as the information becomes available and their relevance to the development, evaluation, and revision of the FEPs becomes clearer. 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.

2.7.2 Response to Previous Plan Team and Council Recommendations

There were no Council recommendations relevant to the climate and oceanic indicators section of the annual SAFE report for the American Samoa Archipelago in 2021.

2.7.3 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 impact 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).

As described in the 2014 NCADAC report, the conceptual model presents 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 were considered for inclusion in the Annual SAFE Reports, though the final list of indicators varied somewhat. Other indicators will be added over time as data become available and an understanding 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. This guide will ideally enable the Council and its partners to move forward from observations and correlations to understanding the specific nature of interactions, and to develop capabilities to predict future changes of importance in the developing, evaluating, and adapting of FEPs in the Western Pacific region.

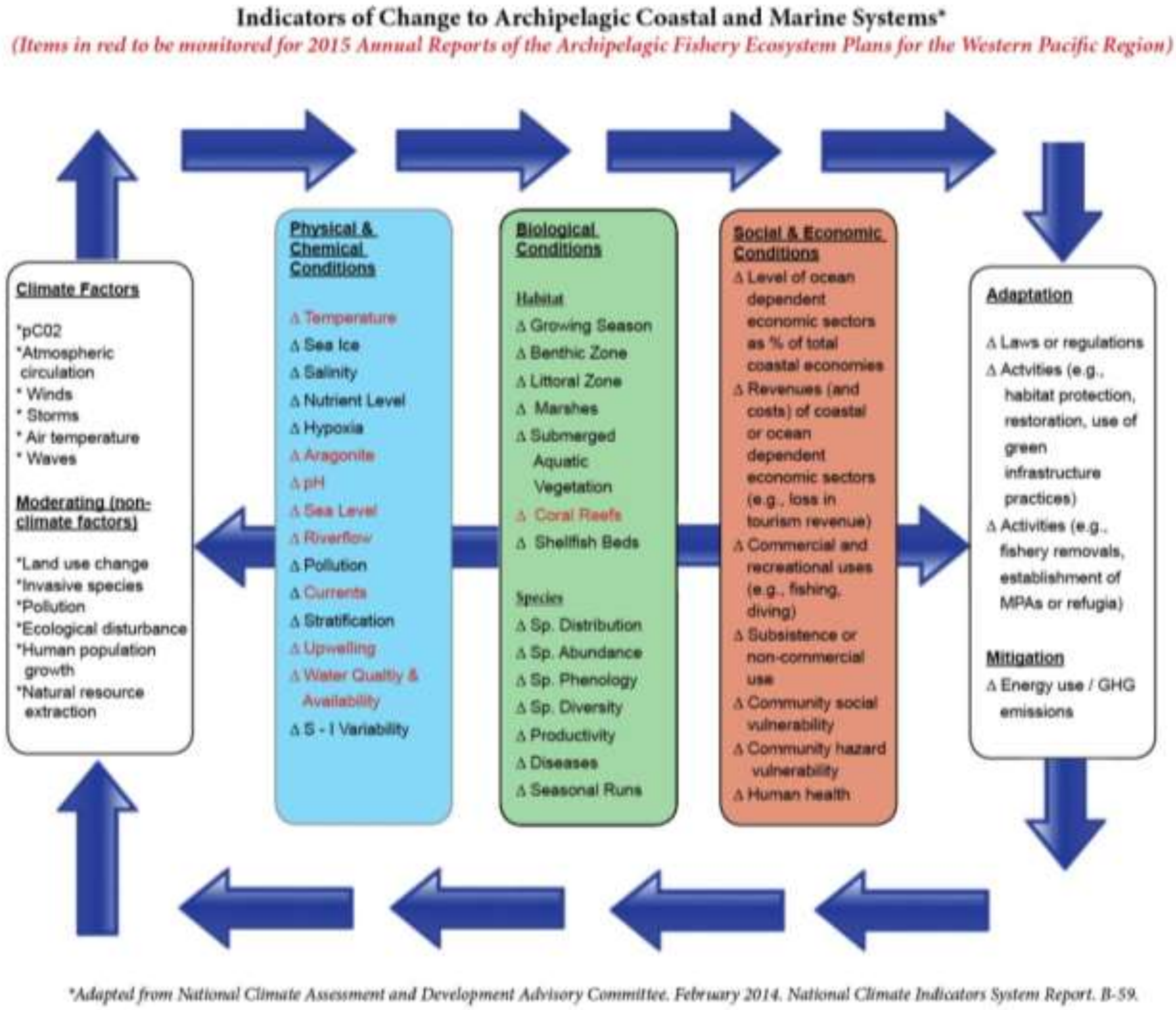

Figure 10. Indicators of change of archipelagic coastal and marine systems; conceptual model

2.7.4 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 considering changing climate;
- Provide historical context; and
- Recognize patterns and trends.

In this context, this section includes the following climate and oceanic indicators:

- Atmospheric concentration of carbon dioxide (CO_2)
- Oceanic pH at Station ALOHA;

- Oceanic Niño Index (ONI);
- Pacific Decadal Oscillation (PDO);
- Tropical cyclones;
- Sea surface temperature (SST);
- Coral Thermal Stress Exposure
- Chlorophyll-A
- Rainfall
- Sea Level (Sea Surface Height)

Figure 11 and Figure 12 provide a description of these indicators and illustrate how they are connected to each other in terms of natural climate variability and anthropogenic climate change.

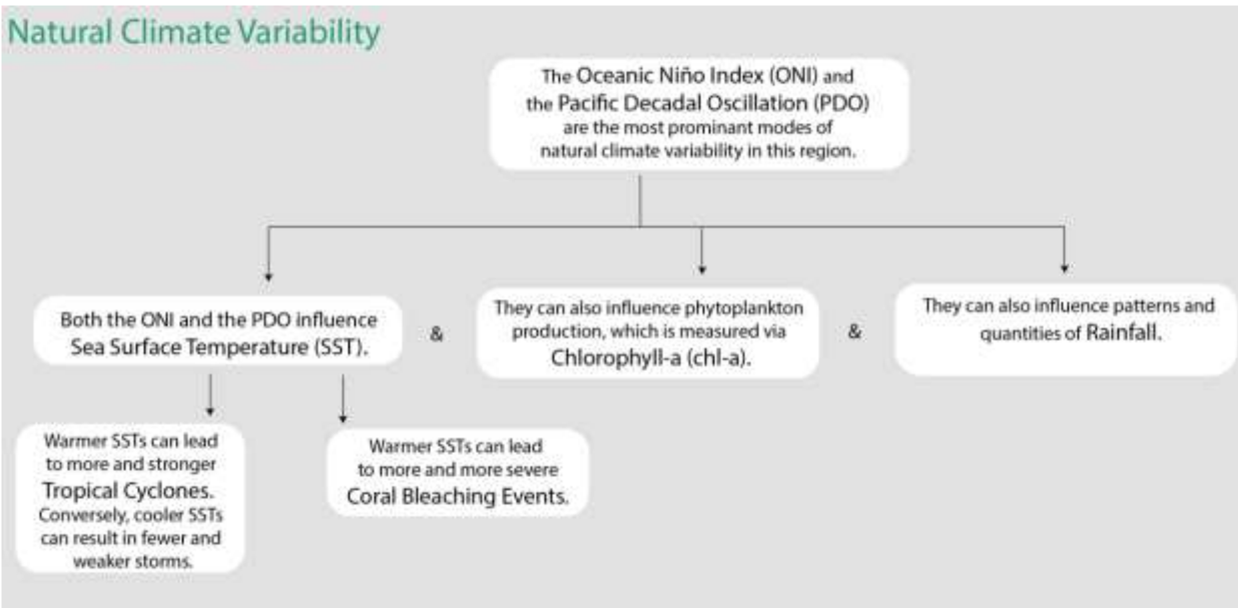

Figure 11. Schematic diagram illustrating how indicators are connected to one another and how they vary as a result of natural climate variability

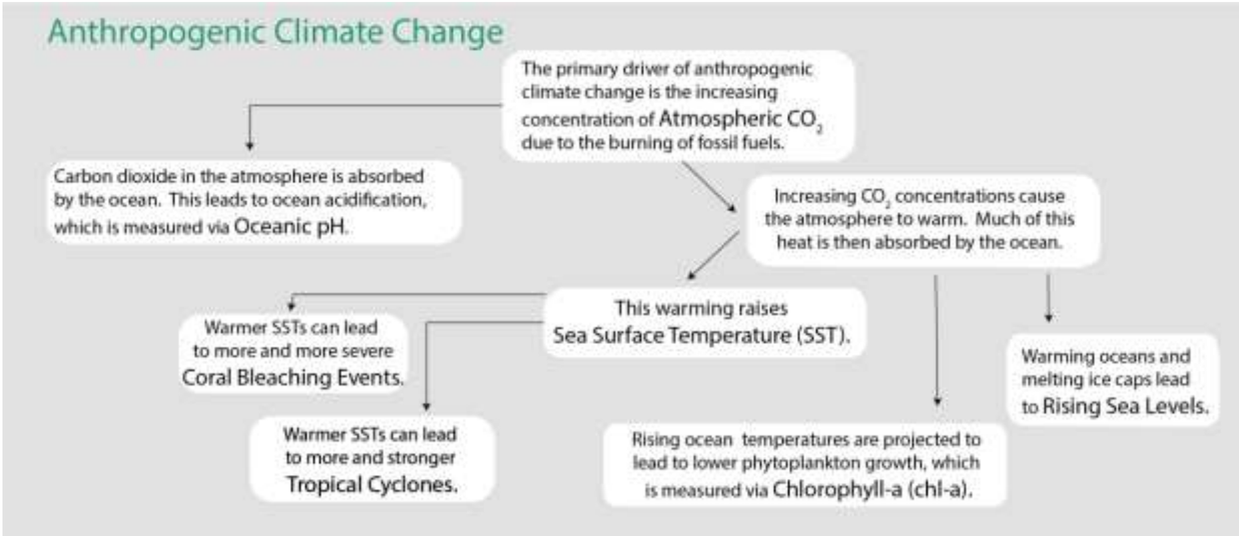

Figure 12 Schematic diagram illustrating how indicators are connected to one another and how they vary as a result of anthropogenic climate change

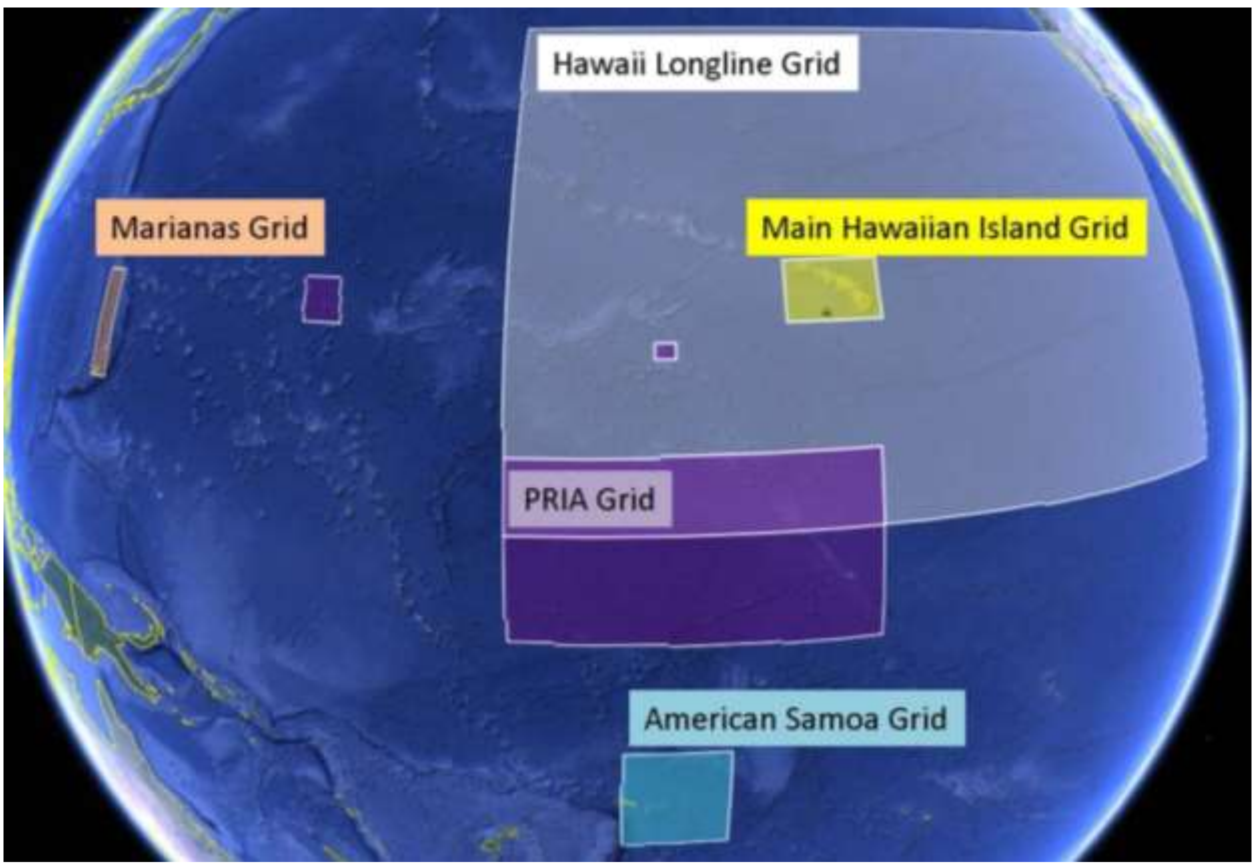

Figure 13. Regional spatial grids representing the scale of the climate change indicators being monitored

2.7.4.1 Atmospheric Concentration of Carbon Dioxide at Mauna Loa

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, warming influence) of greenhouse gases in the atmosphere has increased substantially over the last several decades.

Status: Atmospheric CO_2 is increasing exponentially. This means that atmospheric CO_2 is increasing more quickly over time. In 2021, the annual mean concentration of CO_2 was 416 ppm. This is the highest annual value recorded. This year also saw the highest monthly value, which was 419 ppm. In 1959, the first year of the time series, the atmospheric concentration of CO_2 was 316 ppm. The annual mean passed 350 ppm in 1988, and 400 ppm in 2015.

Description: Monthly mean atmospheric carbon dioxide (CO_2) at Mauna Loa Observatory, Hawaiʻi in parts per million (ppm) from March 1958 to present. The observed increase in monthly average carbon dioxide concentration is primarily due to CO_2 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 approximately one year. The annual variations at Mauna Loa, Hawaiʻi are due to the seasonal imbalance between the photosynthesis and respiration of terrestrial plants. During the summer growing season, photosynthesis exceeds respiration, and CO_2 is removed from the atmosphere. In the winter (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 its larger land mass.

Timeframe: Annual, monthly.

Region/Location: Mauna Loa, Hawaii, but representative of global atmospheric carbon dioxide concentration.

Measurement Platform: *In-situ* station.

Data available at: https://gml.noaa.gov/ccgg/trends/data.html.

Sourced from: Keeling et al. (1976), Thoning et al. (1989), and NOAA (2022a).

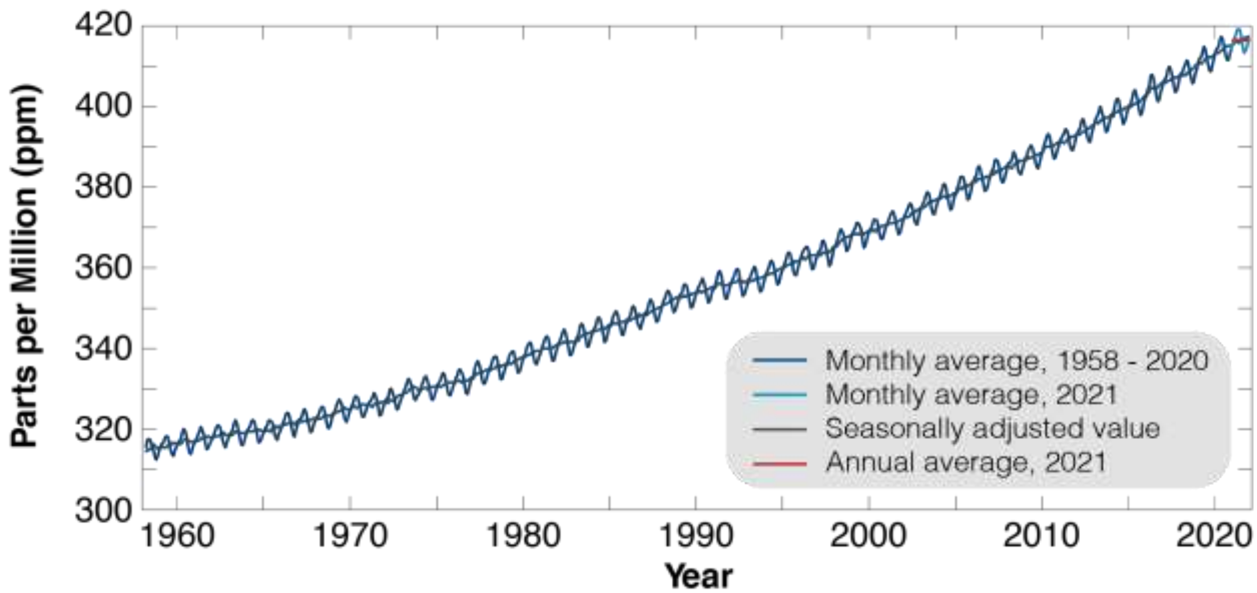

Figure 14. Monthly mean (black) and seasonally corrected (blue) atmospheric carbon dioxide at Mauna Loa Observatory, Hawaii

2.7.4.2 Oceanic pH

Rationale: Oceanic pH is a measure of how greenhouse gas emissions have already impacted the ocean. This indicator demonstrates that oceanic pH has decreased significantly over the past several decades (i.e., the ocean has become more acidic). Increasing ocean acidification limits the ability of marine organisms to build shells and other calcareous structures. Recent research has shown that pelagic organisms such as pteropods and other prey for commercially valuable fish species are already being negatively impacted by increasing acidification (Feely et al. 2016). The full impact of ocean acidification on the pelagic food web is an area of active research (Fabry et al. 2008).

Status: The ocean is roughly 10.2% more acidic than it was 30 years ago at the start of this time series. Over this time, pH has declined by 0.042 at a constant rate. In 2020, the most recent year for which data are available, the average pH was 8.07. Additionally, small variations seen over the course of the year are outside the range seen in the first year of the time series for the fourth year in a row. The highest pH value reported for the most recent year (8.077) is lower than the lowest pH value reported in the first year of the time series (8.083).

Description: Trends in surface (5 m) pH at Station ALOHA, north of Oahu (22.75°N, 158°W), collected by the Hawai‘i Ocean Time Series (HOT) from October 1988 to 2020 (2021 data are not yet available). Oceanic pH is a measure of ocean acidity, which increases as the ocean absorbs carbon dioxide from the atmosphere. Lower pH values represent greater acidity. Oceanic pH is calculated from total alkalinity (TA) and dissolved inorganic carbon (DIC). Total alkalinity represents the ocean’s capacity to resist acidification as it absorbs CO_2 and the amount of CO_2 absorbed is captured through measurements of DIC. The multi-decadal time series at Station ALOHA represents the best available documentation of the significant downward trend in oceanic pH since the time series began in 1988. Oceanic pH varies over both time and space, though the conditions at Station ALOHA are considered broadly representative of those across the Western and Central Pacific’s pelagic fishing grounds.

Timeframe: Monthly.

Region/Location: Station ALOHA: 22.75°N, 158°W.

Measurement Platform: *In-situ* station.

Data available at: https://hahana.soest.hawaii.edu/hot/hot-dogs/bseries.html.

Sourced from: Fabry et al. (2008), Feely et al. (2016), and the Hawai'i Ocean Time Series as described in Karl and Lukas (1996) and on its website (HOT 2022) using the methodology provided by Zeebe and Wolf-Gladrow (2001).

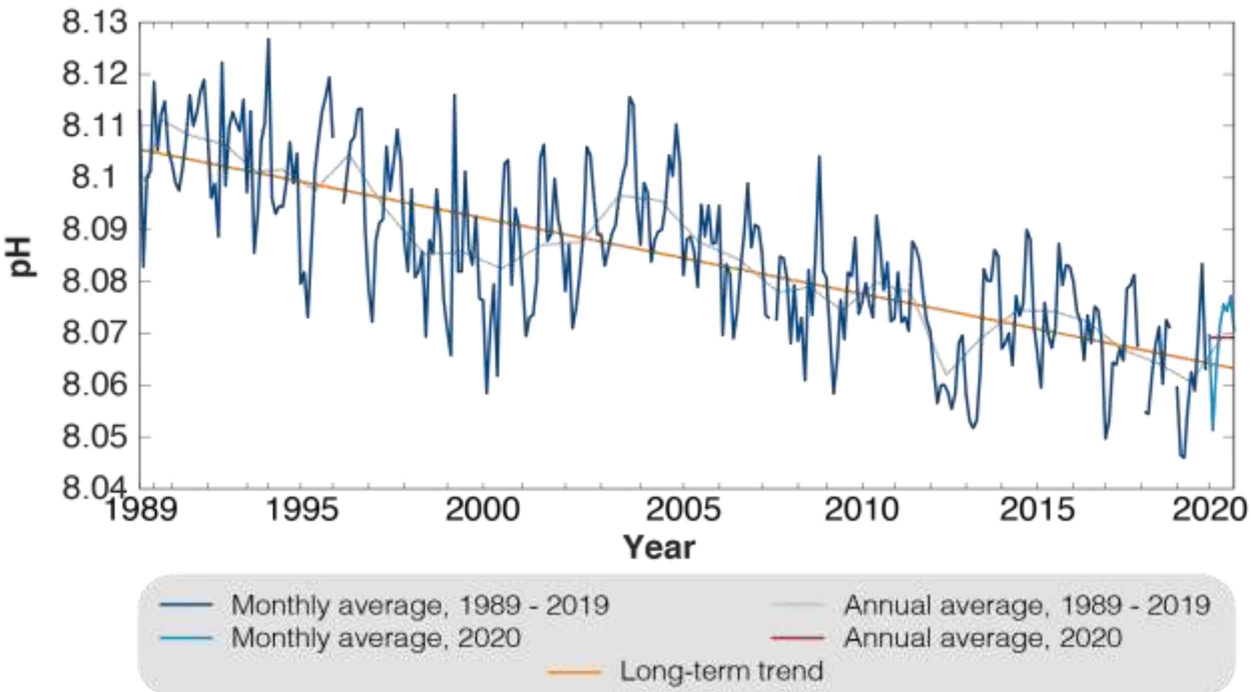

Figure 15. Time series and long-term trend of oceanic pH measured at Station ALOHA from 1989-2020

2.7.4.3 Oceanic Niño Index

Rationale: The El Niño – Southern Oscillation (ENSO) cycle is known to have impacts on Pacific fisheries including tuna fisheries. The ONI focuses on ocean temperature, which has the most direct effect on these fisheries.

Status: The ONI indicated La Niña conditions for most of 2021, with two consecutive neutral seasons punctuating the year mid-year. In 2021, the ONI ranged from -1.1 to -0.0.4. This is within the range of values observed previously in the time series.

Description: The three-month running mean (referred to as a season) of satellite remotely-sensed sea surface temperature (SST) anomalies in the Niño 3.4 region (5°S – 5°N, 120° – 170°W). The Oceanic Niño Index (ONI) is a measure of the El Niño – Southern Oscillation (ENSO) phase. Warm and cool phases, termed El Niño and La Niña respectively, are based in part on an ONI threshold of ± 0.5 °C being met for a minimum of five consecutive overlapping seasons. Additional atmospheric indices are needed to confirm an El Niño or La Niña event, as the ENSO is a coupled ocean-atmosphere phenomenon. The atmospheric half of ENSO is measured using the Southern Oscillation Index.

Timeframe: Every three months.

Region/Location: Niño 3.4 region, 5°S – 5°N, 120° – 170°W.

Measurement Platform: *In-situ* station, satellite, model.

Data available at: https://www.cpc.ncep.noaa.gov/data/indices/oni.ascii.txt.

Sourced from NOAA CPC (2022).

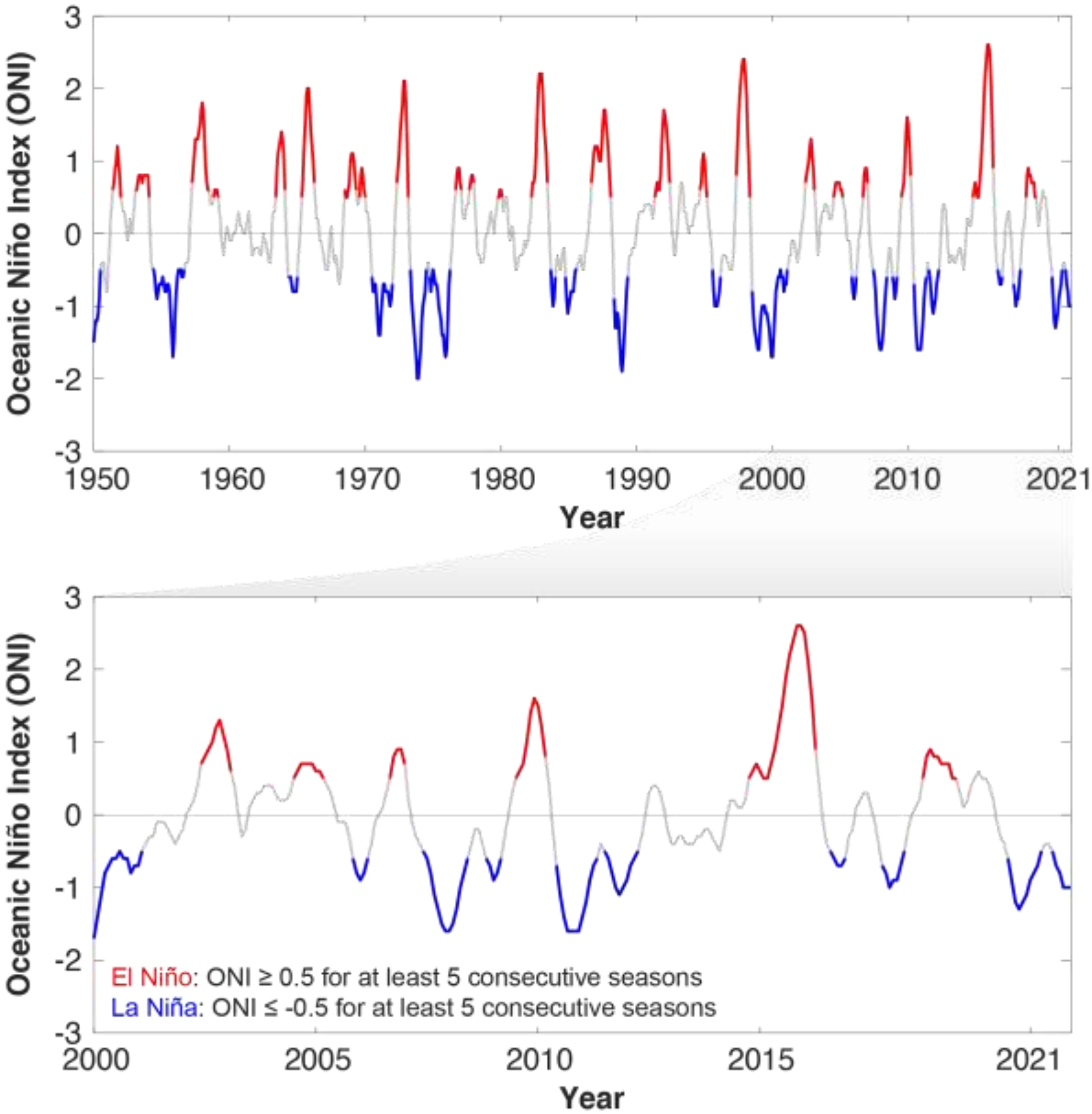

Figure 16. Oceanic Niño Index from 1950-2021 (top) and 2000-2021 (bottom) with El Niño periods in red and La Niña periods in blue

2.7.4.4 Pacific Decadal Oscillation

Rationale: The Pacific Decadal Oscillation (PDO) was initially named by fisheries scientist Steven Hare in 1996 while researching connections between Alaska salmon production cycles and Pacific climate. Like ENSO, the PDO reflects changes between periods of persistently warm or persistently cool ocean temperatures, but over a period of 20 to 30 years (versus six to 18 months for ENSO events). The climatic fingerprints of the PDO are most visible in the Northeastern Pacific, but secondary signatures exist in the tropics.

