ANNUAL STOCK ASSESSMENT AND FISHERY EVALUATION REPORT: PACIFIC REMOTE ISLAND AREA FISHERY ECOSYSTEM PLAN 2019

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The ANNUAL STOCK ASSESSMENT AND FISHERY EVALUATION REPORT for the PACIFIC REMOTE ISLAD AREA FISHERY ECOSYSTEM PLAN 2019 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.

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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 report as resources allow.

The 2019 Pacific Remote Island Area (PRIA) FEP annual SAFE report does not contain fully developed Fishery Performance or Data Integration chapters due to the absence of consistent fisheries data in the PRIAs. There were four total bottomfish permits issued in 2019, which was same as the number of permits issued in 2018. There were no lobster or shrimp permits issued in 2019, and there is no record of these permits being issued since at 2008. Logbook data are not currently included in the annual SAFE report, but fishery dependent data sections will be updated as resources allow.

An Ecosystem Considerations chapter was added to the annual SAFE report following the Council's review of its FEPs and revised management objectives. Fishery independent ecosystem survey, protected species, socioeconomic, oceanic and climate, essential fish habitat, and marine planning information are all included in the Ecosystem Considerations chapter.

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 PRIAs, American Samoa, Guam, the Commonwealth of the Northern Mariana Islands (CNMI), 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 reef areas as well as habitat condition using mean coral coverage per island averaged over the past decade for each of these locations.

The highest amount of mean coral coverage over the past ten years in the PRIAs was observed at Howland and Baker Islands at nearly 28% coverage, while the lowest observed was at Jarvis Island and Johnston Atoll at just over 10% coverage. Fish biomass varied between groups at each of the PRIAs over the past decade. Wake Island had the lowest estimated fish biomass among the PRIAs for all fishes, species of the family Lutjanidae, and for planktivores while having the highest biomass for species of the family Scaridae (though the standard error for the estimate was relatively high). Johnston Atoll had the lowest biomass for species of the family Serranidae and corallivores. Kingman Reef had the highest biomass for non-planktivorous butterflyfish and species of the family Lutjanidae while having the lowest biomass among the PRIAs for herbivores. Palmyra Atoll had the highest biomass for mobile invertebrate feeders. Howland Island had the highest fish biomass among the PRIAs for species of the family Serranidae, corallivores, and planktivores, but the lowest biomass for species of the family Scardiae. Jarvis Island had the highest biomass for all fishes, mid-large target surgeonfish, and herbivores.

The protected species section of this report describes monitoring and summarizes protected species interactions in fisheries managed under the PRIA FEP. There are currently no major bottomfish, crustacean, or precious coral fisheries operating in the PRIAs and no historical observer data are available for fisheries under this FEP. No new fishing activity was reported in 2019, and there is no new information to indicate that impacts to protected species from PRIA fisheries have changed over in recent years. In late 2018, NMFS concluded that PRIA coral reef ecosystem, crustacean, and precious coral fisheries will have no effect on the oceanic whitetip shark and giant manta ray.

The socioeconomics section is meant to outline the pertinent economic, social, and community information available for assessing the successes and impacts of management measures or the achievements of the FEP within the PRIAs. The section provides an overview of the socioeconomic context for the region, but socioeconomic information is limited because human habitation is scarce. The socioeconomics section of this report will be expanded in later years if activity increases and as resources allow. There were no new socioeconomic data reported for the PRIAs in 2019.

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 jurisdiction. 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 recognize patterns and trends.

The trend of atmospheric concentration of carbon dioxide (CO_2) is increasing exponentially with a time series maximum at 411 ppm in 2019. Since 1989, the oceanic pH at Station ALOHA in Hawaii has shown a significant linear decrease of -0.0401 pH units, or roughly a 9.7% increase in acidity ([H+]). The Oceanic Niño Index, which is a measure of the El Niño – Southern Oscillation (ENSO) phase, transitioned from a weak El Niño to neutral conditions in 2019. The Pacific Decadal Oscillation (PDO) was nearly evenly split between values that were slightly negative and values that were slightly positive over the course of 2019. The Accumulated Cyclone Energy (ACE) Index was slightly below the 30-year mean in the Eastern North Pacific and was average in the Central North Pacific. The mean sea surface temperature (SST) data from the PRIAs had annual anomalies that were slightly warmer than average. After a major heat stress events in 2015 and 2016 that were relevant to coral bleaching, another heat stress event was experienced in 2019 excluding Wake Island where the event was minor. The chlorophyll-a concentrations around the PRIAs were approximately in line with previous climatological ranges, while the precipitation anomalies were slightly positive in the beginning of 2019 before becoming negative at the end of the year. Sea level rise is approximately 0.75 mm/year on Johnston Atoll and 2.1 mm/year on Wake Island.