Status: The PDO was negative in 2021. The index ranged from -2.66 to -0.56 over the course of the year. This is within the range of values observed previously in the time series.

Description: The PDO is often described as a long-lived El Niño-like pattern of Pacific climate variability. As seen with the better-known ENSO, extremes in the PDO pattern are marked by widespread variations in the Pacific Basin and the North American climate. In parallel with the ENSO phenomenon, the extreme cases of the PDO have been classified as either warm or cool, as defined by ocean temperature anomalies in the northeast and tropical Pacific Ocean. When SST is below average in the [central] North Pacific and warm along the North American coast, and when sea level pressures are below average in the North Pacific, the PDO has a positive value. When the climate patterns are reversed, with warm SST anomalies in the interior and cool SST anomalies along the North American coast, or above average sea level pressures over the North Pacific, the PDO has a negative value. Description inserted from NOAA (2021b).

Timeframe: Annual, monthly.

Region/Location: Pacific Basin north of 20°N.

Measurement Platform: *In-situ* station, satellite, model.

Data available at: https://psl.noaa.gov/pdo/.

Sourced from: NOAA (2022b), Mantua (1997), and Newman (2016).

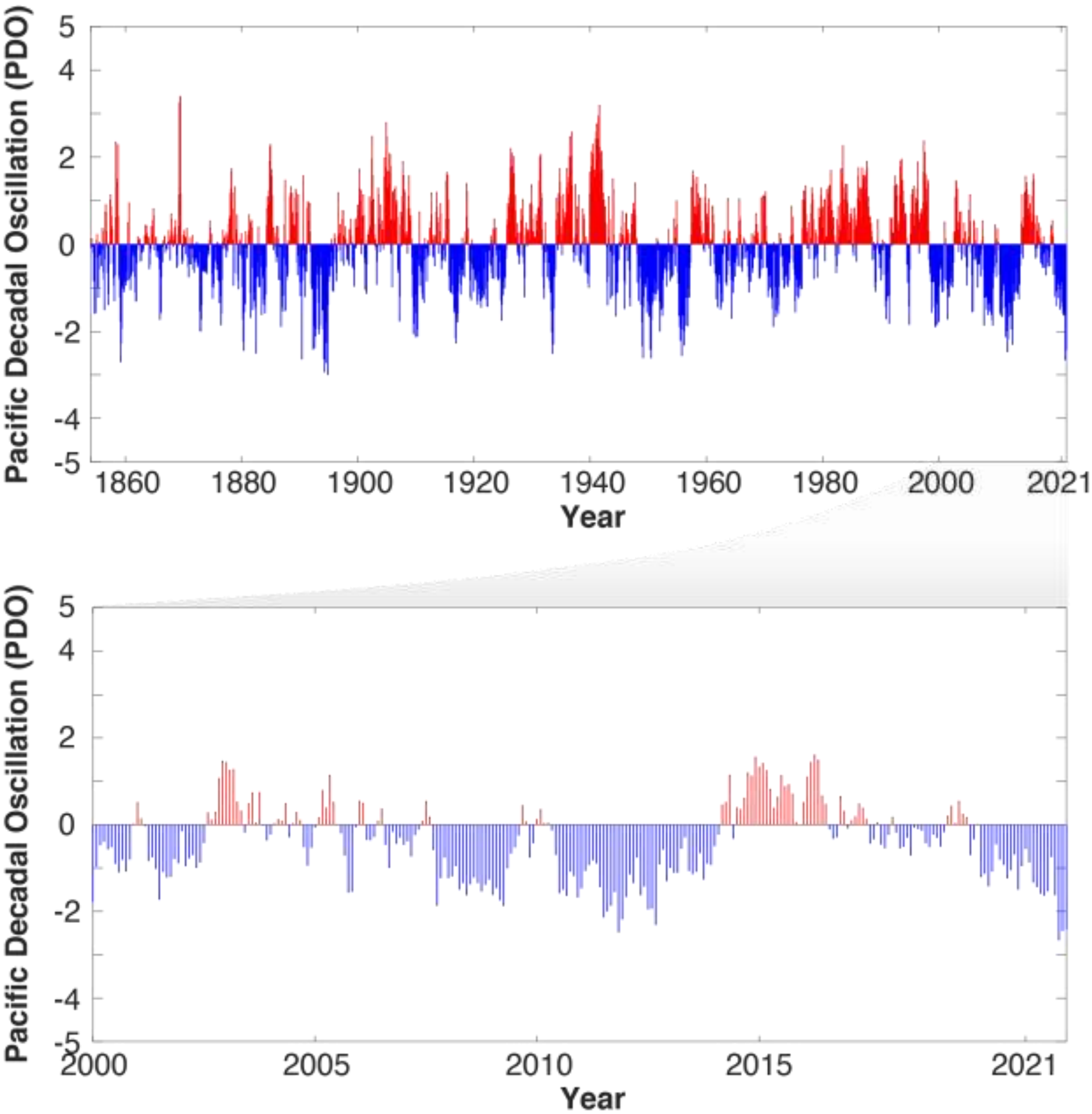

Figure 17. Pacific Decadal Oscillation from 1950-2021 (top) and 2000-2021 (bottom) with positive warm periods in red and negative cool periods in blue

2.7.4.5 Tropical Cyclones

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 Hawaiʻi longline fishery, for example, has had serious problems 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. Associated storm surge, the large volume of ocean water pushed toward shore by cyclones' strong winds, can cause severe flooding and destruction.

Status:

Eastern North Pacific. In the East Pacific in 2021, the 19 named storms and eight hurricanes were both near normal. However, only two storms became major hurricanes, which is less than half of normal. The Accumulated Cyclone Energy (ACE) was also about 30% below the 1991–2020 average. The beginning and end of the hurricane season were noteworthy. The East Pacific had four named storms in June, which tied for the 4th most on record. The total of five for the year through June tied a record as well. Additionally, two tropical cyclones formed in November in the eastern Pacific basin. Based on a 30-year climatology (1991–2020), one named storm typically forms in November every second or third year. However, this is the fourth straight November with at least one named storm forming. In addition, both Sandra and Terry were tropical storms simultaneously, which is the first time this has occurred in the eastern Pacific in November.

Summary inserted from https://www.ncdc.noaa.gov/sotc/tropical-cyclones/202113#summary, https://www.nhc.noaa.gov/text/MIATWSEP.shtml, and https://www.ncdc.noaa.gov/sotc/tropical-cyclones/202106.

Central North Pacific. Tropical cyclone activity in the central Pacific in 2021 was below the 1991–2020 average. There was only one named storm, which did not reach hurricane status. However, the remnants of the Eastern Pacific's Hurricane Linda caused heavy rainfall over the main Hawaiian Islands in August. On average (1991–2020), the central Pacific sees four named storms, two hurricanes, and one major hurricanes. The 2021 ACE index was about two orders of magnitude, or roughly 100 times, below the 1991–2020 average. Information on Hurricane Linda inserted from https://www.ncdc.noaa.gov/sotc/tropical-cyclones/202108.

Western North Pacific. Tropical cyclone activity was below the 1991–2020 average in 2021. The 23 named storms in the West Pacific in 2021 was near normal (1991–2020), but the ten typhoons and five typhoons were both among the five lowest years since 1981. The ACE was also about 30% below the 1991–2020 average in the West Pacific. Portions of the summary inserted from https://www.ncdc.noaa.gov/sotc/tropical-cyclones/202113#summary

South Pacific. Tropical cyclone activity in the South Pacific was roughly average in 2021. The 10 named storms, 4 cyclones, and 2 major cyclones were very close to the 1991–2020 average of 9 named storms, 5 cyclones and 2 major cyclones. The 2021 ACE index was also close to the 1991–2020 average. Of note, the South Pacific produced two named storms in late January, including Tropical Cyclone Ana. Ana brought heavy rain and flooding to Fiji, which has been impacted by an unusual number of tropical cyclones in 2020–2021. Portions of the summary inserted from https://www.ncdc.noaa.gov/sotc/tropical-cyclones/202101

Description: This indicator uses historical data from the NOAA National Climate Data Center (NCDC) International Best Track Archive for Climate Stewardship to track the number of tropical cyclones in the western, central, eastern, and southern Pacific basins. This indicator also monitors the Accumulated Cyclone Energy (ACE) Index and the Power Dissipation Index 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 each basin is tracked and Figure 18 shows the representative breakdown of Saffir-Simpson hurricane categories.

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 knots; 39 mph). Therefore, a storm's ACE Index value accounts for both strength and duration. Figure 19 shows the ACE values for each hurricane/typhoon season and has a horizontal line representing the average annual ACE value.

Timeframe: Annual.

Region/Location:

Eastern North Pacific: east of 140° W, north of the equator.

Central North Pacific: 180° - 140° W, north of the equator.

Western North Pacific: west of 180°, north of the equator.

South Pacific: south of the equator.

Measurement Platform: Satellite.

Data available at: https://www.ncei.noaa.gov/data/international-best-track-archive-for-climate-stewardship-ibtracs/v04r00/access/csv.

Sourced from: Knapp et al. (2010), Knapp et al. (2018), and NOAA (2022c).

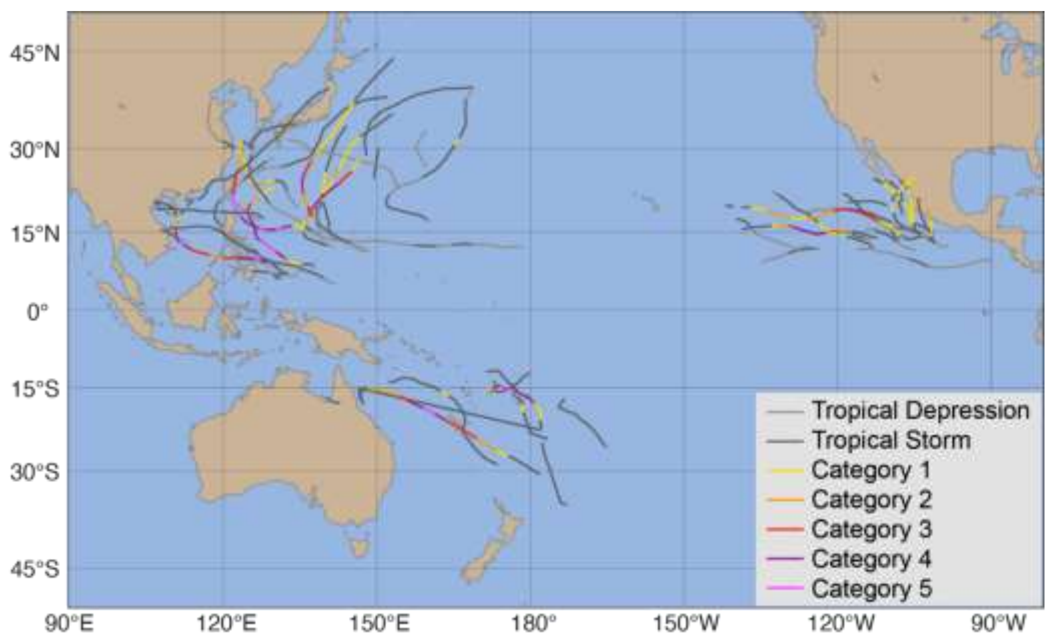

Figure 18. 2021 Pacific basin tropical cyclone tracks

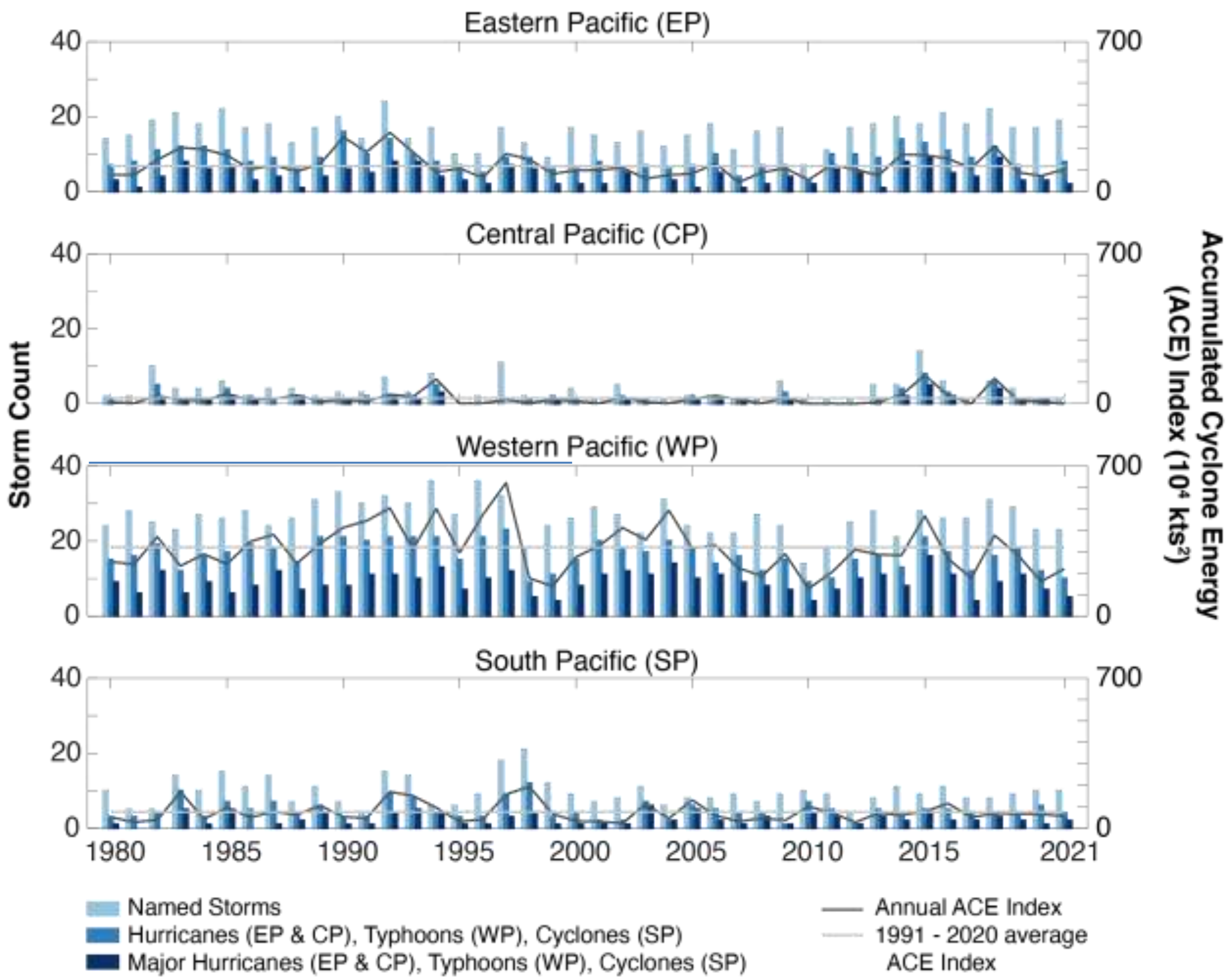

Figure 19. 2021 tropical storm totals by region

2.7.4.6 Sea Surface Temperature and Anomaly

Rationale: Sea surface temperature (SST) is one of the most directly observable existing measures for tracking increasing ocean temperatures. SST varies in response to natural climate cycles such as the El Niño – Southern Oscillation (ENSO) and is projected to rise as a result of anthropogenic climate change. Both short-term variability and long-term trends in SST impact the marine ecosystem. Understanding the mechanisms through which organisms are impacted and the time scales of these impacts is an area of active research.

Status*:* Annual mean SST was 28.78ºC in 2021. Over the period of record, annual SST has increased at a rate of 0.022 ºC/yr. Monthly SST values in 2021 ranged from 28.02–29.36 ºC, within the climatological range of 26.55–29.96 ºC. The annual anomaly was 0.22 ºC hotter than average, with a small area that was cooler than the average in the north-east part of the region.

Note that from the top to bottom in Figure 20, panels show climatological SST (1985–2020), 2021 SST anomaly, time series of monthly mean SST, and time series of monthly SST anomaly. The white box in the upper panels indicates the area over which SST is averaged for the time series plots.

Description: Satellite remotely-sensed monthly sea surface temperature (SST) is averaged across the American Samoa Grid (10° – 17.5°S, 165° – 172°W). A time series of monthly mean SST averaged over the American Samoa Grid Region is presented. Additionally, spatial climatology and anomalies are shown. Data from NOAA Coral Reef Watch CoralTemp v3.1 (NOAA, 2020c).

Timeframe: Monthly.

Region/Location: American Samoa Grid (10° – 17.5°S, 165° – 172°W).

Measurement Platform: Satellite.

Sourced from: NOAA OceanWatch (2022a).

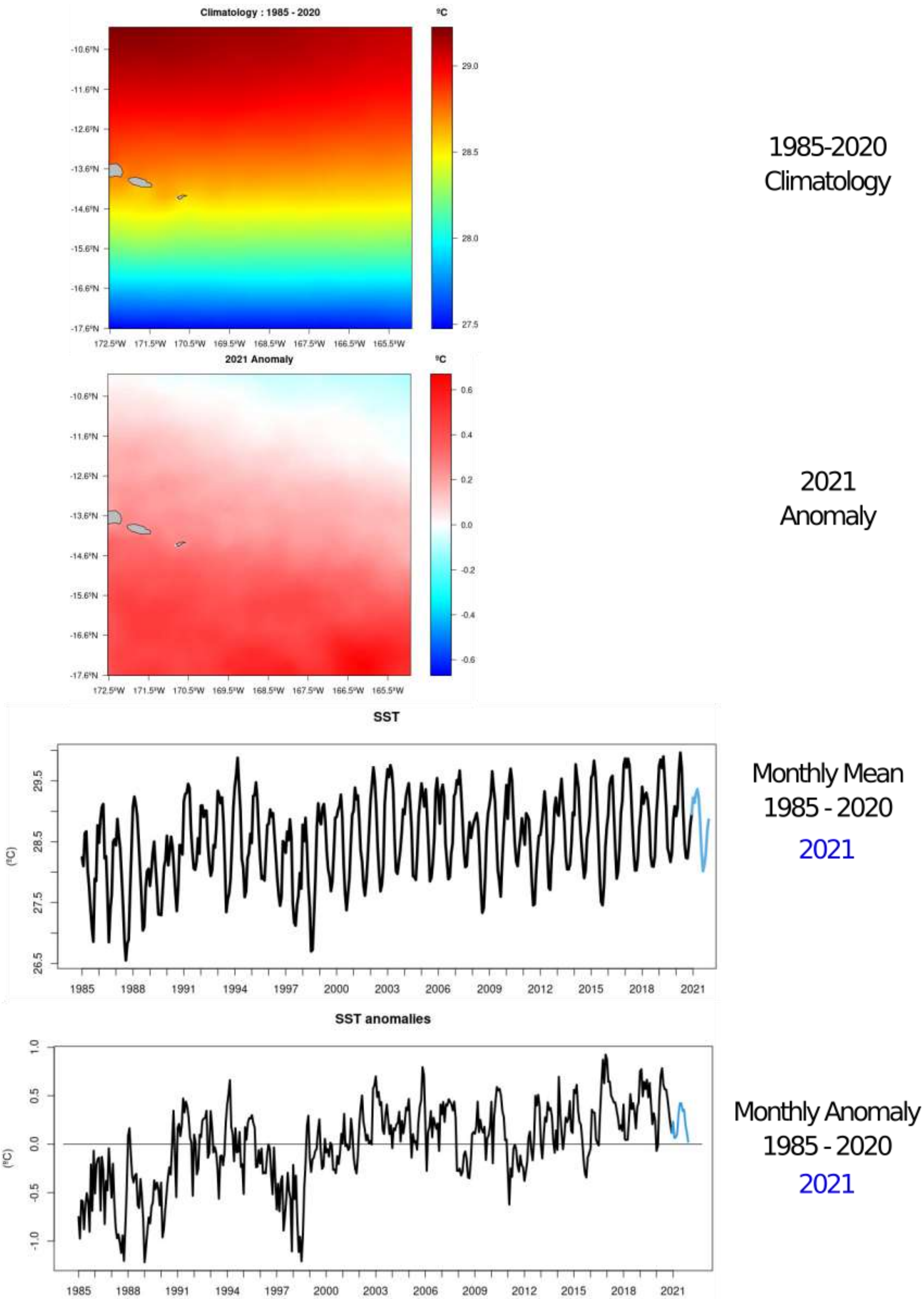

Figure 20. Sea surface temperature climatology and anomalies from 1985-2021

2.7.4.7 Coral Thermal Stress Exposure: Degree Heating Weeks

Rationale: Degree heating weeks are one of the most widely used metrics for assessing exposure to coral bleaching-relevant thermal stress.

Status: After a series of stress events in 2014, 2015, 2016, 2017 and 2019, the Samoas experienced little coral heat stress in 2021.

Description: Here we present a metric of exposure to thermal stress that is relevant to coral bleaching. Degree Heating Weeks (DHW) measure time and temperature above a reference 'summer maximum', presented as rolling sum weekly thermal anomalies over a 12-week period. Higher DHW measures imply a greater likelihood of mass coral bleaching or mortality from thermal stress.

The NOAA Coral Reef Watch program uses satellite data to provide current reef environmental conditions to quickly identify areas at risk for coral bleaching. Bleaching is the process by which corals lose the symbiotic algae that give them their distinctive colors. If a coral is severely bleached, disease and death become likely.

The NOAA Coral Reef Watch (CRW) daily 5-km satellite coral bleaching Degree Heating Week (DHW) product presented here shows accumulated heat stress, which can lead to coral bleaching and death. The scale goes from 0 to 20 °C-weeks. The DHW product accumulates the instantaneous bleaching heat stress (measured by Coral Bleaching HotSpots) during the most-recent 12-week period. It is directly related to the timing and intensity of coral bleaching. Significant coral bleaching usually occurs when DHW values reach 4 °C-weeks. By the time DHW values reach 8 °C-weeks, widespread bleaching is likely and significant mortality can be expected (NOAA Coral Reef Watch 2022).

Timeframe: 2014-2021, Daily data.

Region/Location: Global.

Sourced from: NOAA Coral Reef Watch (2022).

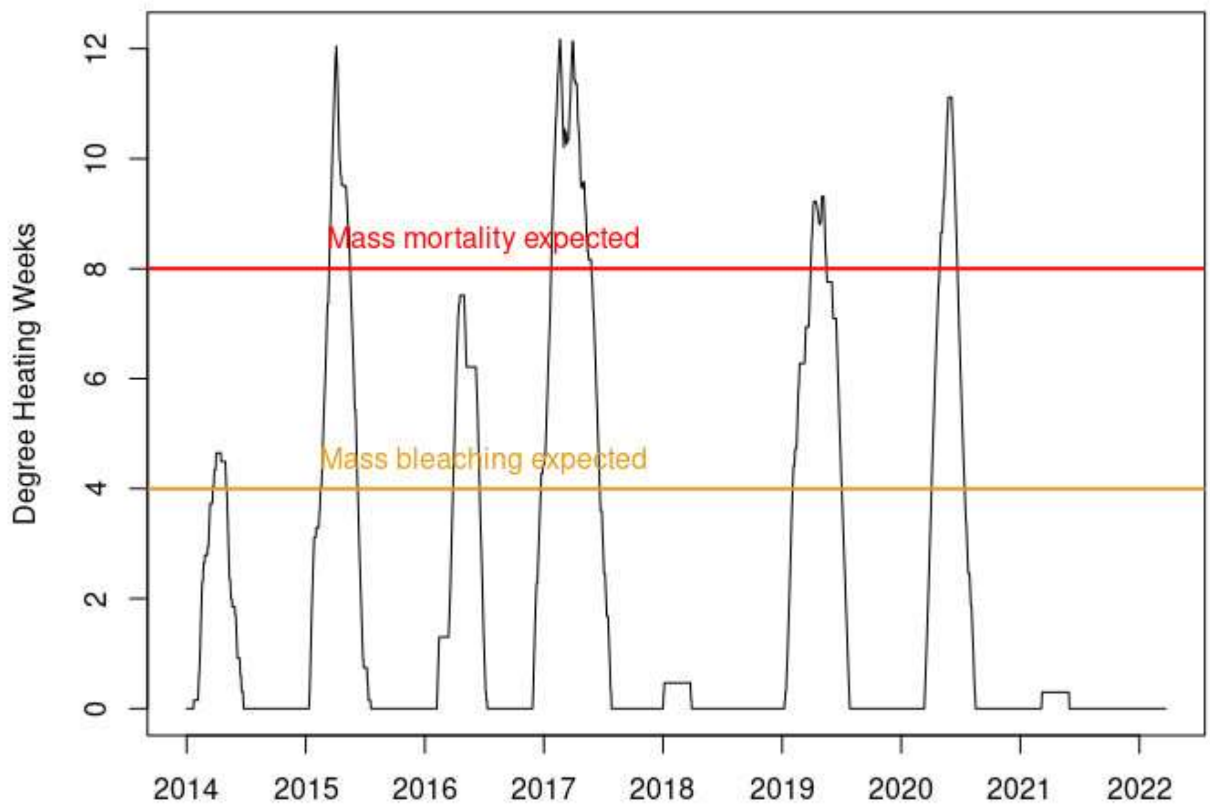

Figure 21. Coral Thermal Stress Exposure measured at Samoa Virtual Station 2014-2021 (Coral Reef Watch Degree Heating Weeks)

2.7.4.8 Chlorophyll-*a* and Anomaly

Rationale: Chlorophyll-*a* is one of the most directly observable measures we have for tracking increasing ocean productivity.

Status: Annual mean chlorophyll-*a* was 0.064 mg/m^3 in 2021. Over the period of record, annual chlorophyll-*a* has shown no significant temporal trend. Monthly chlorophyll-*a* values in 2021 ranged from 0.047–0.075 mg/m3, within the climatological range of 0.036–0.090 mg/m^3. The annual anomaly was 0.0062 mg/m^3 higher than average, with an area of below average chlorophyll concentration in the central section of the region.

Description: Chlorophyll-*a* concentration from 1998–2021 derived from the ESA Ocean Color Climate Change Initiative dataset, v5.0. A monthly climatology was generated across the entire period (1998–2020) to provide both a 2021 spatial anomaly and an anomaly time series.

ESA Ocean Color Climate Change Initiative dataset is a merged dataset, combining data from SeaWIFS, MODIS-Aqua, MERIS, and VIIRS to provide a homogeneous time-series of ocean color. Data was accessed from the OceanWatch Central Pacific portal.

Timeframe: 1998–2021, Daily data available, Monthly means shown.

Region/Location: Global.

Measurement Platform: SeaWIFS, MODIS-Aqua, MERIS, and VIIRS.

Sourced from: NOAA OceanWatch (2022b).

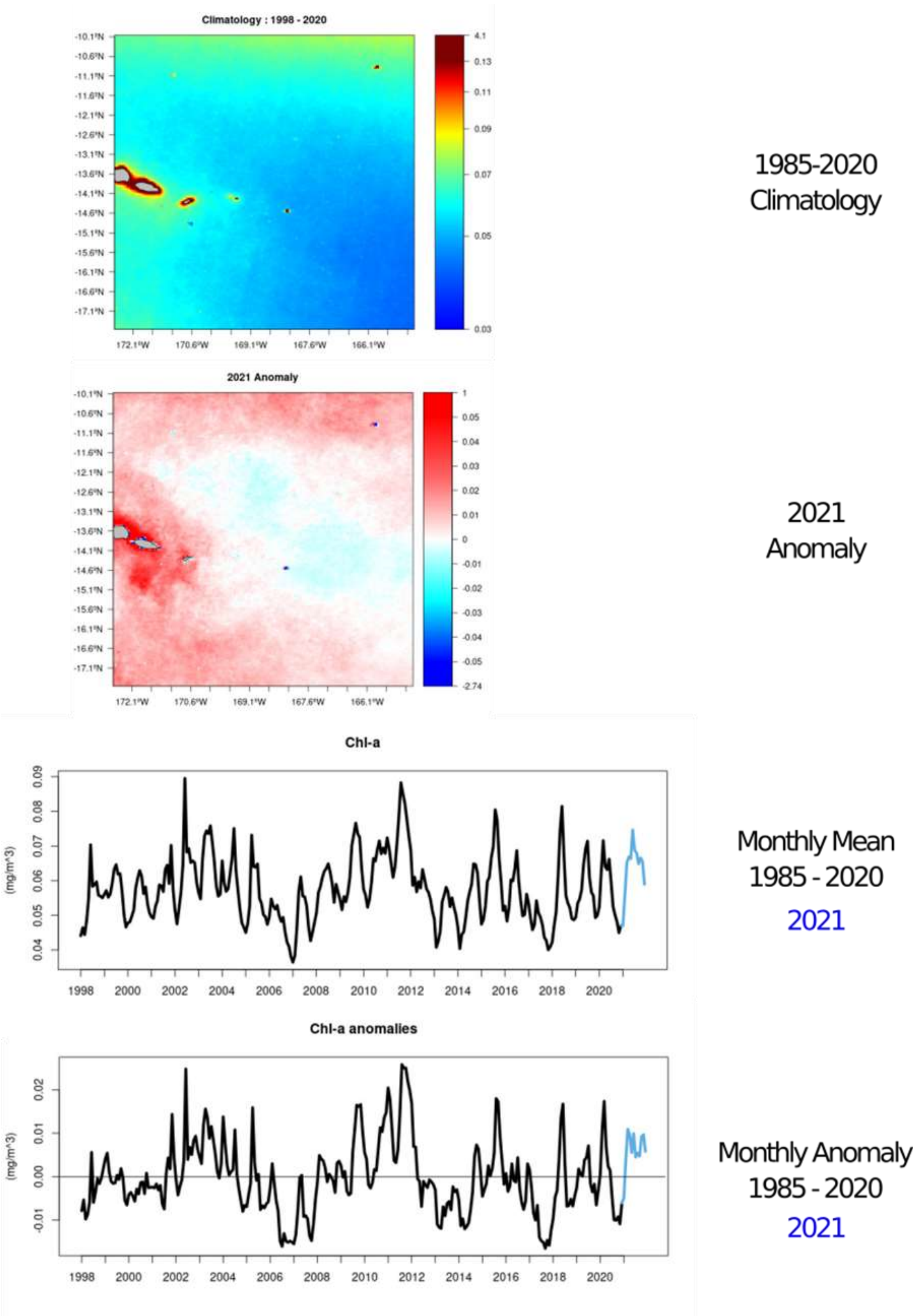

Figure 22. Chlorophyll-*a* and Chlorophyll-*a* Anomaly from 1998-2021

2.7.4.9 Rainfall

Rationale: Rainfall may have substantive effects on the nearshore environment and is a potentially important co-variate with the landings of stocks.

Description: The CPC Merged Analysis of Precipitation (CMAP) is a technique which produces pentad and monthly analyses of global precipitation in which observations from rain gauges are merged with precipitation estimates from several satellite-based algorithms, such as infrared and microwave (NOAA 2002). The analyses are on a 2.5 x 2.5-degree latitude/longitude grid and extend back to 1979. CMAP Precipitation data are provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, from their website at https://www.esrl.noaa.gov/psd/. The data are comparable (but should not be confused with) similarly combined analyses by the Global Precipitation Climatology Project described in Huffman et al. (1997).

It is important to note that the input data sources to make these analyses are not constant throughout the period of record. For example, SSM/I (passive microwave - scattering and emission) data became available in July 1987; prior to that the only microwave-derived estimates available are from the MSU algorithm (Spencer1993) which is emission-based thus precipitation estimates are available only over oceanic areas. Furthermore, high temporal resolution IR data from geostationary satellites (every 3-hr) became available during 1986; prior to that, estimates from the OPI technique (Xie and Arkin 1997) are used based on OLR from orbiting satellites.

The merging technique is thoroughly described in Xie and Arkin (1997). Briefly, the methodology is a two-step process. First, the random error is reduced by linearly combining the satellite estimates using the maximum likelihood method, in which case the linear combination coefficients are inversely proportional to the square of the local random error of the individual data sources. Over global land areas the random error is defined for each time period and grid location by comparing the data source with the rain gauge analysis over the surrounding area. Over oceans, the random error is defined by comparing the data sources with the rain gauge observations over the Pacific atolls. Bias is reduced when the data sources are blended in the second step using the blending technique of Reynolds (1988).

Timeframe: Monthly.

Region/Location: Global.

Measurement Platform: *In-situ* station gauges and satellite data.

Sourced from: APDRC (2022).

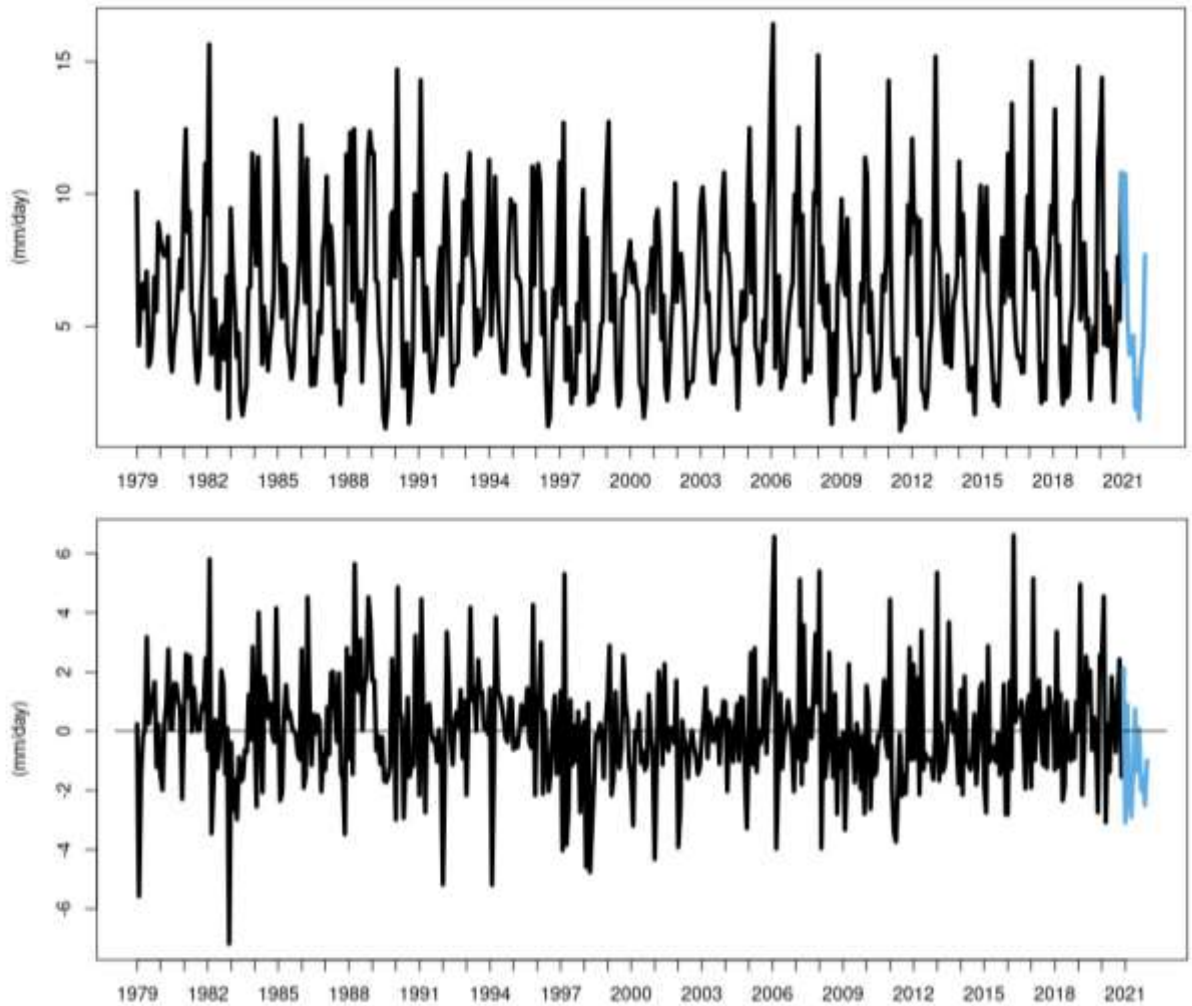

Figure 23. CMAP precipitation (top) and anomaly (bottom) across the American Samoa Longline Grid with 2021 values in blue

2.7.4.10 Sea Level (Sea Surface Height and Anomaly)

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

Description: Monthly mean sea level time series of local and basin-wide sea surface height and sea surface height anomalies, including extremes.

Timeframe: Monthly.

Region/Location: Observations from selected sites within the Samoan Archipelago.

Measurement Platform: Satellite and *in situ* tide gauges.

Sourced from: Aviso (2022), NOAA (2022d), and NOAA CoastWatch (2022).

2.7.4.10.1 Basin-Wide Perspective

This image of the mean sea level anomaly for March 2021 compared to 1993-2016 climatology from satellite altimetry provides a glimpse into the 2021 weak La Niña conditions across the Pacific Basin. The image captures the fact that sea level is higher in the Western Pacific and lower in the Central and Eastern Pacific (this basin-wide perspective provides a context for the location-specific sea level/sea surface height images that follow).

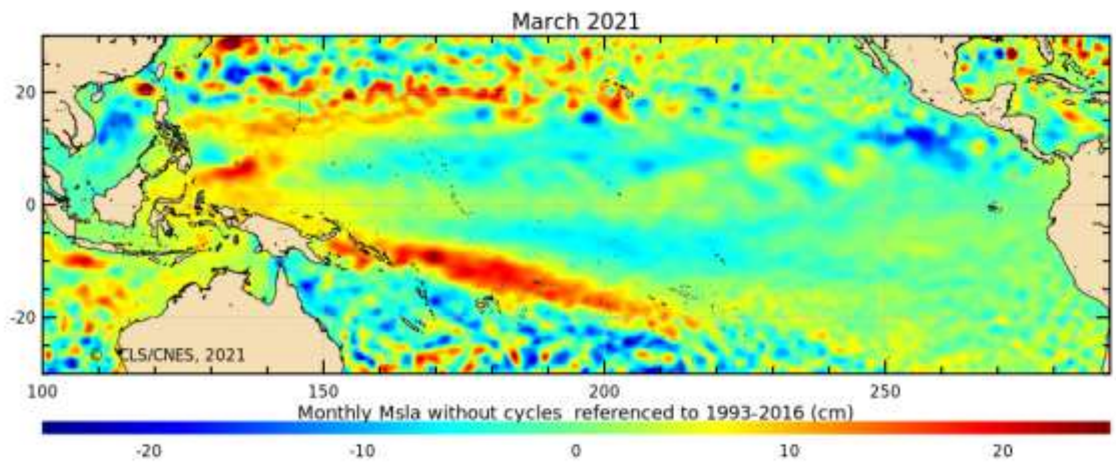

Figure 24a. Sea surface height and anomaly

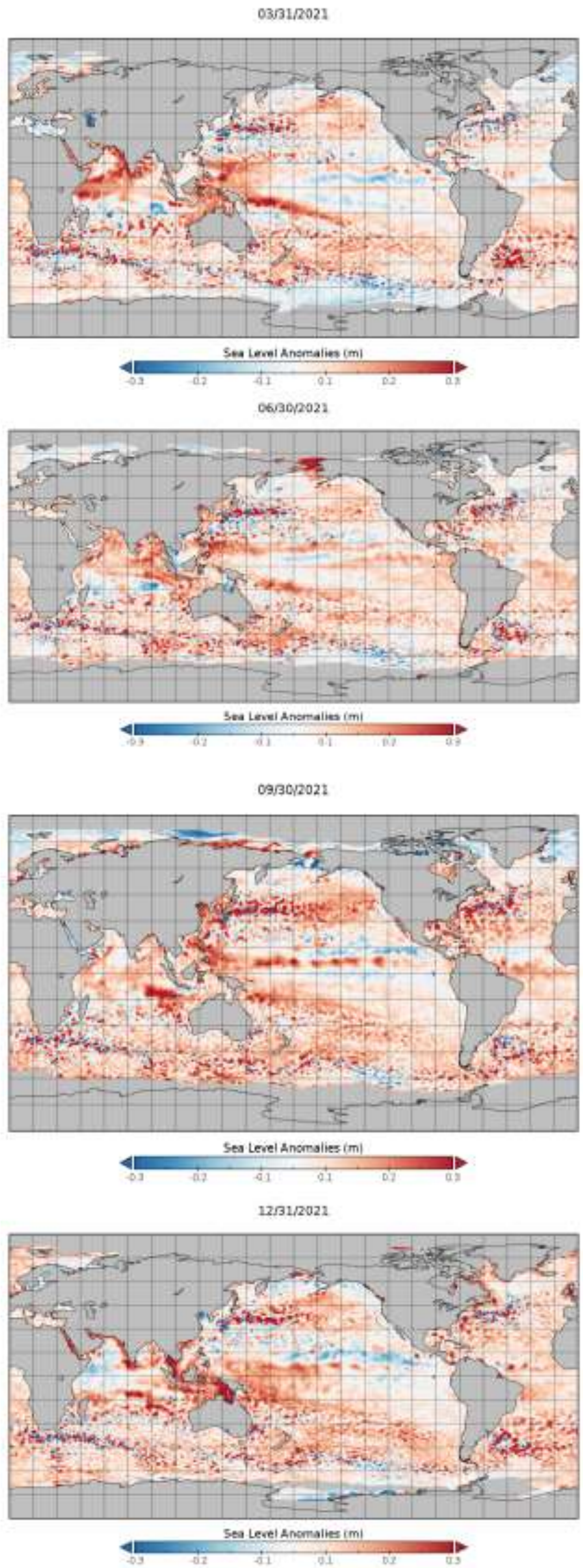

Figure 24b. Quarterly time series of mean sea level anomalies during 2021.

Altimetry data are provided by the NOAA Laboratory for Satellite Altimetry, accessed from NOAA CoastWatch (2022).

2.7.4.10.2 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 Center for Operational Oceanographic Products and Services, or CO-OPS).

The following figures and descriptive paragraphs were inserted from the NOAA Tides and Currents website (NOAA 2022d). Figure 25 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. 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.

The relative sea level trend is 2.41 millimeters/year with a 95% confidence interval of +/- 0.8 mm/yr based on monthly mean sea level data from 1948 to 2009 which is equivalent to a change of 0.79 feet in 100 years. The trend is based only on data before September 2009 earthquake.

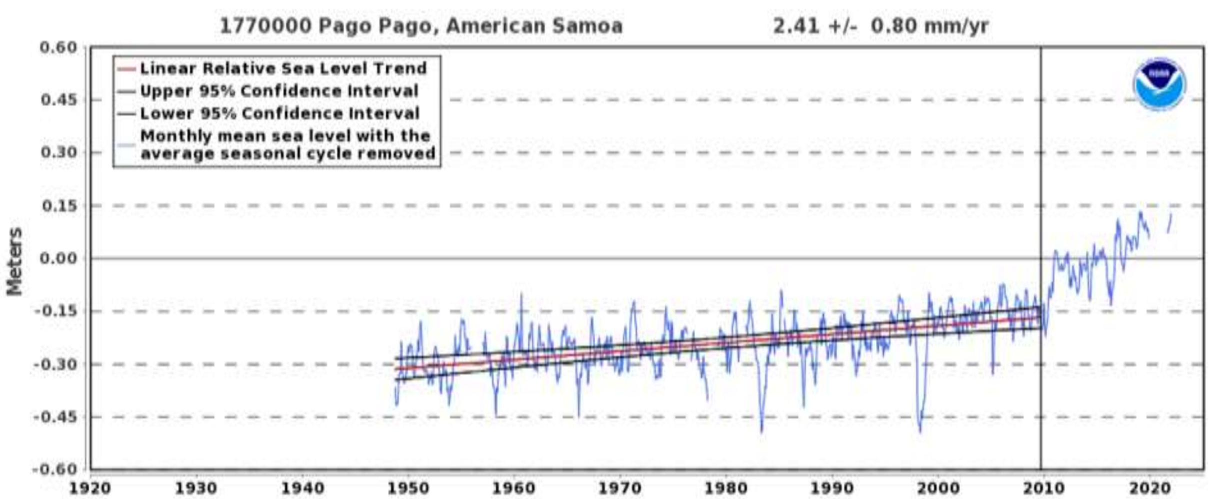

Figure 25. Monthly mean sea level without regular seasonal variability due to coastal ocean temperatures, salinities, winds, atmospheric pressures, and ocean currents

Source: https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=1770000.

2.8 ESSENTIAL FISH HABITAT

2.8.1 Introduction

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) 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 MSA 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.

NMFS and the regional fishery management councils must describe and identify EFH in fishery management plans (FMPs) or fishery ecosystem plans (FEPs), 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. Fishery management actions must be evaluated for impacts to all EFH and HAPC in the area of effect and not just the EFH and HAPC for the fishery to which the management action applies.

The EFH Final Rule strongly recommends regional fishery management councils and NMFS to conduct a review and revision of the EFH components of FMPs 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 SAFE 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.

2.8.1.1 EFH Information

The EFH components of FMPs include the description and identification of EFH, lists of prey species and locations for each managed species, and optionally, HAPC. 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 is described in the FEP but implemented in the annual SAFE report.

The Council has described EFH for five management unit species (MUS) under its management authority, most of which are no longer MUS: pelagic (PMUS), bottomfish (BMUS), crustaceans (CMUS), former coral reef ecosystem species (CREMUS), and precious corals (PCMUS). Only bottomfish remain designated as MUS after Amendment 4 to the American Samoa FEP that reduced the number of MUS from 205 species/families to 11, with the other species being classified as ECS (84 FR 2767, February 8, 2019).

EFH reviews of the biological components, including the description and identification of EFH, lists of prey species and locations, and HAPC, consist of three to four parts:

- Updated species descriptions, which can be found appended to the SAFE report. These can be used to directly update the FEP;
- Updated EFH levels of information tables, which can be found in Section 0;
- Updated research and information needs, which can be found in Section 0. These can be used to directly update the FEP; and
- An analysis that distinguishes EFH from all potential habitats used by the species, which is the basis for an options paper for the Council. This part is developed if enough information exists to refine EFH.

2.8.1.2 Habitat Objectives of FEP

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

- 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; and
- 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.

2.8.1.3 Response to Previous Council Recommendations

At its 172nd meeting in March 2018, the Council recommended that staff develop an omnibus amendment updating the non-fishing impact to EFH sections of the FEPs, incorporating the non-fishing impacts EFH review report by Minton (2017) by reference. An options paper was developed.

At its 182nd meeting in June 2020, the Council requested that NMFS work with the Council to determine “non-essential” fish habitat to look at ways to remove areas that are degraded from being considered EFH.

At its 187th meeting in September 2021, the Council recommended that the Chair recommend at the October 2021 CCC meeting that NMFS work with the Council to review EFH guidance in terms of how that guidance requiring the Council to identify and describe how EFH has been applied in the Western Pacific Region.

2.8.2 Habitat Use by MUS and Trends in Habitat Condition

American Samoa is made up of five high volcanic islands (Tutuila, Aunu'u, Ofu, Olosega, and Ta'u) with fringing reefs, two coral atolls (Rose Atoll or Muliava and Swains Island), and several seamounts and banks. The high islands have surrounding banks where sand can accumulate, in contrast with the Rose and Swains, where slopes plunge steeply to abyssal depths (PIFSC 2011). Tutuila is the largest island in the territory and has banks (320 km^2) surrounding the island that extend between one and nine km offshore (according to the PIBHMC) and extends more than three km from shore in most places (PIFSC 2011). The islands of Ofu, Olosega, and Ta'u make up the Manu'a Islands group, which have more limited shallow submerged banks (Figure 26). The nearshore habitat consists of narrow reef flat lagoons and fringing coral reefs (PIFSC 2011). While the five high, volcanic islands are part of the hot-spot chain that also includes the surrounding seamounts of Muli, Vailulu'u, South Bank and independent Samoa, Swains Island is part of the Tokelau hot-spot chain (Neall and Trewick 2008). Rose Atoll's geological origin is not well studied.

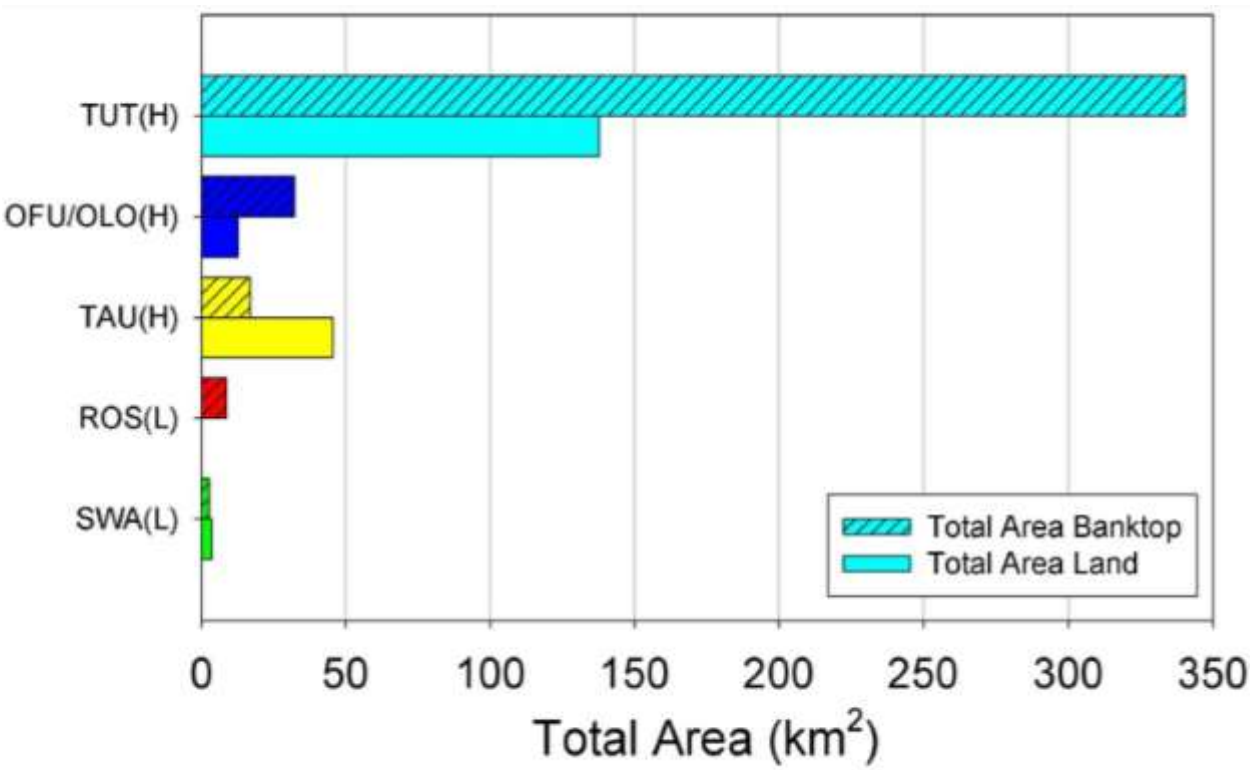

Figure 26. Bank top and terrestrial land area on high (H) or low (L) islands of Tutuila and Aunu'u (TUT), Ofu and Olosega (OFU/OLU), Ta'u (TAU), Rose (ROS), and Swains (SWA)

While the coral reef ecosystems surrounding the islands in the American Samoa archipelago have been the subject of a comprehensive monitoring program through the PIFSC Coral Reef Ecosystem Division (CRED) biennially since 2002, surveys are focused on the nearshore environments surrounding the islands, atolls, and reefs and the offshore banks and pelagic environment in which MSA-managed fisheries operate have been less studied. However, American Samoa's Territorial Monitoring Program has been monitoring bleaching in two backreef lagoon pools on Tutuila from December 2003 to present. PIFSC CRED was replaced by the Coral Reef Ecosystem Program (CREP) within the PIFSC Ecosystem Sciences Division

(ESD) before being shifted to the Archipelagic Research Program (ARP). No new data were collected in 2021 that would allow for updates to habitat use by MUS or trends in habitat condition.

2.8.2.1 Habitat Mapping

No new habitat mapping was conducted in 2021.

2.8.2.1.1 Benthic Habitat

Juvenile and adult bottomfish EFH extends from the shoreline to the 400 m isobath (64 FR 19067, April 19, 1999).

2.8.2.1.2 RAMP Indicators

Benthic percent cover of coral, macroalgae, and crustose coralline algae are surveyed as a part of the Pacific Reef Assessment and Monitoring Program (RAMP) led by the PIFSC ESD. No RAMP field work was conducted in American Samoa in 2021.

2.8.2.2 Oceanography, Water Quality, and Other Environmental Data

The water column is also designated as EFH for selected 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, 150 m; and bottomfish, 400 m. Please see the Climate and Oceanic Indicators section (Section 2.6.4) for information related to oceanography and water quality. While no substantial field research data efforts occurred in 2021, satellite and buoy data are continuously collected and archived. PIFSC staff recently developed an advanced data compilation tool, the Environmental Data Summary (EDS), that gives users a simple, consistent way to enhance existing *in situ* observations with external gridded environmental data. The EDS is written in R and provides users an interface to NOAA CoastWatch and OceanWatch datasets through the ERDDAP server protocol. The EDS allows users to download, filter, and/or extract large amounts of gridded and tabular data given user-defined time stamps and geographical coordinates. The various external environmental data summarized at individual survey sites can aid scientists in assessing and understanding how environmental variabilities impact living marine resources. The EDS outputs were summarized at the National Coral Reef Monitoring Program (NCRMP) Rapid Ecological Assessment (REA) site level from 2000 to 2020 across 57 islands covered by the survey. PIFSC is planning to expand the utility of EDS with a broader range of gridded NOAA CoastWatch and OceanWatch data products (e.g., wave, wind) at finer spatiotemporal scales (e.g., water columns). Target data content includes spatial data (e.g., remote sensing), modeled data (e.g., Regional Ocean Modeling Systems), and socioeconomic data, including human densit

2.8.3 Report on Review of EFH Information

There were no EFH reviews completed in 2021 for American Samoa. Non-fishing and cumulative impacts to EFH were reviewed in 2016 through 2017, which can be found in Minton (2017).

2.8.4 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:

- Level 1: Distribution data are available for some or all portions of the geographic range of the species.
- Level 2: Habitat-related densities of the species are available.
- Level 3: Growth, reproduction, or survival rates within habitats are available.
- 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 managed species' life stage. The existing level of data for individual MUS in each fishery are presented in tables per fishery.