The essential fish habitat (EFH) section of the 2019 annual SAFE report for the PRIA FEP includes responses to previous Council recommendations regarding EFH, habitat use by management unit species (MUS) in the PRIAs, trends in habitat conditions, and cumulative impacts on EFH. Guidelines also require a report on the condition of the habitat; mapping progress and benthic cover are included as preliminary indicators pending development of habitat condition indicators for the PRIAs not otherwise represented in other sections of this report. The mean percent cover of live coral, macroalgae, and crustose coralline algae from RAMP sites collected from towed-diver surveys in the PRIAs are also presented for the available years between 2001 and 2016. Levels of available EFH information are summarized for bottomfish, crustacean, and precious coral MUS. There were no Council directives to the Plan Team in 2019 associated with EFH for the PRIAs.

The marine planning section of the annual SAFE report for the PRIA FEP tracks activities with multi-year planning horizons and begins to monitor the cumulative impact of established facilities. The Pacific Islands Marine National Monument (PIMNM) remains intact around the islands and atolls of the PRIAs. No new ocean activities with multi-year planning horizons were identified for the PRIAs in 2019.

The Data Integration chapter of this report is not fully developed. Previously, in late 2016, the Council hosted a data integration workshop with participants from the NMFS Pacific Islands Regional Office (PIRO) and PIFSC to identify policy-relevant fishery ecosystem relationships. However, no updates have been made for the PRIA Data Integration chapter for the 2019 annual SAFE report. Despite the presence of data for certain ecological parameters throughout the PRIAs, there exists no fishery performance data in the absence of fishery-dependent information streams. In 2019, recent relevant abstracts of primary publications related to data integration were added. The chapter will be expanded in the future if fishing activity and data availability increases in the PRIAs.

Regarding the revisions to the 2019 annual SAFE reports, the 2020 Archipelagic Plan Team generated several work items:

- Provide direction on report structure for next year, particularly for the protected species module.
- Add the revised list of research needs incorporating Plan Team input into the protected species module version for the Council meeting.
- Improve bycatch reporting in the SAFE report in coordination with the ongoing standardized bycatch reporting methodology review:
    - Develop a bycatch data sections for the Hawaii fisheries.
    - Improve bycatch data sections for American Samoa and Mariana Archipelago annual SAFE reports, where data are available.
- Incorporate discussed changes to the Fishery Performance and Ecosystem Components sections of annual SAFE reports.
- Explore other benthic cover categories in the future reports.
- Review the report on potential updates for the habitat module and identify the data streams that would be useful for the habitat module of the annual SAFE reports.
- Include summaries of the federal logbook data where available.

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ACRONYMS AND ABBREVIATIONS

Acronym	Meaning
ACE	Accumulated Cyclone Energy
BiOp	Biological Opinion
BMUS	Bottomfish Management Unit Species
BRFA	Bottomfish Restricted Fishing Area
CFR	Code of Federal Regulations
Chl-A	Chlorophyll-*a*
CMAP	CPC Merged Analysis of Precipitation
CMUS	Crustacean Management Unit Species
CRED	Coral Reef Ecosystem Division (PIFSC)
CREP	Coral Reef Ecosystem Program (PIFSC)
CNMI	Commonwealth of the Northern Mariana Islands
COOPS	Center for Operational Oceanographic Products and Services
Council	Western Pacific Regional Fishery Management Council
CPC	Climate Prediction Center (NOAA)
CPUE	Catch Per Unit Effort
CREMUS	Coral Reef Ecosystem Management Unit Species
DIC	Dissolved Inorganic Carbon
DHW	Degree Heating Weeks
DPS	Distinct Population Segment
ECS	Ecosystem Component Species
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
ENSO	El Niño – Southern Oscillation
EO	Executive Order
ESA	Endangered Species Act
ESD	Ecosystem Sciences Division (PIFSC)
FEP	Fishery Ecosystem Plan
FMP	Fishery Management Plan
FR	Federal Register
FSSI	Fish Stock Sustainability Index
GAC	Global Area Coverage
HAPC	Habitat Area of Particular Concern
HOT	Hawaii Ocean Time Series
LAA	Likely to Adversely Affect
LAC	Local Area Coverage
LOC	Letter of Concurrence
LOF	List of Fisheries
MBTA	Migratory Bird Treaty Act
MERIS	Moderate Resolution Imaging Spectroradiometer
MHI	Main Hawaiian Islands
MLCD	Marine Life Conservation District
MMA	Marine Managed Area