2.8.4.1 Bottomfish

EFH for bottomfish was originally designated in Amendment 6 to the Bottomfish and Seamount Groundfish FMP (64 FR 19067, April 19, 1999), and the levels of EFH information available for American Samoa BMUS are shown in Table 33. The designated areas of EFH and HAPC for American Samoa FEP bottomfish by life stage are summarized in Table 34. To analyze the potential effects of a proposed fishery management action on EFH, one must consider all designated EFH, but research examining depth and habitat requirements for most species is generally lacking (PIFSC 2021). The levels of information available for American Samoa BMUS did not change in 2021.

Table 33. Level of EFH information available for American Samoa BMUS

Life History Stage	Eggs	Larvae	Juvenile	Adult
Aphareus rutilans (red snapper/silvermouth)	0	0	0	1
Aprion virescens (gray snapper/jobfish)	0	0	1	1
Caranx lugubris (black trevally/jack)	0	0	0	1
Etelis carbunculus (red snapper)	0	0	1	1
E. coruscans (red snapper)	0	0	1	1
Lethrinus rubrioperculatus (redgill emperor)	0	0	0	1
Lutjanus kasmira (blueline snapper)	0	0	1	1
Pristipomoides filamentosus (pink snapper)	0	0	1	1
P. flavipinnis (yelloweye snapper)	0	0	0	1
P. zonatus (snapper)	0	0	0	1
Variola louti (lunartail grouper)	0	0	0	1

Table 34. EFH and HAPC for American Samoa BMUS

American Samoa BMUS	EFH	HAPC
Aphareus rutilans (red snapper/silvermouth)	**Eggs and larvae:** the water column extending from the shoreline to the outer limit of the	All slopes and escarpments between 40–280

Aprion virescens (gray snapper/jobfish) *Caranx lugubris* (black trevally/jack) *Etelis carbunculus* (red snapper) E. *coruscans* (red snapper) *Lethrinus rubrioperculatus* (redgill emperor) *Lutjanus kasmira* (blueline snapper) *Pristipomoides filamentosus* (pink snapper) *P*. *flavipinnis* (yelloweye snapper) *P*. *zonatus* (snapper) *Variola louti* (lunartail grouper)	EEZ down to a depth of 400 m (200 fm). **Juvenile/adults:** the water column and all bottom habitat extending from the shoreline to a depth of 400 m (200 fm)	m (20 and 140 fm)

2.8.5 Project Updates

No field work related to EFH was conducted in American Samoa in 2021.

A WPRFMC SSC working group and PIFSC, American Samoa DMWR, and Council staff held two remote data evaluation workshops to improve information used in the stock assessment. PIFSC also completed a thorough evaluation of all published reports related to life history and habitat (depth, substrate, feeding) for BMUS species of shallow and deep water snappers found in American Samoa (PIFSC, 2021). None of the data summarized in this report would support changes to the current EFH levels of information for American Samoa bottomfish.

Moving forward, a collaborative effort between the PIFSC Life History Program and Am. Samoa will take place in Tutuila and the Manu'a Islands as soon as travel and other research efforts resume. This plan hopes to conduct shore-based bottomfish research to provide life history (e.g., growth rate, size-at-maturity), population dynamics (e.g., mortality rate), and ecological (e.g., how the life history and population dynamics vary over space and time) information for a large variety of economical, recreational, and subsistence valued coral reef fishes, deepwater snappers and groupers, and pelagic fishes. Parts of this work should contribute to the understanding of bottomfish habitats in American Samoa.

2.8.6 Research and Information Needs

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

2.8.6.1 All FMP Fisheries

- Distribution of early life history stages (eggs and larvae) of MUS by habitat.
- Juvenile habitat (including physical, chemical, and biological features that determine suitable juvenile habitat).
- Food habits (feeding depth, major prey species etc.).
- Habitat-related densities for all MUS life history stages.

- Growth, reproduction, and survival rates for MUS within habitats.

2.8.6.2 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/CNMI 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.

2.9 MARINE PLANNING

2.9.1 Introduction

Marine planning is a science-based management 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 formalize incorporation of marine planning in its actions began in response to Executive Order (EO) 13547, Stewardship of the Ocean, Our Coasts, and the Great Lakes. EO 13158, Marine Protected Areas (MPAs), proposes that agencies strengthen the management, protection, and conservation of existing MPAs, develop a national system of MPAs representing diverse ecosystems, and avoid causing harm to MPAs through federal activities. MPAs, or marine managed areas (MMAs) are one tool used in fisheries management and marine planning.

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; and
d. As needed, periodically evaluate the management effectiveness of existing spatial-based fishing zones in federal waters.

To monitor implementation of this objective, this annual report includes the Council's spatially based fishing restrictions or MMAs, the goals associated with those, and the most recent evaluation. Council research needs are identified and prioritized through the Five-Year Research Priorities and other processes and are not tracked in this report.

To meet the EFH and National Environmental Policy Act (NEPA) mandates, this annual SAFE report tracks activities that occur in the ocean that are of interest to the Council, and incidents or facilities that may contribute to cumulative impact. NMFS is responsible for NEPA compliance, and the Council must assess the environmental effects of ocean activities for the FEP's EFH cumulative impacts section. These are redundant efforts; therefore, this report can provide material or suggest resources to meet both mandates.

2.9.2 Response to Previous Council Recommendations

There are no standing Council recommendations indicating review deadlines for American Samoa MMAs.

At its 147th meeting in March 2010, the Council recommended a no-take area from 0-12 nautical miles around Rose Atoll Marine National Monument (MNM) with the Council to review the no-take regulations after three years. The most recent review took place in 2013, with the subsequent review previously scheduled for 2016. PIRO received no requests for non-commercial permits to fish within the Rose Atoll MNM. Further, inquiries in American Samoa showed that there was no indication that the 12 nm closure around Rose Atoll MNM has been limiting fishing. Thus, there is no interest to fish within the monument boundaries. The Pelagic Plan Team deferred decision on Rose Atoll in May 2017 until after the Administration reviews to make any decision on the monument provisions. At its 172nd meeting in March 2018, the Council requested that NOAA and USFWS provide a report to the Council at its following meeting to review resultant benefits to fish populations, protected species, and coral reef, deep-slope, and pelagic ecosystems from the establishment of the Rose MNM. USFWS presented this report to the Council at its 173rd meeting in June 2018, from which no recommendations were generated. No further action was taken on the Rose Atoll MNM.

At its 162nd meeting in March 2015, the Council recommended a regulatory amendment for the temporary exemption to the Large Vessel Protected Area (LVPA) by American Samoa longline limited entry permitted vessels greater than 50 ft. in length. The Council would review the LVPA exemption on an annual basis with regards, but not limited to; catch rates of fishery participants; small vessel participation; and fisheries development initiatives. In 2016, NMFS published a final rule that allowed large, federally-permitted U.S. longline vessels to fish in specific areas of the LVPA (81 FR 5619, February 3, 2016). In July 2016, American Samoa sued NMFS and the Council in the Hawaii Federal District Court, claiming that NMFS did not consider the 1900 and 1904 Deeds of Cession with respect to the protection of the cultural fishing rights of the people of American Samoa. In 2017, the Hawaii Federal District Court deemed the final rule invalid and ordered NMFS to vacate the LVPA exemption rule (82 FR 43908, September 20, 2017).

At its 173rd meeting in June 2018, regarding the LVPA applicable to the American Samoa limited entry vessels, the Council recognized the LVPA rule has led to disagreement within the American Samoa fishing community and was the subject of litigation. The Council noted that last year's court decision requires the consideration and protection of American Samoa cultural fishing. To this end, the Council requested PIFSC conduct research on American Samoa cultural fishing practices to facilitate understanding and potential impacts of opening some restricted fishing areas within the U.S. EEZ for American Samoa vessels that primarily target albacore. PIFSC presented the results of this research at the Council's 172nd meeting in March 2018, which indicate that all fishing in American Samoa has cultural importance, whether commercial longline, commercial alia vessels, troll, or other fishing sectors, because catch from all locally-based fishing sectors flows into the American Samoa community for cultural purposes. The Council also recommended a regulatory amendment to provide a four-year exemption for vessels permitted under the American Samoa longline limited entry program to fish within the LVPA seaward of 12 nm around Tutuila, 12 nmi around Manu'a, 12 nm around Swains, and 2 nmi around the offshore banks, and recommended annual monitoring of the American Samoa longline and troll catch rates, small vessel participation, and local fisheries development.

NMFS appealed Hawaii Federal District Court's 2017 decision that invalidated the 2016 LVPA reduction to the U.S. Ninth Circuit Court of Appeals. Oral arguments were in February 2020 in Honolulu, Hawaii, and the decision was reversed in a September 2020 ruling.

At its 184th meeting in December 2020, the Council directed staff to monitor the fishing operation and fishery performance of the American Samoa longline and alia fisheries and report back to the Council at its September 2021 meeting. Council staff provided this presentation to the Council as scheduled. On July 9, 2021, NMFS published a final rule reimplementing the 2016 regulations that the Council submitted to NMFS (86 FR 36239).

2.9.3 Marine Managed Areas established under the FEPs

Council-established MMAs are compiled in

Table 35 from 50 CFR § 665, Western Pacific Fisheries, the Federal Register, and Council amendment documents. Geodesic areas were calculated in square kilometers in ArcGIS. All regulated fishing areas and large MMAs, including Rose Atoll Marine National Monument, are shown in Figure 27.

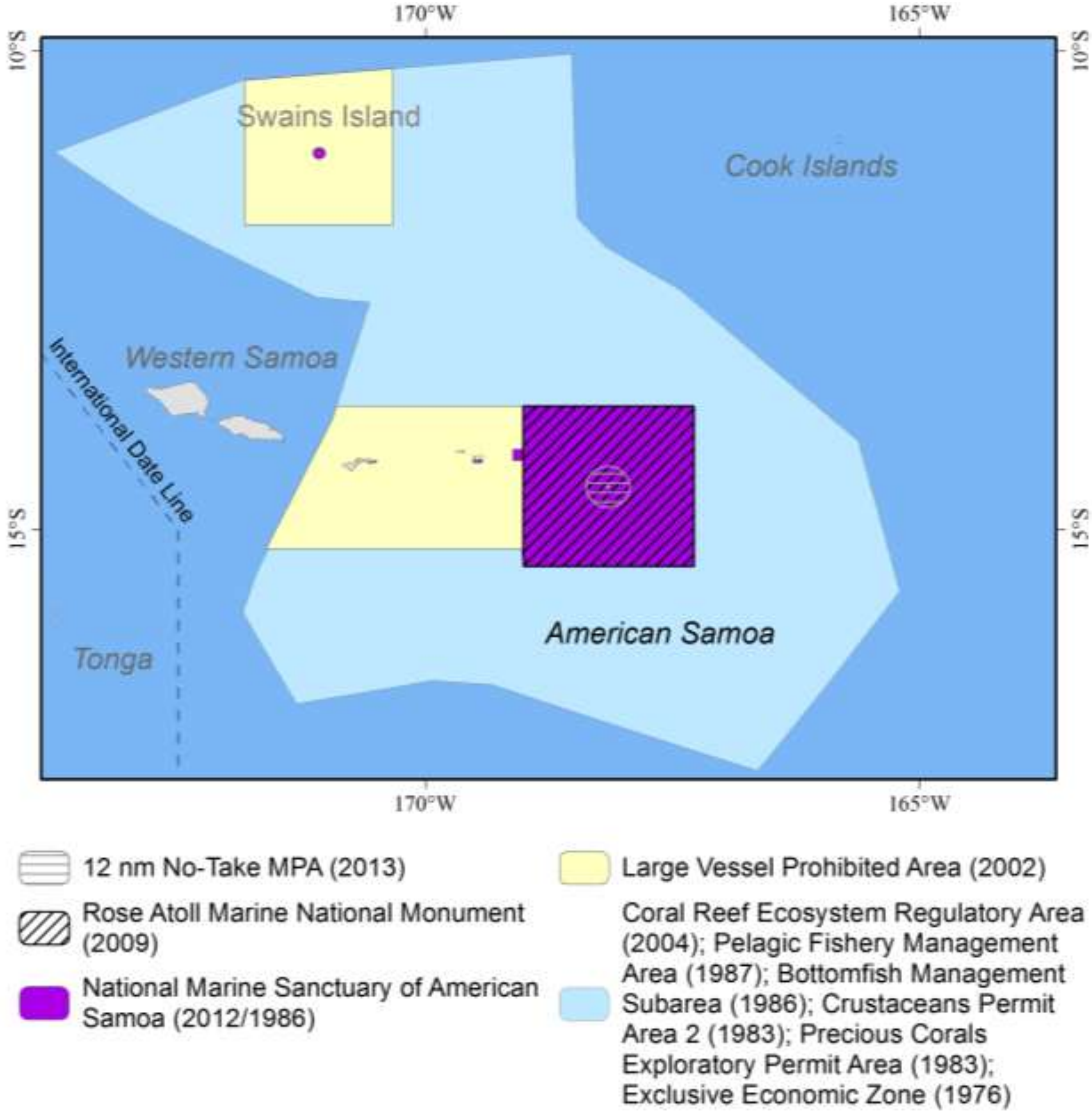

Figure 27. Regulated fishing areas of American Samoa

Table 35. MMAs established under FEPs from 50 CFR § 665

Name	FEP	Island	50 CFR / FR / Amendment Reference	Marine (km^2) Area	Fishing Restriction	Goals	Most Recent Evaluation	Review Deadline
Large Vessel Prohibited Area	Pelagic (American Samoa)	Tutuila, Manu'a, and Rose Atoll	665.806 (b)(1) 81 FR 5619 82 FR 43908	74,857.32	Vessels ≥ 50 ft. prohibited	Prevent gear conflict with smaller alia vessels; longline vessels >50 ft. exempted from 12 to 50 nm to improve the viability of the American Samoa longline fishery and achieve optimum yield from the fishery while preventing overfishing	Jan 29, 2016	-
Large Vessel Prohibited Area	Pelagic (American Samoa)	Swains Island	665.806 (b)(2) 81 FR 5619 82 FR 43908 Pelagic FEP	28,352.17	Vessels ≥ 50 ft. prohibited	Prevent gear conflict with smaller alia vessels; longline vessels over 50 ft. exempted between 12 and 50 nm due to improve the viability of the American Samoa longline fishery and achieve optimum yield from the fishery while preventing overfishing	Jan 29, 2016	-
Rose Atoll No-Take MPA/Rose Atoll Marine National Monument	American Samoa Archipelago/ Pelagic	Rose Atoll	665.99 and 665.799(a)(2) 69 FR 8336 Coral Reef Ecosystem FMP 78 FR 32996 American Samoa FEP Am. 3	-	All Take Prohibited	Minimize adverse human impacts on coral reef resources; commercial fishing prohibited within 12 nm	June 3, 2013	June 3, 2016

2.9.4 Fishing Activities and Facilities

There are no aquaculture activities currently occurring in the offshore waters of American Samoa.

2.9.5 Non-Fishing Activities and Facilities

There are no alternative energy facilities or military training and testing activities currently occurring in the federal or territorial waters of American Samoa. The Plan Team will add to this section as new facilities are proposed and/or built.

2.9.6 American Samoa Spatial Planning Tools

In June 2018, President Trump signed the EO 13840 *Regarding the Ocean Policy to Advance Economic, Security, and Environmental Interests of the United States*, which established a policy focused on public access to marine data and information and requires federal agencies to 1) coordinate activities regarding ocean-related matters and 2) facilitate the coordination and collaboration of ocean-related matters with governments and ocean stakeholders. To that end, the American Samoa Coastal and Marine Spatial Planning Data Portal was created by Marine Cadastre to share information and data for coastal and marine spatial planning in American Samoa.

3 DATA INTEGRATION

3.1 INTRODUCTION

3.1.1 Potential Indicators for Insular Fisheries

The purpose of this section ("Chapter 3") of the Stock Assessment and Fishery Evaluation (SAFE) annual report is to identify and evaluate potential fishery ecosystem relationships between fishery parameters and ecosystem variables to assess how changes in the ecosystem affect fisheries in the Main Hawaiian Islands (MHI) and across the Western Pacific region (WPR). "Fishery ecosystem relationships" are those associations between various fishery-dependent data measures (e.g., catch, effort, or catch-per-unit-effort), and other environmental attributes (e.g., precipitation, sea surface temperature, primary productivity) that may contribute to observed trends or act as potential indicators of the status of prominent stocks in the fishery. These analyses represent a first step in a sequence of exploratory analyses that will be utilized to inform new assessments of what factors may be useful going forward.

To support the development of Chapter 3 of the annual SAFE report, staff from the Council, National Marine Fisheries Service (NMFS), Pacific Islands Fisheries Science Center (PIFSC), Pacific Islands Regional Offices (PIRO), and Triton Aquatics (consultants), held a SAFE Report Data Integration Workshop (hereafter, "the Workshop") convened on November 30, 2016 to identify potential fishery ecosystem relationships relevant to local policy in the WPR and determine appropriate methods to analyze them. The archipelagic fisheries group developed nearly 30 potential fishery ecosystem relationships to examine across bottomfish, coral reef, and crustacean fisheries based on data reliability, suitability of methodology, repeatability on an annual basis, and how well analyses could potentially inform management decisions.

Brief introductory analyses, presented in this section and initially introduced in the 2017 report, were intended to be "proof of concept" such that similar evaluations could be carried out on remaining fishery data for American Samoa in the future. However, the Fishery Ecosystem Plan Team determined that the quantitative analyses were not enough to act as a model for future evaluations. Using the direction from the Plan Team, the data integration module was updated for the Hawaii Archipelagic Annual SAFE Report, but each of the remaining archipelagic reports still contain data integration assessments from 2017. The Annual SAFE Report for the Mariana Archipelago will be updated in the following year similar to the Annual SAFE Report for the Hawaii Archipelago pending PPT approval.

Going forward, relationships deemed potentially relevant will be emphasized and recommended for further analysis. In subsequent years, this chapter will be updated with these analyses through the SAFE report process as the strength of certain fishery ecosystem relationships relevant to advancing ecosystem-based fishery management are determined.

To begin, this chapter described feedback from the Plan Team, SSC, and Council members on the initial drafts of the data integration module. Next, the chapter includes brief descriptions of past work on fishery ecosystem relationship assessment in coral reefs of the U.S. Western Pacific, followed by initial evaluations of relationships previously recommended for evaluation by participants of the Workshop using current data streams from American Samoa. The evaluations completed were exploratory in nature, being the first step of analyses to know which comparisons may be more useful to focus on going forward.

Going forward with the analyses and presentation of results for the data integration chapter of the American Samoa Annual SAFE Report, the Plan Team suggested several improvements to implement in the coming year: standardizing and correcting values in CPUE time series, incorporating longer stretches of phase lag, completing comparisons on the species-level and by dominant gear types, incorporating local knowledge on shifts in fishing dynamics over the course of the time series, and utilizing the exact environmental data sets presented in the ecosystem consideration chapter of the annual report. Many of these recommendations were applied to datasets from Hawaii in 2018 and will similarly be done for American Samoa data integration analyses in the upcoming report cycles. Implementation of these suggestions will allow for the preparation of a more finalized version of the data integration chapter in the coming report cycles.

3.1.2 2018 Recommendations and Direction for Chapter Development

At the FEP Team Meeting held on April 30th and May 1st, 2018, participants were presented preliminary data integration results shown here, and provided detailed recommendations to support the ongoing development of the data integration section of the Archipelagic Annual SAFE Report. These suggestions, both general and specific, will be implemented in the coming year to ensure that more refined analyses comprise the data integration section. FEP Plan Team participants recommended that:

- CPUE data should be standardized and calculated in a more robust fashion, measuring the average catch per unit effort rate over the course of a year to analyze variance.
- Analyses of fishery performance data against environmental variables should focus on dominant gear types rather than the entirety of the fishery or other gear aggregates;
- There should be additional phase lag implemented in the analyses;
- Local knowledge of fishery dynamics, especially pertaining to shifting gear preferences, should be utilized. Changes in dynamics that may have impacted observed fishery trends over the course of available time series, both discreetly and long-term for taxa-specific and general changes should be emphasized; and
- Spatial specificity and precision should be increased for analyses of environmental variables in relation to areas commonly fished.

The analyses presented in the data integration chapter of the 2018 Hawaii Annual SAFE Report reflect a thoughtful re-approaching to these data integration evaluations based on this feedback. Additional data can be added to either time series as they are made available. Incorporating such recommendations into the American Samoa Annual SAFE Report will mark the beginning of a standardized process to implement current data integration analyses on an annual basis. Doing so will promote more proactive management action with respect to ecosystem-based fishery management objectives.

3.2 PAST WORK

Richards et al. (2012) performed a study on a range environmental factors that could potentially affect the distribution of large-bodied coral reef fish in Mariana Archipelago. Large-bodied reef fish were determined to typically be at the greatest risk of overfishing, and their distribution in the region was shown to be negatively associated with human population density. Additionally, depth, sea surface temperature (SST), and distance to deep water were identified as important environmental factors to large-bodied coral reef fish, whereas topographic complexity, benthic habitat structure, and benthic cover had little association with reef fish distribution in the Mariana Archipelago.

Kitiona et al. (2016) completed a study of the impacts of climate and/or ecosystem change on coral reefs fish stocks of American Samoa using climate and oceanic indicators (see Section 2.7.4). The evaluation of environmental variables showed that certain climate parameters (e.g., SST anomaly, sea level height, precipitation, and tropical storm days) are likely linked to fishery performance. It was also noted that larger natural disturbances in recent decades, such as cyclones and tsunamis, negatively impacted reef fish assemblages and lowed reef fishery CPUE in American Samoa (Ochavillo et al. 2012).

On a larger spatial scale, an analysis of various drivers on coral reef fish populations across 37 U.S.-affiliated islands in the Central and Western Pacific was performed by Williams et al. (2015) and evaluated relationships between fish biomass in these reefs with human and environmental factors. Again, reef fish assemblages were negatively associated with increasing human population density (even at relatively low levels) across the WRP but were positively associated with elevated levels of ocean productivity across islands. The authors warned, however, that the ability of reefs surrounding uninhabited islands to maintain fish populations varies, and that high biomass observed in remote areas (e.g., the NWHI) may not necessarily be reflective of baselines or recovery response levels for all reef systems.

A common method of EBFM used in coral reef ecosystems is the implementation of biological reference points, statistical indicators of potential overfishing used to help determine how a fishery is performing relative to these points at a given time (McClanahan et al., 2011). Hawhee (2007) adapted this idea, generating biological reference points in the form of CPUE-based proxies to be used as indicators for reef fish stocks in the WPR. However, the devised method was determined to be inappropriate for application in management of reef stocks in the U.S. Western Pacific due to the lack of a historical CPUE to use as a baseline for the reference points and their limit thresholds (Remington and Field, 2016).

3.3 SEA SURFACE TEMPERATURE

Sea surface temperature (SST) is a commonly used diagnostic tool in monitoring climate change and its affects both regionally and globally, as it is representative of changes in ocean temperatures over time that can affect coastal fisheries (see Section 2.7.4). The potential influence of temperature-derived variables in fishery ecosystem relationships for U.S. Western Pacific coral reef stocks was deemed to be among the highest priority by the participants of the Workshop. Data for SST was gathered from the NOAA's Advanced Very High Resolution Radiometer (AVHRR) Pathfinder v5.0 through the OceanWatch program in the Central Pacific (NOAA/National Environmental Satellite, Data, and Information Service [NESDIS]/OceanWatch). Future work will utilize time series of SST described in Section 2.7.4in hopes of better integrating analyses that have already been completed as well as avoiding redundant effort. Available catch and effort data streams were supplied from creel surveys completed by the American Samoa Department of Marine and Wildlife and submitted for organization by WPacFIN. These surveys, while not able to entirely capture the noncommercial aspect of reef fisheries in the WPR, represent the best data available for these sorts of analyses. Efforts are being made to improve information streams in data-poor fisheries across the U.S. Western Pacific.

A time series of SST for American Samoa from 1989-2016 is shown in Figure 28. The SST for American Samoa over this period had relatively little variability (CV = 1.15). SST has been seemingly increasing over the course of available data, though its variability appeared to be decreasing in the last decade. This decrease followed the hottest observed temperatures in the last three decades at just over 29°C in 2005. The lowest recorded SST over the course of the time series was approximately 28°C in the first year of evaluated data.

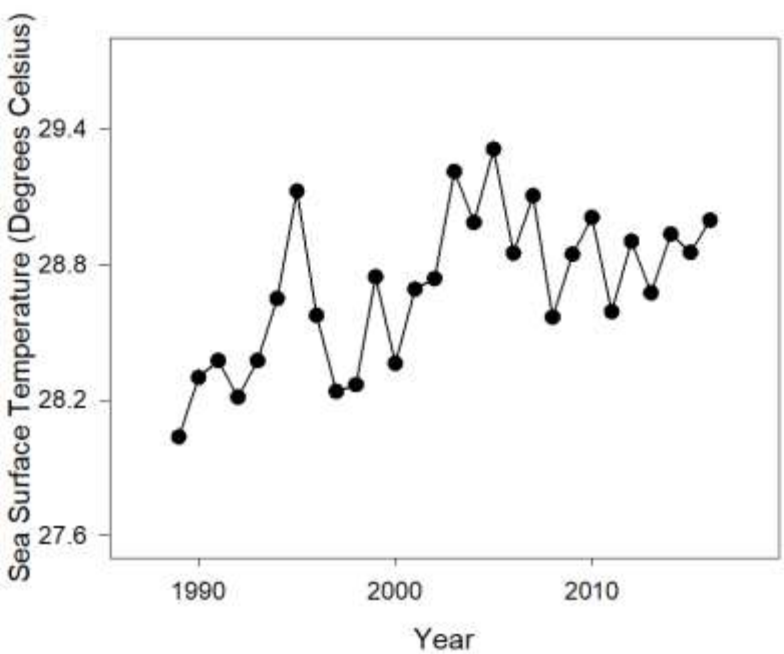

Figure 28. Average annual SST (°C) in American Samoa from 1985-2016 (CV = 1.15)

3.3.1 Evaluating relationship for entire coral reef fishery

Figure 29 shows a plot depicting the relationship between SST and catch time series for the coral reef fishery in American Samoa from 1989-2016. Landings were notably variable over the course of the time series (CV = 91.4), likely attributed to a large multi-year inflation in catch from 1993 to 2000. Total annual catch in the fishery had been observably decreasing over the last decade despite following an abrupt maximum in the late 1990s (~965,000 lb). Recent recorded catch levels (i.e., 2016) are among the lowest for the fishery through the available time series of data (~105,000 lb; Figure 29).

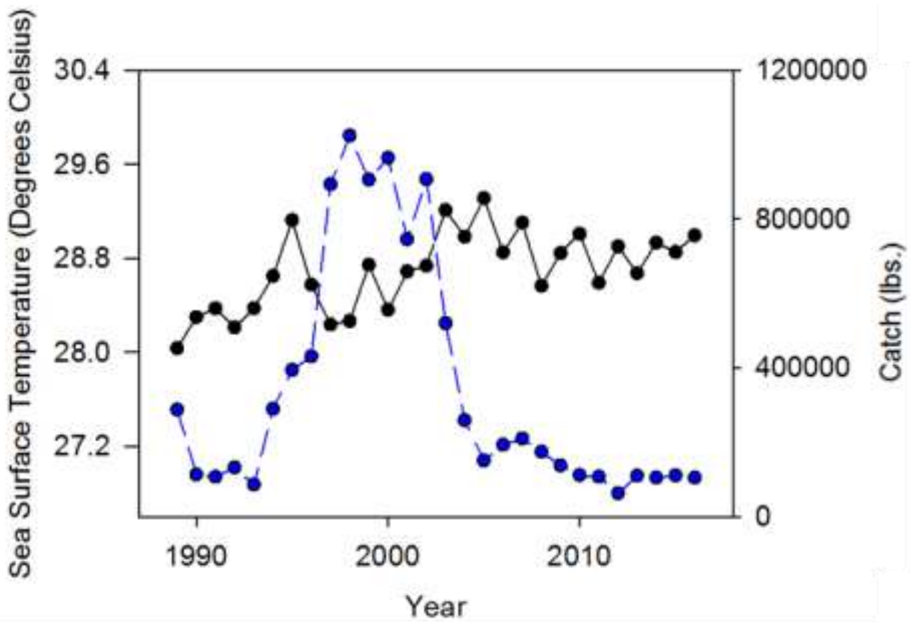

Figure 29. Total annual catch (lb; blue) for the American Samoa coral reef fishery plotted with average annual SST (°C; black) from 1989-2016

In performing comparisons between fishery parameters and environmental variables such as SST, data were grouped into categories based on family due to data scarcity for species-level analyses in many cases. Table 36 displays the different dominant family groups considered in this evaluation alongside their common names. Note that because fishery performance with respect to participation/effort has not changed in large amounts over the past three decades, analyzing the only species-level information available in terms of creel survey catch can give some indication as to the potential for a fishery ecosystem relationship.

Table 36. Families recorded in creel survey data in the U.S. Western Pacific evaluated in these analyses

Four-letter code	Family	Common Name
LUTJ	Lutjanidae	snappers
LETH	Lethrinidae	emperors
CARA	Carangidae	jacks/mackerel/trevally
ACAN	Acanthuridae	unicornfish/tang
SERR	Serranidae	Sea bass/grouper
SIGA	Siganidae	rabbitfish
SCAR	Scaridae	parrotfish
MULL	Mullidae	goatfish
MUGI	Mugilidae	mullet
LABR	Labridae	wrasse
HOLO	Holocentridae	squirrelfish/soldierfish
BALI	Balistidae	triggerfish

Linear regressions and correlation analyses on time series of coral reef fishery catch and annual mean SST from American Samoa were performed (Table 37). Assessments measuring this potential relationship for the entirety of the coral reef fishery catch in American Samoa showed no general relationship between 1989 and 2016 ($R^2 = 0.06$, $p = 0.20$; Table 37; Figure 30). The observed association between the two parameters appeared to associate negatively over time despite the lack of a statistically significant trend (Figure 30).

Table 37. Correlation coefficients (*r*) between the coral reef fishery catch (lb) and SST (°C) in American Samoa for 12 taxa harvested from 1989-2016; significant correlations are indicated in bold (α=0.05)

Taxa Code	Total Catch	LUTJ	LETH	CARA	ACAN	SERR	SIGA	SCAR	MULL	MUGI	LABR	HOLO	BALI
n = 24													
p	0.20	0.43	0.24	0.96	0.052	0.30	0.78	**0.02**	**0.03**	0.22	0.78	0.15	0.17
r	-0.25	0.17	0.25	0.01	-0.40	-0.22	-0.06	**-0.47**	**0.44**	0.26	-0.06	-0.30	0.29
R^2	0.06	0.03	0.06	0.00	0.16	0.05	0.00	**0.22**	**0.19**	0.07	0.00	0.09	0.09

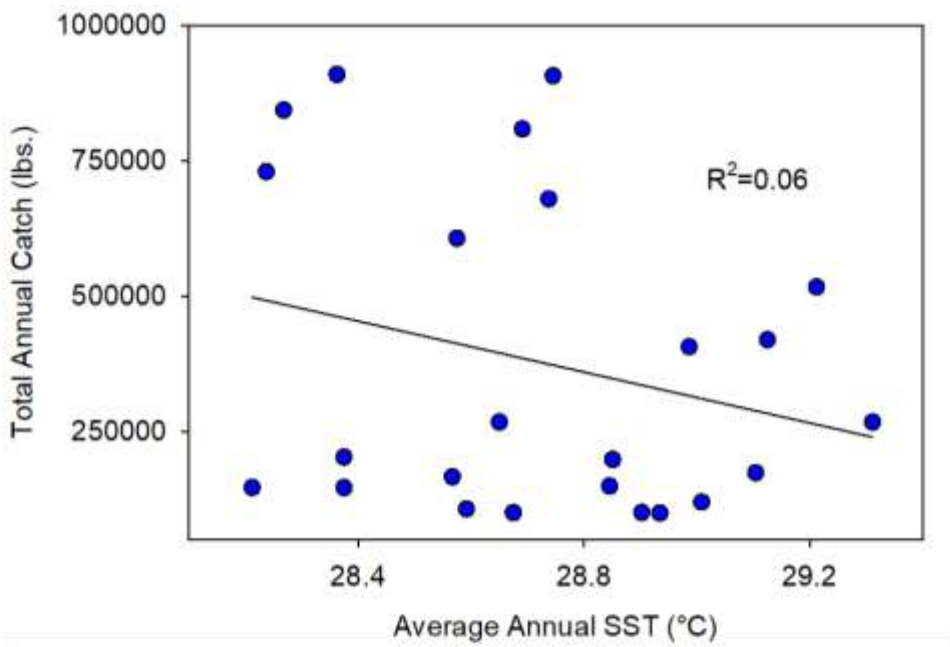

Figure 30. Linear regression showing the correlation between total annual catch (lb) for the coral reef fishery and average annual sea surface temperature (°C) in American Samoa from 1989-2016

3.3.2 Evaluating relationships for dominant taxa

Similar linear regressions were performed for the time series of SST with catch for dominant family groups in American Samoa as well, and it was found that two of the 12 evaluated families had statistically significant relationships with average annual temperature in the surface waters surrounding the archipelago (Table 37). The strongest relationship observed was between SST and annual Scaridae catch and negative, where the regression suggested that for every degree Celsius of temperature increase, catch would decrease by approximately 5,000 lb (R^2 = 0.22, p = 0.02; Table 37; Figure 31a). Note that because participation statistics could not be taken into consideration for these types of analyses on a family- and gear-specific level, it is always possible that changes in catch could be reflective of changes in effort over time that could not be observed in the available data. This section will be updated with more integrated forms of analysis in upcoming years as resources allow.

The next strongest association observed was for the Mullidae family, which was shown to have catch levels with positive statistical significance to SST such that every increase in one degree Celsius would hypothetically increase annual catch by less than 100 lb (~67 lb; R^2 = 0.19, p = 0.03; Table 37; Figure 31b) The third strongest fishery ecosystem relationship identified in this region between catch and SST was for the Acanthurids, which fell short of the threshold of significance by 0.002 (R^2=0.16, p=0.052; Table 37; Figure 31c). Despite the narrow miss for statistical significance at the α = 0.05 level, the generated regression equation suggested that landings of this family would decrease by almost ~10,000 lb for every 1°C increase temperature.

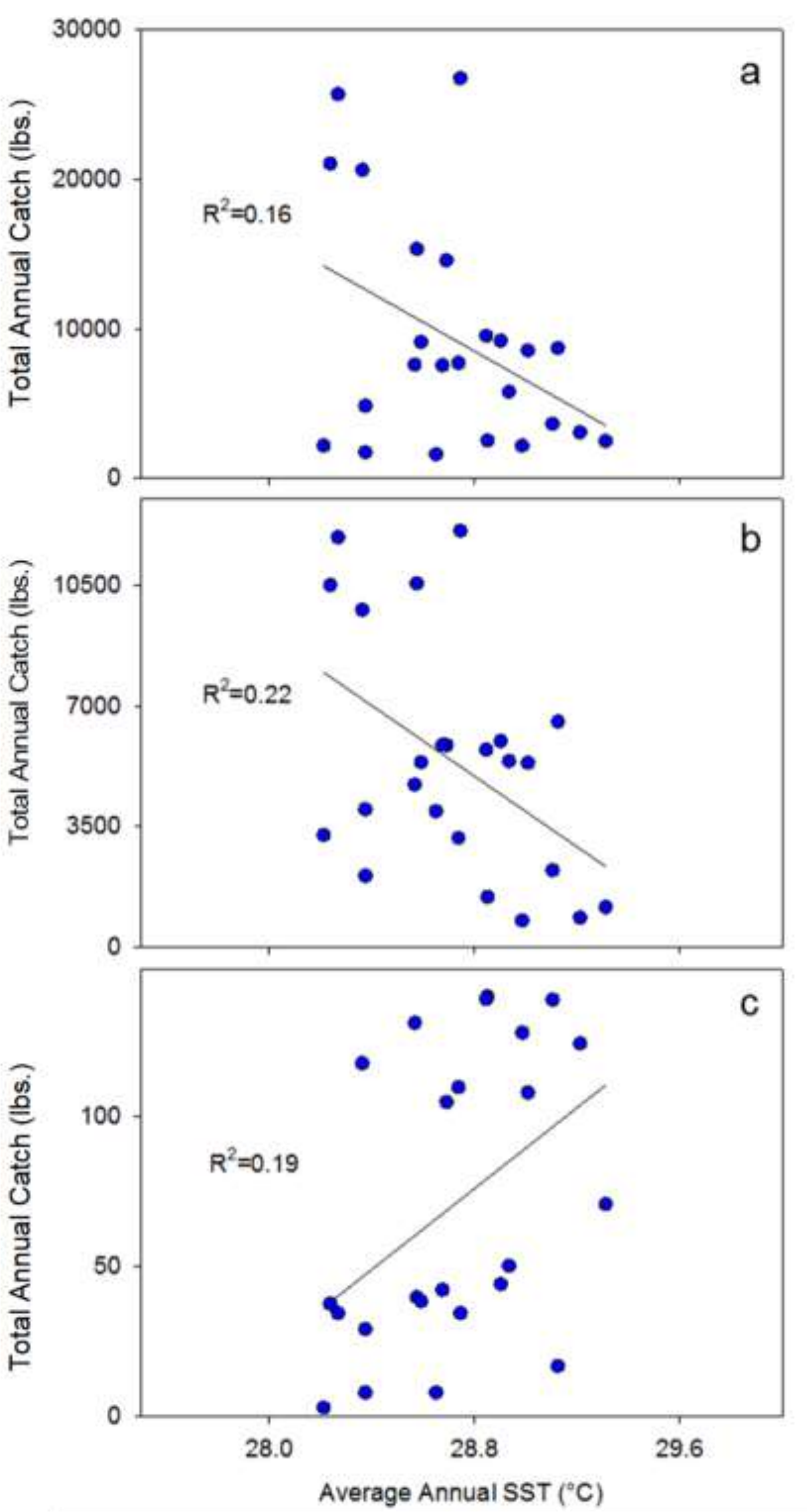

Figure 31. Linear regressions showing the three top correlations between total annual catch (lb) for the coral reef fishery and average annual SST (°C) in American Samoa for (a) Acanthurids, (b) Scarids, and (c) Mullids from 1989-2016

3.4 PRIMARY PRODUCTIVITY

Concentrations of the pigment chlorophyll-*a* are frequently used as an index of phytoplankton biomass to represent primary production, are a commonly utilized tool in identifying eutrophication, and are noted to be among the highest priority fishery ecosystem relationships in the WPR by participants of the Workshop as well (Islam and Tanaka 2004). In Pacific regions where interannual precipitation and associated coastal runoff are relatively high, the physio-chemistry of nearshore reefs can especially be impacted by nutrient input accompanying precipitation and result in increased primary production (Ansell et al. 1996).

Long-term changes in regional primary productivity have the potential to change reef fish population abundance due to the susceptibility of these assemblages in shallow areas of coastal reefs to variations in water chemistry, especially when combined with the variability of other environmental parameters like sea surface temperature (Kitiona et al. 2016). For example, it has been suggested that warming ocean temperatures coupled with decreasing environmental productivity, likely due to a reduction in upwelling that isolated nutrients at depth, led to waning reef fish assemblages in the Southern California Bight (Roemmich and McGowan, 1995). With recent progress in satellite and fluorometric measurements of oceanic surface waters, time series of global and regional primary production generated using chlorophyll-a concentration estimates have become increasingly available and are commonly used for evaluating the impact of environmental productivity on reef fish population abundance and the marine food web in general (Behrenfeld et al. 2006; Messié and Radenac 2006). Data for the study at hand were gathered from the ESA Ocean Colour Climate Change Initiative dataset version 3.1.

Uncertainty levels were relatively high in evaluations including chlorophyll-*a* concentrations due to the nature of incorporating phase lag and not smoothing the catch data as is typically done for creel survey information. The largest issue in performing comparison analyses between catch levels from reef fisheries in American Samoa and fluorometric chlorophyll-*a* concentrations was the relatively short time series (i.e., small sample size) muddying any signals that might have been teased out. Robust, homogenous time series highlighting interdecadal patterns in these regions were difficult to obtain due to time series merging several sources of chlorophyll concentration information to elongate the range of continuous data. For example, the ESA's Ocean Colour Climate Change Initiate dataset only permitted the use of less than two decades of data when evaluating the territories with the incorporation of phase lag. The length of the applied lag has a large impact in the patterns observed, so the relatively short extent of the available time series may obfuscate some of the identified relationships.

Time series of fluorometric chlorophyll-*a* concentrations (mg/m^3) from 1998 to 2016 in American Samoa is shown in Figure 32. The chlorophyll levels had relatively low variability over the course of evaluated data (CV = 4.90; Figure 32). Local chlorophyll-*a* concentrations appeared to be increasing over the course of the time series, despite the non-significant nature of the trend. Given the 17 available years of data, the average chlorophyll-*a* concentration was 0.039 mg/m^3, and the lowest recorded level was seen at the inception of the time series in 2005 at 0.036 mg/m^3 (Figure 32).

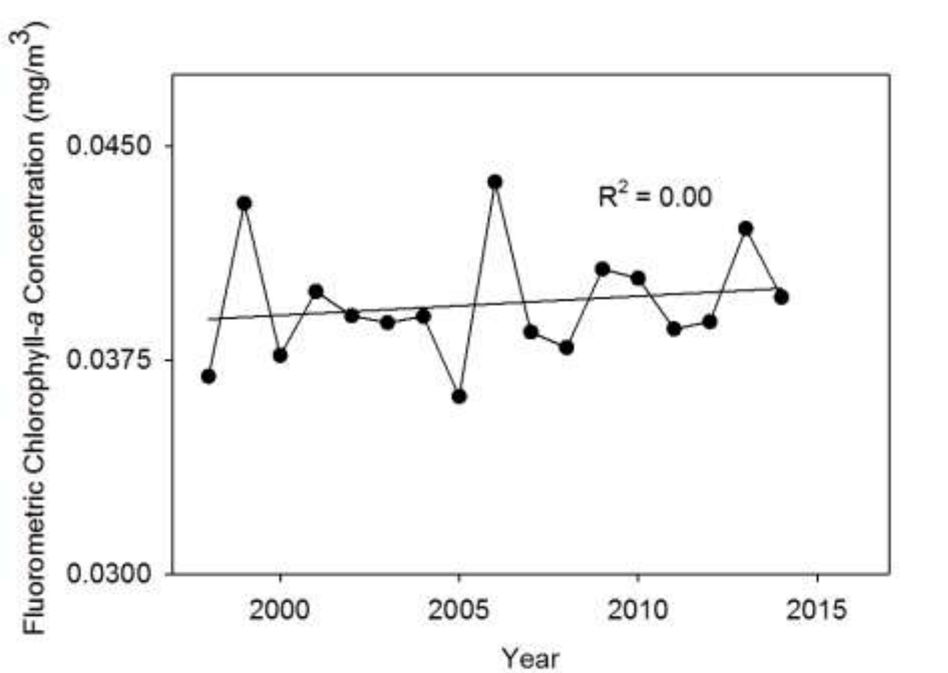

Figure 32. Fluorometric chlorophyll-a concentrations (mg/m^3) from 1998–2016 (CV = 4.90)

3.4.1 Evaluating relationship for entire coral reef fishery

A comparison plot depicting the relationship between chlorophyll-*a* concentrations and catch time series gathered through creel surveys measuring American Samoa's coral reef fishery from 1998 to 2014 is depicted in Figure 43. Catch for this region was relatively variable (CV=91.6) likely due to a large spike seen at the beginning of evaluated data in the early 2000s. Despite the abrupt maximum in 1998 (>1 million lb), total annual catch for the noncommercial reef fishery in American Samoa has been in decline through recent years. Current recorded catch levels (i.e., averaged over 2014 to 2016) are among the lowest for the fishery through the available time series of data (less than 100,000 lb; Figure 33).

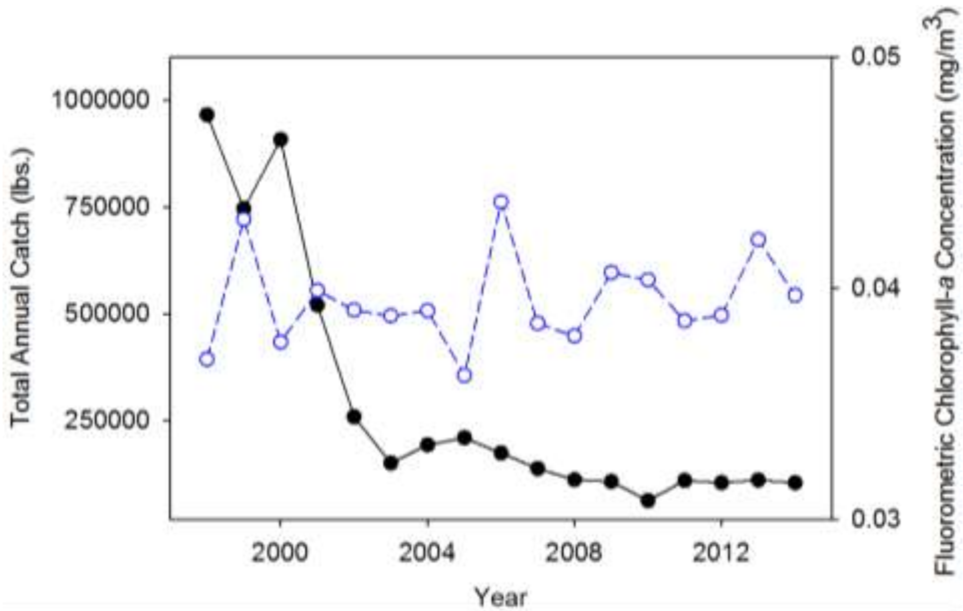

Figure 33. Comparison of American Samoa reef fish catch (lb; black) and chlorophyll-*a* concentrations (mg/m^3; blue) from 1998 – 2014 and two years of time lag

The linear regressions performed between noncommercial reef catch in American Samoa and fluorometric chlorophyll-*a* concentrations (mg/m^3) are shown in Figure 34. The chlorophyll-*a* concentrations and total annual catch for the all harvested taxa in the American Samoa noncommercial reef fishery had a negative relationship, but the association was not statistically significant to warrant further analysis especially with such a short time series of available data (r= -0.15, p = 0.57; Table 38; Figure 34). Several outliers in catch (from 1998 to 2001, the beginning of available primary productivity information) aided in complicating evaluation of the relationship between the parameters.

Table 38. Correlation coefficients (*r*) from comparisons of time series of American Samoa coral reef fishery annual catch (lb) and fluorometric chlorophyll-*a* concentrations (mg/m^3) for 12 top taxa harvested from 1998–2014

Taxa Code	Total Catch	LUTJ	LETH	CARA	ACAN	SERR	SIGA	SCAR	MULL	MUGI	LABR	HOLO	BALI
n = 17													
p	0.57	0.25	0.29	0.62	0.28	0.99	0.17	0.54	0.82	0.65	0.37	0.13	0.09
r	-0.15	0.32	0.27	-0.13	-0.28	0.00	0.35	-0.16	0.06	0.12	-0.23	-0.38	-0.42
R^2	0.02	0.10	0.08	0.02	0.08	0.00	0.12	0.03	0.00	0.01	0.05	0.14	0.18

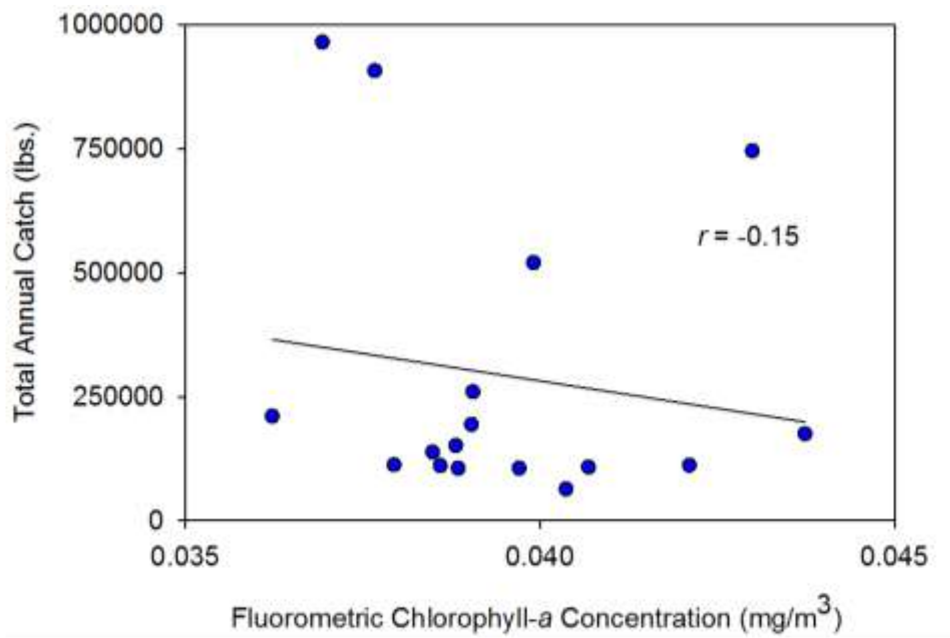

Figure 34. Linear regression showing between total annual catch (lb) for the American Samoa coral reef fishery with phase lag (t+2 years) and fluorometric chlorophyll-*a* concentrations (mg/m^3) from 1998-2014

3.4.2 Evaluating relationships with dominant taxa

After performing similar comparison analyses on the catch time series of the evaluated taxa for American Samoa, it was discovered that zero of the 12 displayed a statistically significant relationship with fluorometric chlorophyll-*a* concentrations in the area (Table 38). The strongest associations identified, though non-significant, were between estimated pigment levels and the catch time series of the Lutjanids ($R^2 = 0.10$; p = 0.25), Holocentrids ($R^2 = 0.10$; p = 0.25), and Acanthurids ($R^2 = 0.08$; p = 0.28); the relationships for Holocentridae and Acanthuridae were trending negative despite the lack of statistical significance (Table 38; Figure 35a-c).

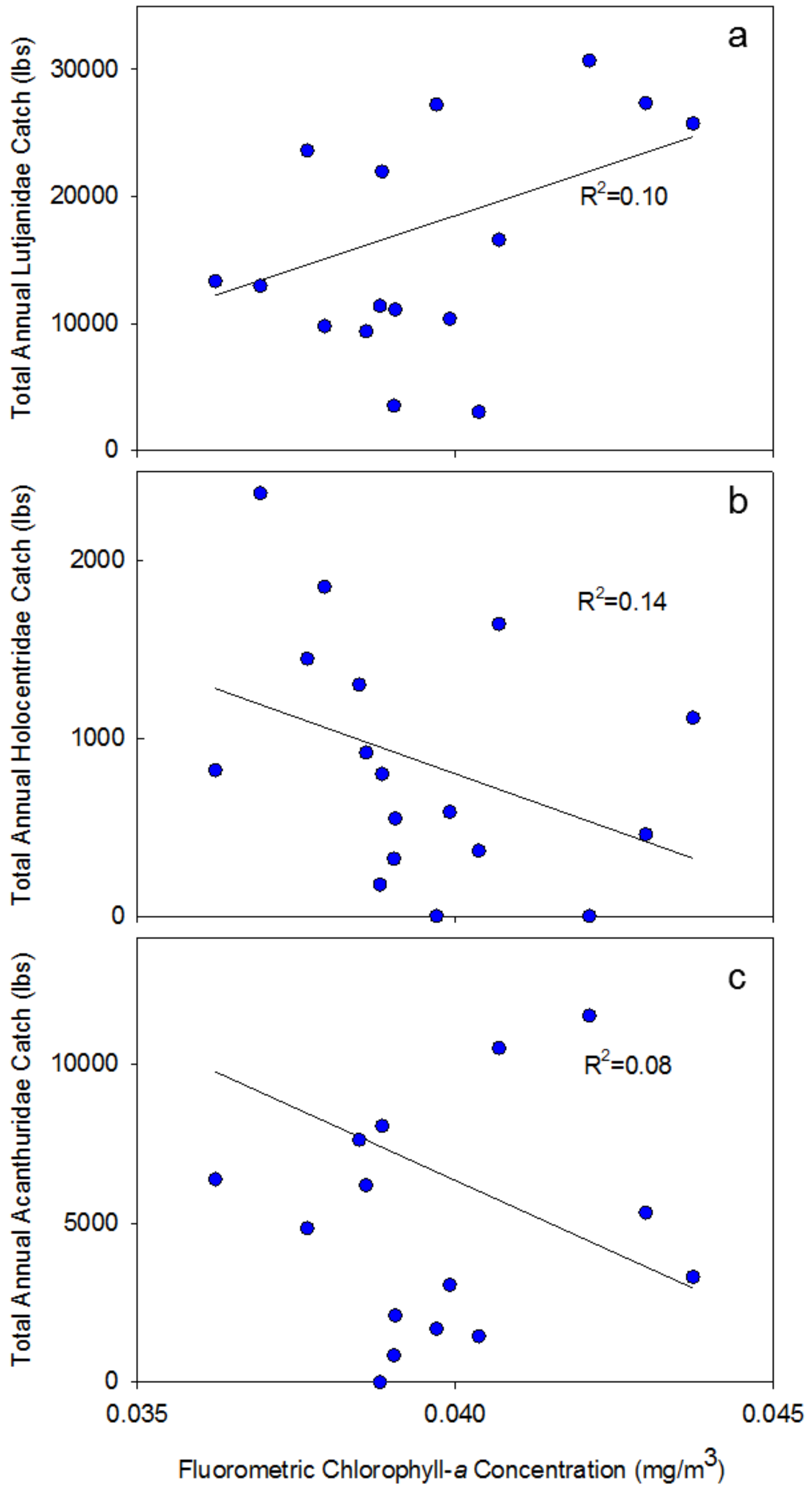

Figure 35. Linear regressions showing three correlations between total annual catch (lb) for the American Samoa coral reef fishery and fluorometric chlorophyll-*a* concentrations (mg/m^3) for (a) Lutjanids, (b) Holocentrids, and (c) Acanthurids from 1998–2014 with phase lag (t+2 years)

3.5 MULTIVARIATE ASSESSMENTS OF ADDITIONAL ENVIRONMENTAL VARIABLES

3.5.1 Non-Metric Multidimensional Scaling

There were several other prioritized fishery ecosystem relationships for coral reefs in the American Samoa involving environmental parameters that were not to be addressed in this initial evaluation including: the Oceanic Niño Index (ONI), the Pacific Decadal Oscillation (PDO), sea level height, pH, dissolved oxygen, and salinity. Further descriptions of these climate and oceanic indicators are available in Section 2.7.4. Sea surface height data were aggregated from the Ocean Service, Tides, and Currents, and Sea Level database operated (NOAA/NOS/CO-OPS). Basin-wide data ONI were taken from NOAA's Nation Centers for Environmental Information- Equatorial Pacific Sea Surface Temperature Database (Climate Prediction Center Internet Team 2015). Similarly, PDO data were obtained from NOAA's Earth System Research Laboratory Physical Sciences Division originally derived from OI.v1 and OI.v2 SST parameters (NOAA PDO). Salinity data for American Samoa were gathered from Simple Ocean Data Assimilation (SODA) version 3.3.1 (Carton and Giese 2008). Rainfall estimates were obtained through the local National Weather Service in American Samoa (NWS-AS).

Non-metric multidimensional scaling (NMS), a form of multivariate analysis that orders sample units along synthetic axes to reveal patterns of composition and relative abundance, is most commonly utilized when looking to identify patterns in heterogenous species response data (Peck 2016). For this study, NMS was used to help identify associations between coral reef fishery parameters and ecological/environmental factors using the program PC-ORD 7. To ensure the same length of time series for all catch and environmental variables considered thus allowing for the general inclusion of more parameters, data was analyzed from 1989 to 2015. The generated axes represented the best fit of patterns of redundancy in the catch data used as input, and the resulting ordination scores were a rank-order depiction of associations in the original dataset.

NMS produces robust results even in the presence of outliers by avoiding parametric and distributional assumptions (Peck, 2016). The only assumption to be met in NMS is that the relationship between the original rank ordered distances between sample units and the reduced distances in the final solution should be monotonic; that is, the slope of the association between the two is flat or positive, as determined by the stress statistic. In the most general terms, interpretable and reliable ordination axes have stress less than 10 up to 25 for datasets with large sample size, but large stress scores (i.e., greater than 30) may suggest that the final ordination results have little association with the original data matrix. Additionally, NMS ordination scores vary depending on the number of dimensions/axes designated to be solved (Peck, 2016). Dimensionality (i.e., number of axes for the final solution) for each test was identified though PC-ORD result recommendations based on final stress being lower than that for 95% of randomized runs (i.e., $p \leq 0.05$). Tau is a statistic that represents the rank correlations of the ordination scores to the original data matrices and was used to identify explanatory variables with associations to the ordination axes. For the American Samoa test, data from 12 families from 1989-2014 (26 years) were included along with eight variables of environmental data collected during the same time period.

The resulting ordination scores from the NMS analysis performed on boat-based expanded creel survey catch records and the previously mentioned environmental parameters selected two completely orthogonal ordination axes in the final solution, accounting for 94.7% of variance observed in the American Samoa boat-based creel survey data (Figure 36). The NMS final stress was low for the real runs (8.05) relative to stress from the randomization runs (15.1), suggesting interpretable results (Figure 36).

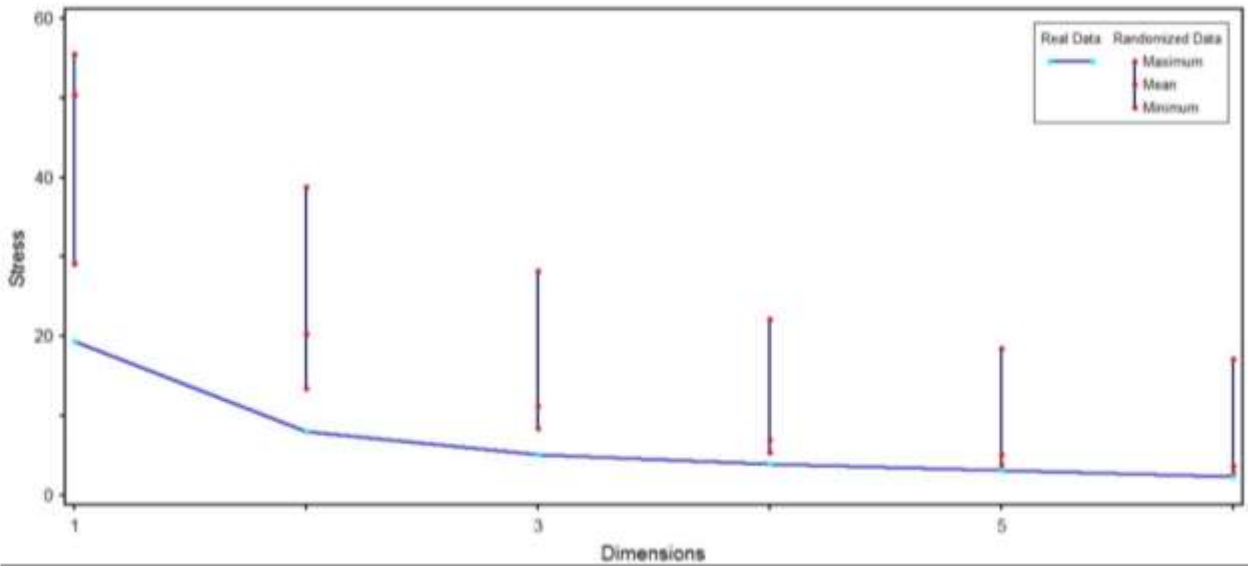

Figure 36. NMS scree plot showing the stress test to determine dimensionality for the final solution for the American Samoa multivariate analysis

The final ordination scores for the families considered were relatively tightly clustered in a positive gradient relative to the two ordination axes, though two prominent groupings are observable with more traditional reef species in the lower left and bottomfish/shallow lagoon species comprising the upper right cluster (Figure 37). While this evaluation was not able to identify any significant levels of association between expanded creel catch data and several environmental parameters, the first axis ($r^2 = 0.91$), illustrated the strongest relationships with salinity (tau = -0.23) and rainfall (tau = 0.21; Figure 37). Analyses including time series of precipitation levels in American Samoa may be useful going forward.

Time series of catch from prominent species and species complexes from American Samoa generally showed weak associations with environmental variable data gathered over the same time period. Stress values for all analyses were relatively low, suggesting that the generated ordination scores were robust and useful for interpretation relative to the ordination axes though little indication of existing fishery ecosystem relationships could be identified. Nearly all included environmental parameters had a statistically significant relationship with at least one ordination axis in at least one of the final solutions, suggesting that these parameters likely intertwine in complicated processes to produce observed impacts on coral reef fisheries in the U.S. Western Pacific. Though a fishery ecosystem relationship may have not been explicitly identified in NMS runs of this preliminary evaluation, it does not preclude the possibility that an association may still exist.

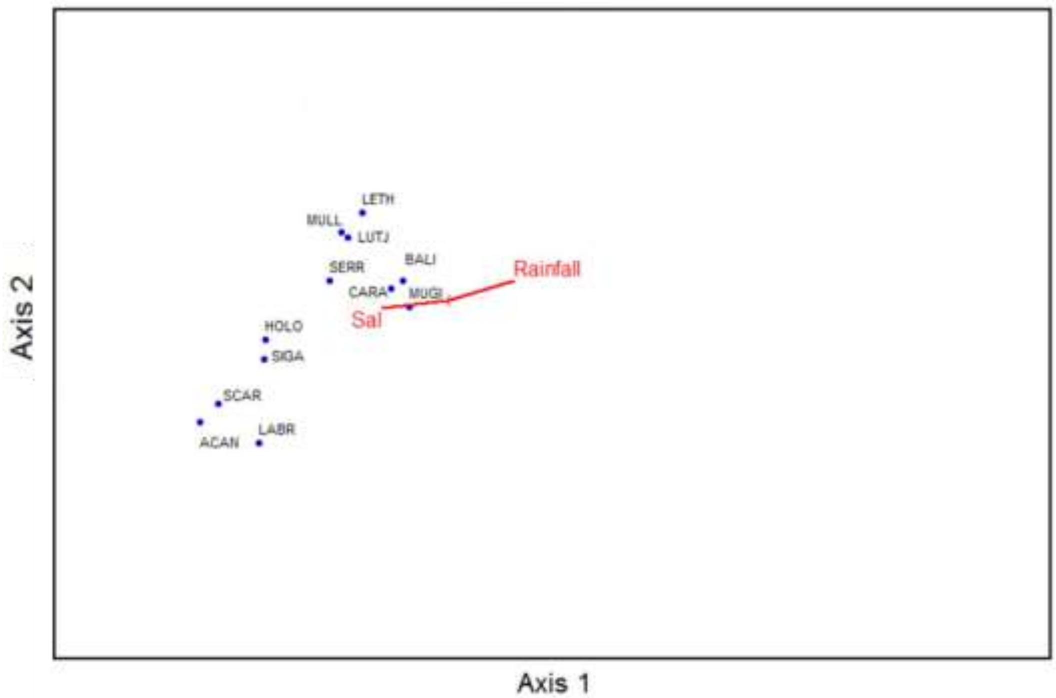

Figure 37. Two-dimensional scatterplot overlaid with a joint biplot depicting ordination scores resulting from an NMS analysis on creel survey expanded catch data and prominent environmental parameters in American Samoa from 1989-2014

3.6 RECENT RELEVANT ABSTRACTS

In this section, abstracts from primary journal articles published in 2020 and relevant to data integration are compiled. Collecting the abstracts of these articles is intended to further the goal of this section being used to guide adaptive management.

Arostegui MC, Braun CD, Woodworth-Jefcoats PA, Kobayashi DR, Gaube P. 2020. Spatiotemporal segregation of ocean sunfish species (Molidae) in the eastern North Pacific. *Mar Ecol Prog Ser 654*:109-125. https://doi.org/10.3354/meps13514

Ocean sunfishes or molas (Molidae) are difficult to study as a result of their extensive movements and low densities in remote waters. In particular, little is known of the environmental niche separation and differences in the reproductive or movement ecology of molids in sympatry. We investigated spatiotemporal dynamics in the distribution of the common mola *Mola mola*, sharptail mola *Masturus lanceolatus*, and slender mola *Ranzania laevis* in the eastern North Pacific. We used observer data from a commercial fishery consisting of 85000+ longline sets spanning 24 yr, >50° in longitude, and >45° in latitude. Satellite altimetry analysis, species distribution modeling, and multivariate ordination revealed thermal niche separation, spatiotemporal segregation, and distinct community associations of the 3 molid species. Our quantitative findings suggest that the common mola is a more temperate species, while slender and sharptail mola are more (sub)tropical species, and that slender (and possibly also sharptail) mola undergo spawning migrations to the region around the Hawaiian Islands. In addition, we identified potential effects of fishing gear type on molid catch probability, an increasing trend in catch probability of a vulnerable species perhaps related to a shift in the distribution of fishing effort, and the possible presence in the fishery of a fourth molid species being misidentified as a congener, all of which are important conservation considerations for these enigmatic fishes.

Guo C, Fu C, Olsen N, Xu Y, Grüss A, Liu H, Verley P, Shin Y-J. 2020 Incorporating environmental forcing in developing ecosystem-based fisheries management strategies, *ICES Journal of Marine Science*, Volume 77, Issue 2, Pages 500–514, https://doi.org/10.1093/icesjms/fsz246.

This study incorporated two pathways of environmental forcing (i.e. "larval mortality forcing" and "somatic growth forcing") into an end-to-end ecosystem model (Object-oriented Simulator of Marine ecOSystEms, OSMOSE) developed for the Pacific North Coast Integrated Management Area (PNCIMA) off western Canada, in order to evaluate alternative fisheries management strategies under environmental changes. With a suite of ecosystem-level indicators, the present study first compared the ecosystem effects of different pathways of environmental forcing scenarios; and then evaluated the alternative fisheries management strategies which encompassed a series of fishing mortality rates relative to FMSY (the fishing mortality rate that produces maximum sustainable yield) and a set of precautionary harvest control rules (HCRs). The main objectives of this study were to (i) explore the ecosystem effects of different environmental forcing scenarios; (ii) identify the impacts of different fishing mortality rates on marine ecosystem structure and function; and (iii) evaluate the ecosystem-level performance of various levels of precautionary HCRs. Results indicated that different pathways of environmental forcing had different ecosystem effects and incorporating appropriate HCRs in the fisheries management process could help maintain ecosystem health and sustainable fisheries. This study provides important information on future fisheries management options within similar marine ecosystems that are facing global changes.

Heck N, Agostini V, Reguero B, Pfliegner K, Mucke P, Kirch L, Beck MW. 2020. Fisheries at Risk – Vulnerability of Fisheries to Climate Change. Technical Report. The Nature Conservancy, Berlin.

Fishing is vital to the lives and livelihoods of coastal communities and countries around the world. Yet marine fish and fishers face growing challenges from coastal hazards and climate change. Many coastal countries and communities need support to build resilience and adapt to these changes. This study examines the impacts of climate change on fish and fishers and informs strategies to support adaptation and risk reduction for fishing communities. It refines previous global fisheries risk assessments by: (i) focusing on overall risk (not just vulnerability) and (ii) separately examining multiple aspects of coastal hazards (e.g., waves, storms) and climate change (warming, acidification) that differentially affect fish and fishing communities. We show that these differences in exposure of fish and fishers to climate change affect the strategies to reduce these risks. We provide an assessment of nearterm and future risk based on expected changes in sea surface temperature, ocean acidification, and sea level rise.

Holsman KK, Haynie AC, Hollowed AB *et al.* 2020. Ecosystem-based fisheries management forestalls climate-driven collapse. *Nat Commun 11*, 4579. https://doi.org/10.1038/s41467-020-18300-3.

Climate change is impacting fisheries worldwide with uncertain outcomes for food and nutritional security. Using management strategy evaluations for key US fisheries in the eastern Bering Sea we find that Ecosystem Based Fisheries Management (EBFM) measures forestall future declines under climate change over non-EBFM approaches. Yet, benefits are species-specific and decrease markedly after 2050. Under high-baseline carbon emission scenarios (RCP 8.5), end-of-century (2075–2100) pollock and Pacific cod fisheries collapse in >70% and >35% of all simulations, respectively. Our analysis suggests that 2.1–2.3 °C (modeled summer bottom temperature) is a tipping point of rapid decline in gadid biomass and catch. Multiyear stanzas above 2.1 °C become commonplace in projections from ~2030 onward, with higher agreement under RCP 8.5 than simulations with moderate carbon mitigation (i.e., RCP 4.5). We find that EBFM ameliorates climate change impacts on fisheries in the near-term, but long-term EBFM benefits are limited by the magnitude of anticipated change.

Kurota H, Szuwalski CS, Ichinokawa M. 2020. Drivers of recruitment dynamics in Japanese major fisheries resources: Effects of environmental conditions and spawner abundance. *Fisheries Research*, *221*. https://doi.org/10.1016/j.fishres.2019.105353.

Identifying driving factors of recruitment dynamics is essential for understanding population dynamics of fisheries resources and managing them sustainably. Spawner abundance and environmental conditions have been assumed as driving factors of recruitment, and the relative influence of these two drivers in fish populations has been debated for a long time. We addressed this issue by applying cross-correlation analysis to the time series of recruitment and spawner abundance of 28 Japanese fisheries stocks. The analysis showed that spawner abundance was significantly related to recruitment in 18 of the 28 stocks, but in many stocks, particularly for small pelagic species, recruitment influenced the later spawner abundance more strongly, suggesting a strong influence of the environment. We also detected temporal shifts of recruitment levels corresponding to shifts of wide-area climatic and oceanographic conditions. These results indicate that both spawner abundance and environment might drive recruitment in many stocks, but the apparent effect of spawner abundance might be a by-product of long-term recruitment changes caused by environmental conditions in some cases. Considering our observations, efficient management strategies are needed that are robust to uncertainties of environmental impacts on fish dynamics and spawner-recruitment relationships and match life-history characteristics of managed stocks.

McGowan DW, Goldstein ED, Arimitsu ML, Deary AL, Ormseth O, De Robertis A, Horne JK, Rogers LA, Wilson MT, Coyle KO, Holderied K. 2020. Spatial and temporal dynamics of Pacific capelin *Mallotus catervarius* in the Gulf of Alaska: implications for ecosystem-based fisheries management. *Marine Ecology Progress Series*, *637*, pp.117-140.

Pacific capelin *Mallotus catervarius* are planktivorous small pelagic fish that serve an intermediate trophic role in marine food webs. Due to the lack of a directed fishery or monitoring of capelin in the Northeast Pacific, limited information is available on their distribution and abundance, and how spatio-temporal fluctuations in capelin density affect their availability as prey. To provide information on life history, spatial patterns, and population dynamics of capelin in the Gulf of Alaska (GOA), we modeled distributions of spawning habitat and larval dispersal, and synthesized spatially indexed data from multiple independent sources from 1996 to 2016. Potential capelin spawning areas were broadly distributed across the GOA. Models of larval drift show the GOA's advective circulation patterns disperse capelin larvae over the continental shelf and upper slope, indicating potential connections between spawning areas and observed offshore distributions that are influenced by the location and timing of spawning. Spatial overlap in composite distributions of larval and age-1+ fish was used to identify core areas where capelin consistently occur and concentrate. Capelin primarily occupy shelf waters near the Kodiak Archipelago, and are patchily distributed across the GOA shelf and inshore waters. Interannual variations in abundance along with spatio-temporal differences in density indicate that the availability of capelin to predators and monitoring surveys is highly variable in the GOA. We demonstrate that the limitations of individual data series can be compensated for by integrating multiple data sources to monitor fluctuations in distributions and abundance trends of an ecologically important species across a large marine ecosystem.

Sandoval-Lugo A, Espinosa-Carreón T, Seminoff J, Hart C, Ley-Quiñónez C, Aguirre A, Jones TT, and Zavala-Norzagaray A. 2020. Movements of loggerhead sea turtles (*Caretta caretta*) in the Gulf of California: Integrating satellite telemetry and remotely sensed environmental variables. *Journal of the Marine Biological Association of the United Kingdom, 100*(5), 817-824. doi:10.1017/S0025315420000636.

The loggerhead turtle (*Caretta caretta*) is a circumglobal species and is listed as vulnerable globally. The North Pacific population nests in Japan and migrates to the Central North Pacific and Pacific coast of North America to feed. In the Mexican Pacific, records of loggerhead presence are largely restricted to the Gulf of Ulloa along the Baja California Peninsula, where very high fisheries by-catch mortality has been reported. Records of loggerhead turtles within the Sea of Cortez also known as the Gulf of California (GC) exist; however, their ecology in this region is poorly understood. We used satellite tracking and an environmental variable analysis (chlorophyll-*a* (Chl-*a*) and sea surface temperature (SST)) to determine movements and habitat use of five juvenile loggerhead turtles ranging in straight carapace length from 62.7–68.3 cm (mean: 66.7 ± 2.3 cm). Satellite tracking durations ranged from 73–293 days (mean: 149 ± 62.5 days), transmissions per turtle from 14–1006 (mean: 462 ± 379.5 transmissions) and total travel distance from 1237–5222 km (mean: 3118 ± 1490.7 km). We used travel rate analyses to identify five foraging areas in the GC, which occurred mainly in waters from 10–80 m deep, with mean Chl-*a* concentrations ranging from 0.28–13.14 mg m^{-3} and SST ranging from 27.8–34.4°C. This is the first study to describe loggerhead movements in the Gulf of California and our data suggest that loggerhead foraging movements are performed in areas with eutrophic levels of Chl-*a*.

Weijerman M, Oyafuso ZS, Leong KM, Oleson KLL, Winston M. 2020. Supporting Ecosystem-based Fisheries Management in meeting multiple objectives for sustainable use of coral reef ecosystems, *ICES Journal of Marine Science*, https://doi.org/10.1093/icesjms/fsaa194.

Ecosystem-based Fisheries Management is a holistic management approach that integrates the dynamics of an entire ecosystem, including societal dimensions. However, this approach seldom lives up to its promise because economic and social objectives are rarely specified. To fill this gap, we explored how an ecosystem model could better integrate economic and social objectives, using the coral reef ecosystem around Hawai`i as a case study. After meeting with stakeholders and conducting a literature review of policy/strategy documents, we identified societal and ecological objectives and associated performance indicators for which data existed. We developed a social–ecological system conceptual framework to illustrate the relationships between ecological and social state components. This framework was the foundation for the development of the final social–ecological system model which we simulated using an Ecopath with Ecosim model. We simulated four gear/species restrictions for the reef-based fishery, two fishing scenarios associated with the opening of hypothetical no-take Marine Protected Areas for the deepwater-based fishery, and a Constant Effort (No Action) scenario. Despite limitations in the model, our approach shows that when social and economic objectives and social–ecological relationships are defined, we can quantify the trade-offs among the identified societal objectives to support managers in choosing among alternative interventions.

Vargas-Ángel B, Huntington B. 2020. Status and trends assessments for land-based sources of pollution impacts on benthic reef communities in Faga‘alu Bay, American Samoa. U.S. Dept. of Commerce, NOAA Technical Memorandum NOAA-TM-NMFS-PIFSC-109, 38 p. doi:10.25923/0gvj-zm69.

This report provides a summary of key findings for work completed between 2012 and 2020 to assess the effectiveness of management actions conducted at the Samoa Maritime quarry in Faga‘alu, American Samoa. Collectively, these data offer a contrast between the 2012/2013 pre-intervention and 2015–2020 post-intervention status, and examine how benthic and coral community response variables differed across factors of year (2012/2013, 2015, 2020) and reef stratum (backreef north, backreef south, forereef north, and forereef south).

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APPENDIX A: LIST OF SPECIES

AMERICAN SAMOA MANAGEMENT UNIT SPECIES

1. Bottomfish Multi-species Stock Complex (FSSI)

DMWR Creel Species Code	Species Name	Scientific Name
247	red snapper, silvermouth (lehi) (silverjaw jobfish)	*Aphareus rutilans*
239	grey snapper, jobfish	*Aprion virescens*
111	black trevally, jack	*Caranx lugubris*
229	lunar tail grouper (yellow edge lyretail)	*Variola louti*
249	red snapper	*Etelis carbunculus*
248	longtail snapper	*Etelis coruscans*
267	redgill emperor	*Lethrinus rubrioperculatus*
231	blueline snapper	*Lutjanus kasmira*
242	pink snapper (paka)	*Pristipomoides filamentosus*
241	yelloweye snapper	*Pristipomoides flavipinnis*
245	flower snapper (gindai)	*Pristipomoides zonatus*

MONITORED ECOSYSTEM COMPONENT SPECIES

1. Species Selected for Monitoring by DMWR

DMWR Creel Species Code	Species Name	Scientific Name
3511	Bluelined squirrelfish	*Sargocentron tiere*
1301	Fringelip mullet	*Crenimugil crenilabis*
504	Green spiny lobster	*Panulirus penicillatus*
None	Small giant clam	*Tridacna maxima*
5061	Day octopus	*Octopus cyanea*
208	One-blotch grouper	*Epinephelus melanostigma*

2. Species Monitored by Trophic, Taxonomic, and Functional Groups

The species presented in Section 2.1 are displayed according to both trophic level and functional group as an effort to foster continued monitoring of ecosystem component species that are no longer categorized as management unit species. These species are monitored according to their ecosystem function as opposed to individually. Monitoring based on these factors allows for a broader outlook on the ecological composition of fish communities in areas of the Western Pacific. For trophic groupings, "H" stands for "Herbivore", "Cor" stands for "Corallivore", "PK" stands for "Planktivore", "MI" stands for "Mobile Invertebrate Feeder", "SI" stands for "Sessile-Invertebrate Feeder, "Om" stands for "Omnivore", and "Pisc" stands for "Piscovore".

Family	Scientific Name	Trophic Group	Functional Group
Acanthuridae	*Naso lituratus*	H	Browsing Surgeons
Acanthuridae	*Naso tonganus*	H	Browsing Surgeons
Acanthuridae	*Naso unicornis*	H	Browsing Surgeons
Acanthuridae	*Naso brachycentron*	H	Browsing Surgeons
Acanthuridae	*Ctenochaetus cyanocheilus*	H	Mid-Large Target Surgeons
Acanthuridae	*Ctenochaetus strigosus*	H	Mid-Large Target Surgeons
Acanthuridae	*Acanthurus nigroris*	H	Mid-Large Target Surgeons
Acanthuridae	*Ctenochaetus hawaiiensis*	H	Mid-Large Target Surgeons
Acanthuridae	*Ctenochaetus striatus*	H	Mid-Large Target Surgeons
Acanthuridae	*Ctenochaetus marginatus*	H	Mid-Large Target Surgeons
Acanthuridae	*Acanthurus lineatus*	H	Mid-Large Target Surgeons
Acanthuridae	*Acanthurus blochii*	H	Mid-Large Target Surgeons
Acanthuridae	*Acanthurus dussumieri*	H	Mid-Large Target Surgeons
Acanthuridae	*Acanthurus xanthopterus*	H	Mid-Large Target Surgeons
Chaetodontidae	*Chaetodon flavocoronatus*	Cor	Non-PK Butterflyfish
Chaetodontidae	*Chaetodon multicinctus*	Cor	Non-PK Butterflyfish
Chaetodontidae	*Chaetodon punctatofasciatus*	MI	Non-PK Butterflyfish
Chaetodontidae	*Chaetodon mertensii*	H	Non-PK Butterflyfish
Chaetodontidae	*Chaetodon citrinellus*	Cor	Non-PK Butterflyfish
Chaetodontidae	*Chaetodon pelewensis*	Cor	Non-PK Butterflyfish
Chaetodontidae	*Chaetodon lunulatus*	Cor	Non-PK Butterflyfish
Chaetodontidae	*Chaetodon melannotus*	Cor	Non-PK Butterflyfish
Chaetodontidae	*Chaetodon rafflesii*	Cor	Non-PK Butterflyfish
Chaetodontidae	*Chaetodon ulietensis*	MI	Non-PK Butterflyfish
Chaetodontidae	*Chaetodon fremblii*	SI	Non-PK Butterflyfish
Chaetodontidae	*Chaetodon quadrimaculatus*	Cor	Non-PK Butterflyfish

Chaetodontidae	*Chaetodon meyeri*	Cor	Non-PK Butterflyfish
Chaetodontidae	*Chaetodon reticulatus*	Cor	Non-PK Butterflyfish
Chaetodontidae	*Chaetodon trifascialis*	Cor	Non-PK Butterflyfish
Chaetodontidae	*Heniochus chrysostomus*	Cor	Non-PK Butterflyfish
Chaetodontidae	*Chaetodon bennetti*	MI	Non-PK Butterflyfish
Chaetodontidae	*Chaetodon tinkeri*	SI	Non-PK Butterflyfish
Chaetodontidae	*Heniochus varius*	Cor	Non-PK Butterflyfish
Chaetodontidae	*Chaetodon ornatissimus*	Cor	Non-PK Butterflyfish
Chaetodontidae	*Chaetodon unimaculatus*	Cor	Non-PK Butterflyfish
Chaetodontidae	*Chaetodon lunula*	SI	Non-PK Butterflyfish
Chaetodontidae	*Forcipiger longirostris*	MI	Non-PK Butterflyfish
Chaetodontidae	*Forcipiger flavissimus*	SI	Non-PK Butterflyfish
Chaetodontidae	*Chaetodon ephippium*	MI	Non-PK Butterflyfish
Chaetodontidae	*Heniochus monoceros*	MI	Non-PK Butterflyfish
Chaetodontidae	*Chaetodon auriga*	SI	Non-PK Butterflyfish
Chaetodontidae	*Chaetodon vagabundus*	SI	Non-PK Butterflyfish
Chaetodontidae	*Chaetodon semeion*	H	Non-PK Butterflyfish
Chaetodontidae	*Chaetodontidae*	Cor	Non-PK Butterflyfish
Chaetodontidae	*Heniochus singularius*	Cor	Non-PK Butterflyfish
Chaetodontidae	*Chaetodon lineolatus*	SI	Non-PK Butterflyfish
Caracanthidae	*Caracanthus typicus*	MI	No Group
Gobiidae	*Eviota* sp.	MI	No Group
Pomacentridae	*Chrysiptera traceyi*	H	No Group
Apogonidae	*Ostorhinchus luteus*	Pk	No Group
Caracanthidae	*Caracanthus maculatus*	MI	No Group
Pseudochromidae	*Pseudochromis jamesi*	MI	No Group
Pomacentridae	*Chromis acares*	Pk	No Group
Serranidae	*Luzonichthys whitleyi*	Pk	No Group
Pomacentridae	*Pomachromis guamensis*	Pk	No Group
Pomacentridae	*Pomachromis richardsoni*	Pk	No Group
Gobiidae	*Fusigobius duospilus*	MI	No Group
Pomacentridae	*Plectroglyphidodon imparipennis*	MI	No Group
Microdesmidae	*Nemateleotris helfrichi*	Pk	No Group
Pomacentridae	*Chromis leucura*	Pk	No Group
Syngnathidae	*Doryrhamphus excisus*	Pk	No Group
Pomacentridae	*Pomacentrus coelestis*	Pk	No Group
Clupeidae	*Spratelloides delicatulus*	Pk	No Group
Pomacentridae	*Chrysiptera biocellata*	H	No Group

Pseudochromidae	*Pictichromis porphyreus*	MI	No Group
Pomacanthidae	*Centropyge fisheri*	H	No Group
Cirrhitidae	*Cirrhitops hubbardi*	MI	No Group
Gobiidae	*Amblyeleotris fasciata*	Pk	No Group
Pomacentridae	*Chromis lepidolepis*	Pk	No Group
Pomacentridae	*Chromis margaritifer*	Pk	No Group
Pomacentridae	*Chromis ternatensis*	Pk	No Group
Pomacentridae	*Chromis viridis*	Pk	No Group
Pomacentridae	*Chrysiptera cyanea*	Pk	No Group
Pomacentridae	*Dascyllus aruanus*	Pk	No Group
Pomacentridae	*Dascyllus reticulatus*	Pk	No Group
Engraulidae	*Encrasicholina purpurea*	Pk	No Group
Pomacentridae	*Neopomacentrus metallicus*	Pk	No Group
Pomacentridae	*Chromis amboinensis*	H	No Group
Pomacentridae	*Chromis iomelas*	H	No Group
Pomacentridae	*Chrysiptera glauca*	H	No Group
Pomacentridae	*Chrysiptera taupou*	H	No Group
Labridae	*Labroides pectoralis*	MI	No Group
Labridae	*Pseudocheilinus hexataenia*	MI	No Group
Labridae	*Pseudocheilinus tetrataenia*	MI	No Group
Scorpaenidae	*Sebastapistes cyanostigma*	MI	No Group
Labridae	*Wetmorella nigropinnata*	MI	No Group
Pseudochromidae	*Pseudochromis* sp.	MI	No Group
Monacanthidae	*Pervagor marginalis*	Om	No Group
Pomacentridae	*Chromis alpha*	Pk	No Group
Pomacentridae	*Plectroglyphidodon phoenixensis*	H	No Group
Gobiidae	*Amblyeleotris guttata*	Pk	No Group
Atherinidae	*Atherinomorus insularum*	Pk	No Group
Pomacentridae	*Chromis caudalis*	Pk	No Group
Pomacentridae	*Chromis hanui*	Pk	No Group
Labridae	*Cirrhilabrus katherinae*	Pk	No Group
Microdesmidae	*Nemateleotris magnifica*	Pk	No Group
Apogonidae	*Ostorhinchus angustatus*	Pk	No Group
Serranidae	*Pseudanthias bartlettorum*	Pk	No Group
Tetraodontidae	*Canthigaster jactator*	H	No Group
Tetraodontidae	*Canthigaster janthinoptera*	H	No Group
Tetraodontidae	*Canthigaster valentini*	H	No Group
Pomacanthidae	*Centropyge shepardi*	H	No Group

Pomacentridae	*Chrysiptera brownriggii*	H	No Group
Monacanthidae	*Oxymonacanthus longirostris*	Cor	No Group
Cirrhitidae	*Amblycirrhitus bimacula*	MI	No Group
Cirrhitidae	*Cirrhitichthys falco*	MI	No Group
Labridae	*Labroides rubrolabiatus*	MI	No Group
Cirrhitidae	*Neocirrhites armatus*	MI	No Group
Labridae	*Pseudojuloides splendens*	MI	No Group
Apogonidae	*Ostorhinchus novemfasciatus*	Pk	No Group
Labridae	*Pteragogus cryptus*	MI	No Group
Scorpaenidae	*Sebastapistes* sp.	Pisc	No Group
Scorpaenidae	*Taenianotus triacanthus*	Pisc	No Group
Pomacentridae	*Amphiprion perideraion*	Pk	No Group
Pomacentridae	*Chromis fumea*	Pk	No Group
Labridae	*Cirrhilabrus jordani*	Pk	No Group
Blenniidae	*Ecsenius bicolor*	Pk	No Group
Blenniidae	*Ecsenius midas*	Pk	No Group
Blenniidae	*Ecsenius opsifrontalis*	Pk	No Group
Pomacentridae	*Lepidozygus tapeinosoma*	Pk	No Group
Blenniidae	*Meiacanthus atrodorsalis*	Pk	No Group
Apogonidae	*Ostorhinchus apogonoides*	Pk	No Group
Pomacentridae	*Plectroglyphidodon lacrymatus*	Pk	No Group
Pomacentridae	*Pomacentrus brachialis*	Pk	No Group
Pomacentridae	*Pomacentrus nigriradiatus*	Pk	No Group
Pomacentridae	*Pomacentrus philippinus*	Pk	No Group
Pomacentridae	*Pomacentrus vaiuli*	Pk	No Group
Serranidae	*Pseudanthias dispar*	Pk	No Group
Serranidae	*Pseudanthias hawaiiensis*	Pk	No Group
Tetraodontidae	*Canthigaster bennetti*	H	No Group
Pomacanthidae	*Centropyge bispinosa*	H	No Group
Pomacanthidae	*Centropyge heraldi*	H	No Group
Pomacanthidae	*Centropyge loricula*	H	No Group
Blenniidae	*Cirripectes obscurus*	H	No Group
Blenniidae	*Cirripectes polyzona*	H	No Group
Blenniidae	*Cirripectes* sp.	H	No Group
Blenniidae	*Cirripectes springeri*	H	No Group
Blenniidae	*Cirripectes stigmaticus*	H	No Group

Blenniidae	*Cirripectes variolosus*	H	No Group
Callionymidae	*Callionymidae*	MI	No Group
Labridae	*Labroides phthirophagus*	MI	No Group
Pomacanthidae	*Paracentropyge multifasciata*	MI	No Group
Blenniidae	*Plagiotremus ewaensis*	MI	No Group
Blenniidae	*Plagiotremus goslinei*	MI	No Group
Scorpaenidae	*Sebastapistes coniorta*	MI	No Group
Monacanthidae	*Pervagor melanocephalus*	Om	No Group
Blenniidae	*Plagiotremus laudandus*	Par	No Group
Blenniidae	*Plagiotremus rhinorhynchos*	Par	No Group
Blenniidae	*Plagiotremus tapeinosoma*	Par	No Group
Labridae	*Pseudocheilinus ocellatus*	MI	No Group
Pomacanthidae	*Centropyge flavissima & vroliki*	H	No Group
Pomacentridae	*Amblyglyphidodon curacao*	Om	No Group
Pomacentridae	*Amphiprion melanopus*	Pk	No Group
Pomacentridae	*Chromis agilis*	Pk	No Group
Gobiidae	*Istigobius* sp.	Pk	No Group
Pomacentridae	*Pomacentrus pavo*	Pk	No Group
Apogonidae	*Pristiapogon fraenatus*	Pk	No Group
Tetraodontidae	*Canthigaster epilampra*	H	No Group
Tetraodontidae	*Canthigaster solandri*	H	No Group
Blenniidae	*Cirripectes vanderbilti*	H	No Group
Pomacentridae	*Stegastes albifasciatus*	H	No Group
Pomacentridae	*Stegastes aureus*	H	No Group
Pomacentridae	*Stegastes marginatus*	H	No Group
Pomacentridae	*Plectroglyphidodon dickii*	Cor	No Group
Cirrhitidae	*Paracirrhites xanthus*	MI	No Group
Monacanthidae	*Paraluteres prionurus*	MI	No Group
Microdesmidae	*Microdesmidae*	Pk	No Group
Scorpaenidae	*Sebastapistes ballieui*	MI	No Group
Apogonidae	*Apogon kallopterus*	Pk	No Group
Pomacentridae	*Chromis weberi*	Pk	No Group
Labridae	*Cirrhilabrus exquisitus*	Pk	No Group
Syngnathidae	*Corythoichthys flavofasciatus*	Pk	No Group
Pomacentridae	*Dascyllus albisella*	Pk	No Group
Microdesmidae	*Gunnellichthys curiosus*	Pk	No Group

Apogonidae	*Pristiapogon kallopterus*	Pk	No Group
Serranidae	*Pseudanthias olivaceus*	Pk	No Group
Ptereleotridae	*Ptereleotris heteroptera*	Pk	No Group
Ptereleotridae	*Ptereleotris zebra*	Pk	No Group
Pomacanthidae	*Centropyge vrolikii*	H	No Group
Pomacentridae	*Plectroglyphidodon leucozonus*	H	No Group
Pomacentridae	*Plectroglyphidodon johnstonianus*	Cor	No Group
Labridae	*Anampses melanurus*	MI	No Group
Apogonidae	*Cheilodipterus quinquelineatus*	MI	No Group
Cirrhitidae	*Cirrhitichthys oxycephalus*	MI	No Group
Cirrhitidae	*Cirrhitops fasciatus*	MI	No Group
Labridae	*Halichoeres biocellatus*	MI	No Group
Labridae	*Labroides dimidiatus*	MI	No Group
Labridae	*Labropsis micronesica*	MI	No Group
Labridae	*Macropharyngodon negrosensis*	MI	No Group
Labridae	*Pseudojuloides cerasinus*	MI	No Group
Labridae	*Pseudojuloides polynesica*	MI	No Group
Blenniidae	*Aspidontus taeniatus*	Par	No Group
Tetraodontidae	*Torquigener randalli*	MI	No Group
Pomacentridae	*Plectroglyphidodon sindonis*	H	No Group
Pomacanthidae	*Centropyge potteri*	H	No Group
Cirrhitidae	*Oxycirrhites typus*	Pk	No Group
Serranidae	*Pseudanthias bicolor*	Pk	No Group
Ptereleotridae	*Ptereleotris microlepis*	Pk	No Group
Pomacentridae	*Stegastes lividus*	H	No Group
Labridae	*Cirrhilabrus punctatus*	MI	No Group
Labridae	*Halichoeres margaritaceus*	MI	No Group
Labridae	*Pseudojuloides atavai*	MI	No Group
Holocentridae	*Sargocentron punctatissimum*	MI	No Group
Monacanthidae	*Pervagor janthinosoma*	Om	No Group
Pomacentridae	*Amphiprion clarkii*	Pk	No Group
Serranidae	*Anthias* sp.	Pk	No Group
Blenniidae	*Blenniella chrysospilos*	Pk	No Group
Chaetodontidae	*Chaetodon kleinii*	Pk	No Group
Pomacentridae	*Dascyllus trimaculatus*	Pk	No Group

Apogonidae	*Ostorhinchus maculiferus*	Pk	No Group
Serranidae	*Pseudanthias cooperi*	Pk	No Group
Gobiidae	*Amblygobius phalaena*	H	No Group
Tetraodontidae	*Canthigaster amboinensis*	H	No Group
Tetraodontidae	*Canthigaster coronata*	H	No Group
Pomacanthidae	*Centropyge flavissima*	H	No Group
Pomacentridae	*Stegastes nigricans*	H	No Group
Labridae	*Halichoeres melanurus*	MI	No Group
Labridae	*Halichoeres melasmapomus*	MI	No Group
Labridae	*Labroides bicolor*	MI	No Group
Labridae	*Labropsis xanthonota*	MI	No Group
Cirrhitidae	*Paracirrhites arcatus*	MI	No Group
Labridae	*Pseudocheilinus evanidus*	MI	No Group
Labridae	*Pseudocheilinus octotaenia*	MI	No Group
Monacanthidae	*Pervagor aspricaudus*	Om	No Group
Ostraciidae	*Lactoria fornasini*	SI	No Group
Labridae	*Pseudojuloides* sp.	MI	No Group
Pomacentridae	*Abudefduf sexfasciatus*	Pk	No Group
Pomacentridae	*Chromis vanderbilti*	Pk	No Group
Pomacentridae	*Chromis xanthura*	Pk	No Group
Labridae	*Cirrhilabrus* sp.	Pk	No Group
Pomacanthidae	*Genicanthus watanabei*	Pk	No Group
Labridae	*Thalassoma amblycephalum*	Pk	No Group
Pomacanthidae	*Centropyge bicolor*	H	No Group
Serranidae	*Belonoperca chabanaudi*	MI	No Group
Labridae	*Coris centralis*	MI	No Group
Labridae	*Halichoeres ornatissimus*	MI	No Group
Malacanthidae	*Hoplolatilus starcki*	MI	No Group
Labridae	*Macropharyngodon meleagris*	MI	No Group
Labridae	*Oxycheilinus bimaculatus*	MI	No Group
Labridae	*Pteragogus enneacanthus*	MI	No Group
Labridae	*Stethojulis balteata*	MI	No Group
Labridae	*Stethojulis strigiventer*	MI	No Group
Labridae	*Stethojulis trilineata*	MI	No Group
Pomacentridae	*Stegastes* sp.	H	No Group
Apogonidae	*Apogon* sp.	Pk	No Group
Apogonidae	*Apogonidae*	Pk	No Group
Chaetodontidae	*Chaetodon miliaris*	Pk	No Group

Pomacentridae	*Dascyllus auripinnis*	Pk	No Group
Labridae	*Pseudocoris yamashiroi*	Pk	No Group
Labridae	*Stethojulis bandanensis*	Pk	No Group
Monacanthidae	*Cantherhines verecundus*	H	No Group
Pomacanthidae	*Centropyge interrupta*	H	No Group
Pomacentridae	*Stegastes fasciolatus*	H	No Group
Blenniidae	*Exallias brevis*	Cor	No Group
Labridae	*Labrichthys unilineatus*	Cor	No Group
Labridae	*Halichoeres prosopeion*	MI	No Group
Labridae	*Macropharyngodon geoffroy*	MI	No Group
Gobiidae	*Valenciennea strigata*	MI	No Group
Ostraciidae	*Ostracion whitleyi*	SI	No Group
Scorpaenidae	*Dendrochirus barberi*	MI	No Group
Blenniidae	*Blenniidae*	Pk	No Group
Synodontidae	*Synodus binotatus*	Pisc	No Group
Pomacentridae	*Amphiprion chrysopterus*	Pk	No Group
Serranidae	*Pseudanthias pascalus*	Pk	No Group
Acanthuridae	*Ctenochaetus flavicauda*	H	No Group
Labridae	*Cheilinus oxycephalus*	MI	No Group
Holocentridae	*Sargocentron diadema*	MI	No Group
Holocentridae	*Sargocentron xantherythrum*	MI	No Group
Labridae	*Thalassoma quinquevittatum*	MI	No Group
Labridae	*Iniistius umbrilatus*	MI	No Group
Labridae	*Thalassoma* sp.	MI	No Group
Pomacentridae	*Pomacentridae*	Om	No Group
Pomacentridae	*Abudefduf notatus*	Pk	No Group
Chaetodontidae	*Hemitaurichthys polylepis*	Pk	No Group
Ptereleotridae	*Ptereleotris evides*	Pk	No Group
Labridae	*Anampses twistii*	MI	No Group
Apogonidae	*Cheilodipterus* sp.	MI	No Group
Labridae	*Cymolutes lecluse*	MI	No Group
Labridae	*Halichoeres hartzfeldii*	MI	No Group
Labridae	*Halichoeres marginatus*	MI	No Group
Pinguipedidae	*Parapercis clathrata*	MI	No Group
Pinguipedidae	*Parapercis schauinslandii*	MI	No Group
Labridae	*Choerodon jordani*	Om	No Group
Monacanthidae	*Pervagor* sp.	Om	No Group
Monacanthidae	*Pervagor spilosoma*	Om	No Group

Pomacanthidae	*Apolemichthys arcuatus*	SI	No Group
Holocentridae	*Neoniphon argenteus*	MI	No Group
Apogonidae	*Cheilodipterus artus*	MI	No Group
Pomacentridae	*Chromis ovalis*	Pk	No Group
Labridae	*Bodianus mesothorax*	MI	No Group
Pinguipedidae	*Parapercis millepunctata*	MI	No Group
Labridae	*Halichoeres* sp.	MI	No Group
Serranidae	*Cephalopholis leopardus*	Pisc	No Group
Apogonidae	*Cheilodipterus macrodon*	Pisc	No Group
Pomacentridae	*Abudefduf vaigiensis*	Pk	No Group
Chaetodontidae	*Heniochus diphreutes*	Pk	No Group
Holocentridae	*Myripristis vittata*	Pk	No Group
Caesionidae	*Pterocaesio trilineata*	Pk	No Group
Labridae	*Thalassoma hardwicke*	Pk	No Group
Monacanthidae	*Cantherhines sandwichiensis*	H	No Group
Tetraodontidae	*Canthigaster rivulata*	H	No Group
Acanthuridae	*Zebrasoma flavescens*	H	No Group
Acanthuridae	*Zebrasoma scopas*	H	No Group
Monacanthidae	*Amanses scopas*	Cor	No Group
Labridae	*Anampses chrysocephalus*	MI	No Group
Labridae	*Anampses* sp.	MI	No Group
Labridae	*Bodianus axillaris*	MI	No Group
Labridae	*Bodianus prognathus*	MI	No Group
Labridae	*Coris dorsomacula*	MI	No Group
Labridae	*Coris venusta*	MI	No Group
Labridae	*Cymolutes praetextatus*	MI	No Group
Labridae	*Pseudocoris aurantiofasciata*	MI	No Group
Labridae	*Pseudocoris heteroptera*	MI	No Group
Scorpaenidae	*Pterois antennata*	MI	No Group
Holocentridae	*Sargocentron microstoma*	MI	No Group
Labridae	*Thalassoma jansenii*	MI	No Group
Nemipteridae	*Scolopsis lineata*	Om	No Group
Zanclidae	*Zanclus cornutus*	SI	No Group
Labridae	*Bodianus anthioides*	Pk	No Group
Chaetodontidae	*Hemitaurichthys thompsoni*	Pk	No Group
Acanthuridae	*Zebrasoma rostratum*	H	No Group
Kuhliidae	*Kuhlia sandvicensis*	Pk	No Group
Scorpaenidae	*Pterois sphex*	Pisc	No Group

Synodontidae	*Synodontidae*	Pisc	No Group
Pomacentridae	*Chromis verater*	Pk	No Group
Pempheridae	*Pempheridae*	Pk	No Group
Serranidae	*Pseudanthias thompsoni*	Pk	No Group
Balistidae	*Xanthichthys auromarginatus*	Pk	No Group
Acanthuridae	*Ctenochaetus binotatus*	H	No Group
Labridae	*Anampses meleagrides*	MI	No Group
Labridae	*Iniistius aneitensis*	MI	No Group
Mullidae	*Parupeneus chrysonemus*	MI	No Group
Balistidae	*Sufflamen chrysopterum*	MI	No Group
Cirrhitidae	*Paracirrhites forsteri*	Pisc	No Group
Synodontidae	*Saurida gracilis*	Pisc	No Group
Holocentridae	*Myripristis kuntee*	Pk	No Group
Pempheridae	*Pempheris oualensis*	Pk	No Group
Pomacentridae	*Abudefduf septemfasciatus*	H	No Group
Acanthuridae	*Acanthurus nigricans*	H	No Group
Acanthuridae	*Acanthurus nigrofuscus*	H	No Group
Holocentridae	*Neoniphon aurolineatus*	MI	No Group
Pinguipedidae	*Parapercis* sp.	MI	No Group
Labridae	*Bodianus sanguineus*	Om	No Group
Synodontidae	*Synodus dermatogenys*	Pisc	No Group
Synodontidae	*Synodus variegatus*	Pisc	No Group
Pomacentridae	*Abudefduf sordidus*	H	No Group
Holocentridae	*Myripristis earlei*	MI	No Group
Pomacentridae	*Abudefduf abdominalis*	Pk	No Group
Pomacanthidae	*Genicanthus personatus*	Pk	No Group
Chaetodontidae	*Heniochus acuminatus*	Pk	No Group
Holocentridae	*Myripristis chryseres*	Pk	No Group
Holocentridae	*Myripristis woodsi*	Pk	No Group
Labridae	*Thalassoma lunare*	Pk	No Group
Acanthuridae	*Acanthurus achilles*	H	No Group
Acanthuridae	*Acanthurus achilles & nigricans*	H	No Group
Acanthuridae	*Acanthurus leucopareius*	H	No Group
Acanthuridae	*Acanthurus pyroferus*	H	No Group
Monacanthidae	*Cantherhines pardalis*	H	No Group
Labridae	*Bodianus diana*	MI	No Group
Balistidae	*Rhinecanthus rectangulus*	MI	No Group

Holocentridae	*Sargocentron caudimaculatum*	MI	No Group
Holocentridae	*Sargocentron ensifer*	MI	No Group
Labridae	*Thalassoma duperrey* & *quinquevittatum*	MI	No Group
Labridae	*Thalassoma lutescens*	MI	No Group
Pomacanthidae	*Apolemichthys griffisi*	SI	No Group
Pomacanthidae	*Apolemichthys trimaculatus*	SI	No Group
Pomacanthidae	*Apolemichthys xanthopunctatus*	SI	No Group
Pomacanthidae	*Pygoplites diacanthus*	SI	No Group
Serranidae	*Epinephelus hexagonatus*	Pisc	No Group
Acanthuridae	*Acanthurus nubilus*	Pk	No Group
Muraenidae	*Gymnothorax melatremus*	MI	No Group
Labridae	*Pseudodax moluccanus*	MI	No Group
Labridae	*Thalassoma duperrey*	MI	No Group
Acanthuridae	*Acanthurus triostegus*	H	No Group
Serranidae	*Grammistes sexlineatus*	MI	No Group
Labridae	*Halichoeres hortulanus*	MI	No Group
Labridae	*Halichoeres trimaculatus*	MI	No Group
Serranidae	*Cephalopholis urodeta*	Pisc	No Group
Cirrhitidae	*Paracirrhites hemistictus*	Pisc	No Group
Acanthuridae	*Acanthurus thompsoni*	Pk	No Group
Siganidae	*Siganus spinus*	H	No Group
Balistidae	*Rhinecanthus lunula*	MI	No Group
Balistidae	*Sufflamen bursa*	MI	No Group
Ostraciidae	*Ostracion meleagris*	SI	No Group
Acanthuridae	*Acanthurus guttatus*	H	No Group
Cirrhitidae	*Cirrhitidae*	MI	No Group
Serranidae	*Cephalopholis spiloparaea*	Pisc	No Group
Labridae	*Oxycheilinus digramma*	Pisc	No Group
Scorpaenidae	*Scorpaenopsis diabolus*	Pisc	No Group
Scorpaenidae	*Scorpaenopsis* sp.	Pisc	No Group
Synodontidae	*Synodus ulae*	Pisc	No Group
Caesionidae	*Caesio lunaris*	Pk	No Group
Balistidae	*Canthidermis maculata*	Pk	No Group
Hemiramphidae	*Hyporhamphus acutus*	Pk	No Group
Caesionidae	*Pterocaesio lativittata*	Pk	No Group
Caesionidae	*Pterocaesio tile*	Pk	No Group

Carangidae	*Selar crumenophthalmus*	Pk	No Group
Balistidae	*Xanthichthys mento*	Pk	No Group
Acanthuridae	*Ctenochaetus* sp.	H	No Group
Acanthuridae	*Naso thynnoides*	H	No Group
Balistidae	*Balistapus undulatus*	MI	No Group
Cirrhitidae	*Cirrhitus pinnulatus*	MI	No Group
Labridae	*Coris ballieui*	MI	No Group
Lethrinidae	*Gnathodentex aureolineatus*	MI	No Group
Malacanthidae	*Malacanthus brevirostris*	MI	No Group
Mullidae	*Mulloidichthys mimicus*	MI	No Group
Holocentridae	*Myripristis violacea*	MI	No Group
Labridae	*Novaculichthys taeniourus*	MI	No Group
Balistidae	*Rhinecanthus aculeatus*	MI	No Group
Synodontidae	*Saurida flamma*	Pisc	No Group
Acanthuridae	*Paracanthurus hepatus*	Pk	No Group
Caesionidae	*Caesionidae*	Pk	No Group
Holocentridae	*Holocentridae*	MI	No Group
Priacanthidae	*Heteropriacanthus carolinus*	Pk	No Group
Holocentridae	*Myripristis adusta*	Pk	No Group
Holocentridae	*Myripristis amaena*	Pk	No Group
Labridae	*Cheilinus chlorourus*	MI	No Group
Labridae	*Gomphosus varius*	MI	No Group
Lethrinidae	*Lethrinus harak*	MI	No Group
Holocentridae	*Neoniphon sammara*	MI	No Group
Serranidae	*Epinephelus melanostigma*	Pisc	No Group
Serranidae	*Epinephelus merra*	Pisc	No Group
Holocentridae	*Myripristis berndti*	Pk	No Group
Priacanthidae	*Priacanthus hamrur*	Pk	No Group
Priacanthidae	*Priacanthus meeki*	Pk	No Group
Acanthuridae	*Acanthurus albipectoralis*	H	No Group
Tetraodontidae	*Arothron nigropunctatus*	Cor	No Group
Mullidae	*Parupeneus insularis*	MI	No Group
Mullidae	*Parupeneus pleurostigma*	MI	No Group
Holocentridae	*Sargocentron tiere*	MI	No Group
Labridae	*Thalassoma trilobatum*	MI	No Group
Mullidae	*Upeneus taeniopterus*	MI	No Group
Balistidae	*Melichthys vidua*	H	No Group
Serranidae	*Epinephelus spilotoceps*	Pisc	No Group

Lutjanidae	*Lutjanus semicinctus*	Pisc	No Group
Serranidae	*Pogonoperca punctata*	Pisc	No Group
Caesionidae	*Caesio caerulaurea*	Pk	No Group
Carangidae	*Decapterus macarellus*	Pk	No Group
Holocentridae	*Myripristinae*	Pk	No Group
Caesionidae	*Pterocaesio marri*	Pk	No Group
Balistidae	*Xanthichthys caeruleolineatus*	Pk	No Group
Labridae	*Iniistius pavo*	MI	No Group
Holocentridae	*Neoniphon opercularis*	MI	No Group
Holocentridae	*Neoniphon* sp.	MI	No Group
Mullidae	*Parupeneus crassilabris*	MI	No Group
Labridae	*Anampses cuvier*	MI	No Group
Labridae	*Cheilinus fasciatus*	MI	No Group
Siganidae	*Siganus punctatus*	H	No Group
Gobiidae	*Gobiidae*	MI	No Group
Scorpaenidae	*Pterois volitans*	Pisc	No Group
Balistidae	*Melichthys niger*	Pk	No Group
Priacanthidae	*Priacanthus* sp.	Pk	No Group
Monacanthidae	*Monacanthidae*	H	No Group
Siganidae	*Siganidae*	H	No Group
Diodontidae	*Diodon holocanthus*	MI	No Group
Mullidae	*Mulloidichthys vanicolensis*	MI	No Group
Mullidae	*Parupeneus multifasciatus*	MI	No Group
Balistidae	*Sufflamen fraenatum*	MI	No Group
Monacanthidae	*Cantherhines dumerilii*	Om	No Group
Pomacanthidae	*Pomacanthus imperator*	SI	No Group
Lethrinidae	*Lethrinus rubrioperculatus*	MI	No Group
Caesionidae	*Caesio teres*	Pk	No Group
Balistidae	*Odonus niger*	Pk	No Group
Acanthuridae	*Acanthurus nigricauda*	H	No Group
Acanthuridae	*Acanthurus olivaceus*	H	No Group
Acanthuridae	*Zebrasoma veliferum*	H	No Group
Labridae	*Bodianus loxozonus*	MI	No Group
Labridae	*Coris gaimard*	MI	No Group
Labridae	*Hologymnosus annulatus*	MI	No Group
Labridae	*Hologymnosus doliatus*	MI	No Group
Mullidae	*Mulloidichthys flavolineatus*	MI	No Group
Acanthuridae	*Acanthurus maculiceps*	H	No Group

Kyphosidae	*Kyphosus hawaiiensis*	H	No Group
Cheilodactylidae	*Cheilodactylus vittatus*	SI	No Group
Ostraciidae	*Ostraciidae*	SI	No Group
Siganidae	*Siganus argenteus*	H	No Group
Labridae	*Anampses caeruleopunctatus*	MI	No Group
Serranidae	*Epinephelus fasciatus*	Pisc	No Group
Labridae	*Thalassoma ballieui*	MI	No Group
Labridae	*Thalassoma purpureum*	MI	No Group
Serranidae	*Cephalopholis miniata*	Pisc	No Group
Hemiramphidae	*Hemiramphidae*	Pk	No Group
Acanthuridae	*Acanthurus leucocheilus*	H	No Group
Ostraciidae	*Ostracion cubicus*	H	No Group
Bothidae	*Bothus mancus*	MI	No Group
Labridae	*Cheilinus* sp.	MI	No Group
Labridae	*Cheilinus trilobatus*	MI	No Group
Malacanthidae	*Malacanthus latovittatus*	MI	No Group
Labridae	*Oxycheilinus unifasciatus*	Pisc	No Group
Labridae	*Oxycheilinus* sp.	MI	No Group
Serranidae	*Epinephelus retouti*	Pisc	No Group
Mullidae	*Mulloidichthys pfluegeri*	MI	No Group
Serranidae	*Cephalopholis sexmaculata*	Pisc	No Group
Serranidae	*Cephalopholis sonnerati*	Pisc	No Group
Serranidae	*Gracila albomarginata*	Pisc	No Group
Mullidae	*Parupeneus cyclostomus*	Pisc	No Group
Belonidae	*Platybelone argalus*	Pisc	No Group
Acanthuridae	*Acanthurus mata*	Pk	No Group
Tetraodontidae	*Arothron meleagris*	Cor	No Group
Balistidae	*Balistoides conspicillum*	MI	No Group
Labridae	*Hemigymnus fasciatus*	MI	No Group
Lethrinidae	*Lethrinus obsoletus*	MI	No Group
Mullidae	*Mullidae*	MI	No Group
Mullidae	*Parupeneus barberinus*	MI	No Group
Holocentridae	*Sargocentron* sp.	MI	No Group
Ephippidae	*Platax orbicularis*	Om	No Group
Serranidae	*Epinephelus macrospilos*	Pisc	No Group
Scorpaenidae	*Scorpaenopsis cacopsis*	Pisc	No Group
Kyphosidae	*Kyphosus cinerascens*	H	No Group
Labridae	*Cheilio inermis*	MI	No Group

Mullidae	*Parupeneus porphyreus*	MI	No Group
Serranidae	*Epinephelus socialis*	Pisc	No Group
Tetraodontidae	*Arothron hispidus*	MI	No Group
Holocentridae	*Sargocentron spiniferum*	MI	No Group
Carangidae	*Trachinotus baillonii*	Pisc	No Group
Labridae	*Epibulus insidiator*	MI	No Group
Serranidae	*Epinephelus howlandi*	Pisc	No Group
Labridae	*Bodianus albotaeniatus*	MI	No Group
Labridae	*Bodianus bilunulatus*	MI	No Group
Acanthuridae	*Acanthurus* sp.	H	No Group
Serranidae	*Aethaloperca rogaa*	Pisc	No Group
Serranidae	*Anyperodon leucogrammicus*	Pisc	No Group
Serranidae	*Cephalopholis argus*	Pisc	No Group
Serranidae	*Cephalopholis* sp.	Pisc	No Group
Serranidae	*Epinephelus maculatus*	Pisc	No Group
Holocentridae	*Myripristis murdjan*	Pk	No Group
Acanthuridae	*Naso brevirostris*	Pk	No Group
Acanthuridae	*Naso maculatus*	Pk	No Group
Acanthuridae	*Naso vlamingii*	Pk	No Group
Kyphosidae	*Kyphosus vaigiensis*	H	No Group
Muraenidae	*Gymnothorax eurostus*	MI	No Group
Labridae	*Hemigymnus melapterus*	MI	No Group
Balistidae	*Pseudobalistes flavimarginatus*	MI	No Group
Lethrinidae	*Lethrinus xanthochilus*	Pisc	No Group
Acanthuridae	*Naso caesius*	Pk	No Group
Lethrinidae	*Monotaxis grandoculis*	MI	No Group
Serranidae	*Variola albimarginata*	Pisc	No Group
Labridae	*Coris flavovittata*	MI	No Group
Tetraodontidae	*Arothron mappa*	Om	No Group
Carangidae	*Carangoides ferdau*	Pisc	No Group
Carangidae	*Carangoides orthogrammus*	Pisc	No Group
Carangidae	*Scomberoides lysan*	Pisc	No Group
Acanthuridae	*Acanthuridae*	H	No Group
Lethrinidae	*Lethrinus amboinensis*	MI	No Group
Lethrinidae	*Lethrinus erythracanthus*	MI	No Group
Ephippidae	*Platax teira*	Om	No Group
Serranidae	*Plectropomus areolatus*	Pisc	No Group

Carangidae	*Gnathanodon speciosus*	Pisc	No Group
Serranidae	*Epinephelus polyphekadion*	Pisc	No Group
Serranidae	*Epinephelus tauvina*	Pisc	No Group
Muraenidae	*Gymnothorax breedeni*	Pisc	No Group
Acanthuridae	*Naso hexacanthus*	Pk	No Group
Acanthuridae	*Naso* sp.	Pk	No Group
Kyphosidae	*Kyphosus sandwicensis*	H	No Group
Kyphosidae	*Kyphosus* sp.	H	No Group
Balistidae	*Balistidae*	MI	No Group
Balistidae	*Balistoides viridescens*	MI	No Group
Muraenidae	*Echidna nebulosa*	MI	No Group
Haemulidae	*Plectorhinchus gibbosus*	MI	No Group
Balistidae	*Balistes polylepis*	MI	No Group
Tetraodontidae	*Tetraodontidae*	MI	No Group
Monacanthidae	*Aluterus scriptus*	Om	No Group
Ophichthidae	*Myrichthys magnificus*	MI	No Group
Aulostomidae	*Aulostomus chinensis*	Pisc	No Group
Muraenidae	*Enchelycore pardalis*	Pisc	No Group
Sphyraenidae	*Sphyraena helleri*	Pisc	No Group
Muraenidae	*Gymnothorax rueppelliae*	MI	No Group
Oplegnathidae	*Oplegnathus fasciatus*	MI	No Group
Serranidae	*Variola louti*	Pisc	No Group
Haemulidae	*Plectorhinchus picus*	MI	No Group
Haemulidae	*Plectorhinchus vittatus*	MI	No Group
Lethrinidae	*Lethrinidae*	MI	No Group
Lethrinidae	*Lethrinus* sp.	MI	No Group
Oplegnathidae	*Oplegnathus punctatus*	MI	No Group
Carangidae	*Caranx papuensis*	Pisc	No Group
Muraenidae	*Gymnothorax steindachneri*	Pisc	No Group
Diodontidae	*Diodon hystrix*	MI	No Group
Labridae	*Labridae*	MI	No Group
Belonidae	*Belonidae*	Pisc	No Group
Carangidae	*Caranx lugubris*	Pisc	No Group
Carangidae	*Caranx sexfasciatus*	Pisc	No Group
Scombridae	*Euthynnus affinis*	Pisc	No Group
Scombridae	*Grammatorcynus bilineatus*	Pisc	No Group
Lethrinidae	*Lethrinus olivaceus*	Pisc	No Group
Acanthuridae	*Naso annulatus*	Pk	No Group

Ophidiidae	*Brotula multibarbata*	MI	No Group
Dasyatidae	*Urogymnus granulatus*	MI	No Group
Scombridae	*Sarda orientalis*	Pisc	No Group
Congridae	*Congridae*	Pisc	No Group
Congridae	*Heterocongrinae*	Pisc	No Group
Scombridae	*Katsuwonus pelamis*	Pisc	No Group
Echeneidae	*Echeneis naucrates*	Pk	No Group
Carangidae	*Trachinotus blochii*	MI	No Group
Carangidae	*Caranx melampygus*	Pisc	No Group
Muraenidae	*Gymnothorax meleagris*	Pisc	No Group
Tetraodontidae	*Arothron stellatus*	Cor	No Group
Labridae	*Coris aygula*	MI	No Group
Carangidae	*Pseudocaranx dentex*	Pisc	No Group
Muraenidae	*Scuticaria tigrina*	Pisc	No Group
Serranidae	*Plectropomus laevis*	Pisc	No Group
Serranidae	*Epinephelus* sp.	Pisc	No Group
Serranidae	*Serranidae*	Pisc	No Group
Belonidae	*Tylosurus crocodilus*	Pisc	No Group
Carangidae	*Alectis ciliaris*	Pisc	No Group
Muraenidae	*Enchelynassa canina*	Pisc	No Group
Muraenidae	*Gymnothorax undulatus*	Pisc	No Group
Muraenidae	*Gymnomuraena zebra*	MI	No Group
Carangidae	*Carangidae*	Pisc	No Group
Fistulariidae	*Fistularia commersonii*	Pisc	No Group
Carangidae	*Caranx ignobilis*	Pisc	No Group
Carangidae	*Caranx* sp.	Pisc	No Group
Sphyraenidae	*Sphyraena qenie*	Pisc	No Group
Carangidae	*Elagatis bipinnulata*	Pisc	No Group
Chanidae	*Chanos chanos*	H	No Group
Dasyatidae	*Taeniurops meyeni*	MI	No Group
Dasyatidae	*Dasyatidae*	MI	No Group
Carangidae	*Seriola dumerili*	Pisc	No Group
Carcharhinidae	*Carcharhinus melanopterus*	Pisc	No Group
Sphyraenidae	*Sphyraena barracuda*	Pisc	No Group
Scombridae	*Thunnus albacares*	Pisc	No Group
Carcharhinidae	*Triaenodon obesus*	Pisc	No Group
Labridae	*Cheilinus undulatus*	MI	No Group
Carcharhinidae	*Carcharhinus amblyrhynchos*	Pisc	No Group

Muraenidae	*Gymnothorax flavimarginatus*	Pisc	No Group
Scombridae	*Scombridae*	Pisc	No Group
Scombridae	*Gymnosarda unicolor*	Pisc	No Group
Muraenidae	*Muraenidae*	Pisc	No Group
Carcharhinidae	*Carcharhinus limbatus*	Pisc	No Group
Muraenidae	*Gymnothorax javanicus*	Pisc	No Group
Muraenidae	*Gymnothorax* sp.	Pisc	No Group
Ginglymostomatidae	*Nebrius ferrugineus*	Pisc	No Group
Myliobatidae	*Aetobatus ocellatus*	MI	No Group
Carcharhinidae	*Carcharhinus galapagensis*	Pisc	No Group
Sphyrnidae	*Sphyrna lewini*	Pisc	No Group
Sphyrnidae	*Sphyrnidae*	Pisc	No Group
Myliobatidae	*Mobula* sp.	Pk	No Group
Scaridae	*Scarus fuscocaudalis*	H	Parrotfish
Scaridae	*Calotomus zonarchus*	H	Parrotfish
Scaridae	*Chlorurus japanensis*	H	Parrotfish
Scaridae	*Scarus globiceps*	H	Parrotfish
Scaridae	*Scarus spinus*	H	Parrotfish
Scaridae	*Scarus psittacus*	H	Parrotfish
Scaridae	*Scarus dubius*	H	Parrotfish
Scaridae	*Scarus oviceps*	H	Parrotfish
Scaridae	*Scarus schlegeli*	H	Parrotfish
Scaridae	*Chlorurus spilurus*	H	Parrotfish
Scaridae	*Scarus niger*	H	Parrotfish
Scaridae	*Scarus festivus*	H	Parrotfish
Scaridae	*Scarus frenatus*	H	Parrotfish
Scaridae	*Chlorurus frontalis*	H	Parrotfish
Scaridae	*Scarus dimidiatus*	H	Parrotfish
Scaridae	*Calotomus carolinus*	H	Parrotfish
Scaridae	*Scarus forsteni*	H	Parrotfish
Scaridae	*Scarus tricolor*	H	Parrotfish
Scaridae	*Scarus xanthopleura*	H	Parrotfish
Scaridae	*Hipposcarus longiceps*	H	Parrotfish
Scaridae	*Scarus altipinnis*	H	Parrotfish
Scaridae	*Chlorurus perspicillatus*	H	Parrotfish
Scaridae	*Scaridae*	H	Parrotfish
Scaridae	*Scarus rubroviolaceus*	H	Parrotfish
Scaridae	*Chlorurus microrhinos*	H	Parrotfish

Scaridae	*Cetoscarus ocellatus*	H	Parrotfish
Scaridae	*Scarus ghobban*	H	Parrotfish
Scaridae	*Chlorurus* sp.	H	Parrotfish
Scaridae	*Scarus* sp.	H	Parrotfish
Scaridae	*Bolbometopon muricatum*	Cor	Parrotfish
Lutjanidae	*Lutjanus fulvus*	MI	Snappers
Lutjanidae	*Lutjanus kasmira*	MI	Snappers
Lutjanidae	*Lutjanus gibbus*	MI	Snappers
Lutjanidae	*Lutjanus monostigma*	Pisc	Snappers
Lutjanidae	*Macolor macularis*	Pk	Snappers
Lutjanidae	*Aphareus furca*	Pisc	Snappers
Lutjanidae	*Macolor niger*	Pk	Snappers
Lutjanidae	*Macolor* sp.	Pk	Snappers
Lutjanidae	*Lutjanus bohar*	Pisc	Snappers
Lutjanidae	*Lutjanus argentimaculatus*	MI	Snappers
Lutjanidae	*Aprion virescens*	Pisc	Snappers

APPENDIX B: LIST OF PROTECTED SPECIES AND DESIGNATED CRITICAL HABITAT

Table B-1. Protected species found or reasonably believed to be found near or in American Samoa waters

Common Name	Scientific Name	ESA Listing Status	MMPA Status	Occurrence	References
Seabirds					
Audubon's Shearwater	*Puffinus lherminieri*	Not Listed	N/A	Resident	Craig, 2005
Black Noddy	*Anous minutus*	Not Listed	N/A	Resident	Craig, 2005
Black-Naped Tern	*Sterna sumatrana*	Not Listed	N/A	Visitor	Craig, 2005
Blue-Gray Noddy	*Procelsterna cerulea*	Not Listed	N/A	Resident	Craig, 2005
Bridled Tern	*Onychoprion anaethetus*	Not Listed	N/A	Visitor	Craig, 2005
Brown Booby	*Sula leucogaster*	Not Listed	N/A	Resident	Craig, 2005
Brown Noddy	*Anous stolidus*	Not Listed	N/A	Resident	Craig, 2005
Christmas Shearwater	*Puffinus nativitatis*	Not Listed	N/A	Resident?	Craig, 2005
Collared Petrel	*Pterodroma brevipes*	Not Listed	N/A	Resident?	Craig, 2005
White Tern	*Gygis alba*	Not Listed	N/A	Resident	Craig, 2005
Greater Crested Tern	*Thalasseus bergii*	Not Listed	N/A	Visitor	Craig, 2005
Gray-Backed Tern	*Onychoprion lunatus*	Not Listed	N/A	Resident	Craig, 2005
Great Frigatebird	*Fregata minor*	Not Listed	N/A	Resident	Craig, 2005
Herald Petrel	*Pterodroma heraldica*	Not Listed	N/A	Resident	Craig, 2005
Laughing Gull	*Leucophaeus atricilla*	Not Listed	N/A	Visitor	Craig, 2005
Lesser Frigatebird	*Fregata ariel*	Not Listed	N/A	Resident	Craig, 2005
Masked Booby	*Sula dactylatra*	Not Listed	N/A	Resident	Craig, 2005
Newell's Shearwater	*Puffinus auricularis newelli*	Threatened	N/A	Visitor	40 FR 44149, Craig, 2005
Red-Footed Booby	*Sula sula*	Not Listed	N/A	Resident	Craig, 2005
Red-Tailed Tropicbird	*Phaethon rubricauda*	Not Listed	N/A	Resident	Craig, 2005
Short-Tailed Shearwater	*Ardenna tenuirostris*	Not Listed	N/A	Visitor	Craig, 2005
Sooty Shearwater	*Ardenna grisea*	Not Listed	N/A	Visitor	Craig, 2005
Sooty Tern	*Sterna fuscata*	Not Listed	N/A	Resident	Craig, 2005

Common Name	Scientific Name	ESA Listing Status	MMPA Status	Occurrence	References
Tahiti Petrel	*Pterodroma rostrata*	Not Listed	N/A	Resident	Craig, 2005
Wedge-Tailed Shearwater	*Ardenna pacifica*	Not Listed	N/A	Resident?	Craig, 2005
White-Necked Petrel	*Pterodroma cervicalis*	Not Listed	N/A	Visitor	Craig, 2005
White-Faced Storm-Petrel	*Pelagodroma marina*	Not Listed	N/A	Visitor	Craig, 2005
White-Tailed Tropicbird	*Phaethon lepturus*	Not Listed	N/A	Resident	Craig, 2005
White-Throated Storm-Petrel	*Nesofregetta fuliginosa*	Not Listed	N/A	Resident?	Craig, 2005
Sea Turtles					
Green Sea Turtle	*Chelonia mydas*	Endangered (Central South Pacific DPS)	N/A	Frequently seen. Nest at Rose Atoll in small numbers.	43 FR 32800, 81 FR 20057, Balacz 1994
Hawksbill Sea Turtle	*Eretmochelys imbricata*	Endangered[a]	N/A	Frequently seen. Nest at Rose Atoll, Swain's Island, and Tutuila.	35 FR 8491, NMFS & USFWS 2013, Tuato'o-Bartley *et al.,* 1993
Leatherback Sea Turtle	*Dermochelys coriacea*	Endangered[a]	N/A	Very rare. One juvenile recovered dead in experimental longline fishing.	35 FR 8491, Grant, 1994
Loggerhead Sea Turtle	*Caretta caretta*	Endangered (South Pacific DPS)	N/A	No known sightings. Found worldwide along continental shelves, bays, estuaries, and lagoons of tropical, subtropical, and temperate waters.	43 FR 32800, 76 FR 58868, Utzurrum 2002, Dodd, 1990
Olive Ridley Sea Turtle	*Lepidochelys olivacea*	Threatened (Entire species, except for the breeding population on the Pacific coast of Mexico, which is listed as endangered)	N/A	Rare. Three known sightings.	43 FR 32800, Utzurrum, 2002
Marine mammals					
Blainville's Beaked Whale	*Mesoplodon densirostris*	Not Listed	Non-strategic	Found worldwide in tropical and temperate waters	Mead, 1989
Blue Whale	*Balaenoptera musculus*	Endangered	Strategic	No known sightings. Occur worldwide and are known to be found in the western South Pacific.	35 FR 18319, Olson *et al.,* 2015
Bottlenose Dolphin	*Tursiops truncatus*	Not Listed	Non-strategic	Distributed worldwide in tropical and warm-temperate waters	Perrin *et al.,* 2009

Common Name	Scientific Name	ESA Listing Status	MMPA Status	Occurrence	References
Bryde's Whale	*Balaenoptera edeni*	Not Listed	Unknown	Distributed widely across tropical and warm-temperate Pacific Ocean.	Leatherwood *et al.,* 1982
Common Dolphin	*Delphinus delphis*	Not Listed	N/A	Found worldwide in temperate and subtropical seas.	Perrin *et al.,* 2009
Cuvier's Beaked Whale	*Ziphius cavirostris*	Not Listed	Non-strategic	Occur worldwide.	Heyning, 1989
Dwarf Sperm Whale	*Kogia sima*	Not Listed	Non-strategic	Found worldwide in tropical and warm-temperate waters.	Nagorsen, 1985
False Killer Whale	*Pseudorca crassidens*	Not Listed	Unknown	Found in waters within the US EEZ of A. Samoa	Bradford *et al.,* 2015
Fin Whale	*Balaenoptera physalus*	Endangered	Strategic	No known sightings. Found worldwide.	35 FR 18319, Hamilton *et al.,* 2009
Fraser's Dolphin	*Lagenodelphis hosei*	Not Listed	Non-strategic	Found worldwide in tropical waters.	Perrin *et al.,* 2009
Humpback Whale	*Megaptera novaeangliae*	Delisted Due to Recovery (Oceania DPS)	Strategic	Migrate through the archipelago and breed during the winter in American Samoan waters.	35 FR 18319, 81 FR 62259, Guarrige *et al.,* 2007, SPWRC, 2008
Killer Whale	*Orcinus orca*	Not Listed	Non-strategic	Found worldwide. Prefer colder waters within 800 km of continents.	Leatherwood & Dalheim, 1978, Mitchell, 1975, Baird *et al.,* 2006
Longman's Beaked Whale	*Indopacetus pacificus*	Not Listed	Non-strategic	Found in tropical waters from the eastern Pacific westward through the Indian Ocean to the eastern coast of Africa.	Dalebout, 2003
Melon-Headed Whale	*Peponocephala electra*	Not Listed	Non-strategic	Found in tropical and warm-temperate waters worldwide, primarily found in equatorial waters.	Perryman *et al.,* 1994
Minke Whale	*Balaenoptera acutorostrata*	Not Listed	Non-strategic	Uncommon in this region, usually seen over continental shelves in the Pacific Ocean.	Brueggeman *et al.,* 1990
Pantropical Spotted Dolphin	*Stenella attenuata*	Not Listed	Non-strategic	Found in tropical and subtropical waters worldwide.	Perrin *et al.,* 2009
Pygmy Killer Whale	*Feresa attenuata*	Not Listed	Non-strategic	Found in tropical and subtropical waters worldwide.	Ross & Leatherwood, 1994
Pygmy Sperm Whale	*Kogia breviceps*	Not Listed	Non-strategic	Found worldwide in tropical and warm-temperate waters.	Caldwell & Caldwell, 1989

Common Name	Scientific Name	ESA Listing Status	MMPA Status	Occurrence	References
Risso's Dolphin	*Grampus griseus*	Not Listed	Non-strategic	Found in tropical to warm-temperate waters worldwide.	Perrin *et al.,* 2009
Rough-Toothed Dolphin	*Steno bredanensis*	Not Listed	Unknown	Found in tropical to warm-temperate waters worldwide. Common in A. Samoa waters.	Perrin *et al.,* 2009, Craig, 2005
Sei Whale	*Balaenoptera borealis*	Endangered	Strategic	Generally found in offshore temperate waters.	35 FR 18319, Barlow, 2003, Bradford *et al.,* 2013
Short-Finned Pilot Whale	*Globicephala macrorhynchus*	Not Listed	Non-strategic	Found in tropical to warm-temperate waters worldwide.	Shallenberger, 1981, Baird *et al.,* 2013, Bradford *et al.,* 2013
Sperm Whale	*Physeter macrocephalus*	Endangered	Strategic	Found in tropical to polar waters worldwide, most abundant cetaceans in the region.	35 FR 18319, Rice, 1960, Barlow, 2006, Lee, 1993, Mobley *et al.,* 2000, Shallenberger, 1981
Spinner Dolphin	*Stenella longirostris*	Not Listed	Unknown	Common in American Samoa, found in waters with mean depth of 44 m.	Reeves *et al.,* 1999, Johnston *et al.,* 2008
Striped Dolphin	*Stenella coeruleoalba*	Not Listed	Non-strategic	Found in tropical to warm-temperate waters throughout the world.	Perrin *et al.,* 2009
Elasmobranchs					
Giant manta ray	*Manta birostris*	Threatened	N/A	Found worldwide in tropical, subtropical, and temperate waters. Commonly found in upwelling zones, oceanic island groups, offshore pinnacles, and seamounts, and on shallow reefs.	Dewar *et al.*, 2008, Marshall *et al.,* 2009, Marshall *et al.*, 2011.
Oceanic whitetip	*Carcharhinus longimanus*	Threatened	N/A	Found worldwide in open ocean waters from the surface to 152 m depth. It is most commonly found in waters > 20°C	Bonfil *et al.*, 2008, Backus *et al.*, 1956, Strasburg, 1958, Compagno, 1984

Common Name	Scientific Name	ESA Listing Status	MMPA Status	Occurrence	References
Scalloped Hammerhead	*Sphyrna lewini*	Threatened (Indo-West Pacific DPS)	N/A	Occur over continental and insular shelves, and adjacent deep waters, but rarely found in waters < 22°C. Range from the intertidal and surface to depths up to 450–512 m.	Compagno, 1984, Schulze-Haugen & Kohler, 2003, Sanches, 1991, Klimley, 1993
Corals					
N/A	*Acropora globiceps*	Threatened	N/A	Occur on upper reef slopes, reef flats, and adjacent habitats in depths from 0 to 8 m	Veron, 2014
N/A	*Acropora jacquelineae*	Threatened	N/A	Found in numerous subtidal reef slope and back-reef habitats, including but not limited to, lower reef slopes, walls and ledges, mid-slopes, and upper reef slopes protected from wave action, and its depth range is 10 to 35 m.	Veron, 2014
N/A	*Acropora retusa*	Threatened	N/A	Occur in shallow reef slope and back-reef areas, such as upper reef slopes, reef flats, and shallow lagoons. Depth range is 1 to 5 m.	Veron, 2014
N/A	*Acropora speciosa*	Threatened	N/A	Found in protected environments with clear water and high diversity of *Acropora* and steep slopes or deep, shaded waters. Depth range is 12 to 40 meters and have been found in mesophotic habitat (40-150 m).	Veron, 2014
N/A	*Euphyllia paradivisa*	Threatened	N/A	Found in environments protected from wave action on at least upper reef slopes, mid-slope terraces, and lagoons in depths ranging from 2 to 25 m depth.	Veron, 2014
N/A	*Isopora crateriformis*	Threatened	N/A	Found in shallow, high-wave energy environments, from low tide to at least 12 meters deep, and have been reported from mesophotic	Veron, 2014

Common Name	Scientific Name	ESA Listing Status	MMPA Status	Occurrence	References
				depths (less than 50 m depth).	

[a] These species have critical habitat designated under the ESA. See Table B-2.

Table B-2. ESA-listed species' critical habitat in the Pacific Ocean[a]

Common Name	Scientific Name	ESA Listing Status	Critical Habitat	References
Hawksbill Sea Turtle	*Eretmochelys imbricata*	Endangered	None in the Pacific Ocean.	63 FR 46693
Leatherback Sea Turtle	*Dermochelys coriacea*	Endangered	Approximately 16,910 square miles (43,798 square km) stretching along the California coast from Point Arena to Point Arguello east of the 3,000 meter depth contour; and 25,004 square miles (64,760 square km) stretching from Cape Flattery, Washington to Cape Blanco, Oregon east of the 2,000 meter depth contour.	77 FR 4170
Hawaiian Monk Seal	*Neomonachus schauinslandi*	Endangered	Ten areas in the Northwestern Hawaiian Islands (NWHI) and six in the main Hawaiian Islands (MHI). These areas contain one or a combination of habitat types: Preferred pupping and nursing areas, significant haul-out areas, and/or marine foraging areas, that will support conservation for the species.	53 FR 18988, 51 FR 16047, 80 FR 50925
North Pacific Right Whale	*Eubalaena japonica*	Endangered	Two specific areas are designated, one in the Gulf of Alaska and another in the Bering Sea, comprising a total of approximately 95,200 square kilometers (36,750 square miles) of marine habitat.	73 FR 19000, 71 FR 38277

[a] For maps of critical habitat, see https://www.fisheries.noaa.gov/national/endangered-species-conservation/critical-habitat.

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