Acronym	Meaning
MMPA	Marine Mammal Protection Act
MODIS	Moderate Resolution Imaging Spectroradiometer
MPA	Marine Protected Area
MPCC	Marine Planning and Climate Change
MPCCC	MPCC Committee (WPRFMC)
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MUS	Management Unit Species
N/A	Not Applicable
NCADAC	National Climate Assessment and Development Advisory Committee
NCDC	National Climate Data Center
NEPA	National Environmental and Policy Act
NLAA	Not Likely to Adversely Affect
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NS	National Standard
NWHI	Northwestern Hawaiian Islands
ONI	Oceanic Niño Index
PCMUS	Precious Coral Management Unit Species
PDO	Pacific Decadal Oscillation
PRI	Pacific Remote Islands
PIFSC	Pacific Islands Fisheries Science Center
PIRO	NOAA NMFS Pacific Islands Regional Office
PMUS	Pelagic Management Unit Species
ppm	Parts Per Million
PRIA	Pacific Remote Island Area
PRIMNM	Pacific Remote Islands Marine National Monument
RAMP	Reef Assessment and Monitoring Program (PIFSC)
RPB	Regional Planning Body
SAFE	Stock Assessment and Fishery Evaluation
SeaWiFS	Sea-Wide Field-of-View Sensor
SFD	Sustainable Fisheries Division (PIRO)
SST	Sea Surface Temperature
TA	Total Alkalinity
TBA	To Be Announced
TBD	To Be Determined
USFWS	United States Fish and Wildlife Service
VIIRS	Visible and Infrared Imager/Radiometer Suite
WPRFMC	Western Pacific Regional Fishery Management Council

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1 FISHERY PERFORMANCE

Fisheries in the Pacific Remote Island Areas (PRIAs), including Palmyra Atoll, Kingman Reef, Jarvis Island, Baker Island, Howland Island, Johnston Atoll, and Wake Island, are limited. Fishery performance will be made available for the PRIAs in future reports as resources allow.

1.1 NUMBER OF FEDERAL PERMIT HOLDERS

The Code of Federal Regulations (CFR), Title 50 Part 665 requires the following Federal permits for fishing in the exclusive economic zone (EEZ) of the PRIAs.

1.1.1 Special Coral Reef Ecosystem Permit

Regulations require the special coral reef ecosystem fishing permit for anyone fishing for coral reef ecosystem component species (ECS) 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. The National Marine Fisheries Service (NMFS) will make an exception to this permit requirement for any person issued a permit to fish under any fishery ecosystem plan (FEP) who incidentally catches Hawaii coral reef ECS while fishing for bottomfish management unit species (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.

1.1.2 Western Pacific Precious Corals Permit

Regulations require a Western Pacific Precious Corals permit for anyone harvesting or landing black, bamboo, pink, red, or gold corals in the EEZs of the U.S. Western Pacific.

1.1.3 Western Pacific Crustaceans Permit (Lobster or Deepwater Shrimp)

Regulations require a Western Pacific Crustaceans permit for any owner of a U.S. fishing vessel used to fish for lobster (now ECS) or deepwater shrimp in the EEZs around of the U.S. Western Pacific.

1.1.4 PRIA Bottomfish Permit

Regulations require obtaining a PRIA Bottomfish permit for anyone using bottomfish gear to fish for bottomfish MUS in the EEZ around the PRIAs. Commercial fishing is prohibited within the boundaries of the Pacific Remote Islands Marine National Monument (PRIMNM).

There is no record of coral reef or precious coral fishery permits issued for the EEZ around the PRIAs since 2008. Table 1 provides the number of permits issued for PRIA fisheries from 2010 to 2019. Historical data from were accessed from the National Oceanic and Atmospheric Administration (NOAA) Pacific Islands Fisheries Science Center (PIFSC), and data for 2018–2019 are from the Pacific Islands Regional Office (PIRO) Sustainable Fisheries Division (SFD) permits program.

Table 1. Number of federal permit holders in the lobster, shrimp, and bottomfish fisheries of the PRIA

PRIA Fisheries	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Lobster	0	0	0	0	0	0	0	0	0	0
Shrimp	1	0	0	0	0	0	0	0	0	0
Bottomfish	6	5	4	1	2	0	1	1	4	4

1.2 ADMINISTRATIVE AND REGULATORY ACTIONS

NMFS did not undertake any regulatory actions for PRIA fisheries during 2019.

2 ECOSYSTEM CONSIDERATIONS

2.1 CORAL REEF FISH ECOSYSTEM PARAMETERS

2.1.1 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 2019. Hard Coral cover is mean cover derived from visual estimates by divers of sites where reef fish surveys occurred.

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, Guam, the Commonwealth of the Northern Mariana Islands (CNMI), Main Hawaiian Islands (MHI), Northwestern Hawaiian Islands (NWHI), and the PRIAs

Spatial Scale: Regional

Data Source: Data used to generate cover and biomass estimates come from visual surveys conducted by the NOAA PIFSC as part of the Pacific Reef Assessment and Monitoring Program (RAMP; https://origin-apps-pifsc.fisheries.noaa.gov/cred/pacific_ramp.php) under the Ecosystem Sciences Division (ESD). Survey methods are described in detail at 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 (http://www.fishbase.org) and converted to biomass per unit area by dividing by the area sampled per survey. Site-level data were pooled into island-scale values by first calculating mean and variance within strata, and then calculating weighted island-scale mean and variance using the formulas given in Smith et al. (2011) with strata weighted by their respective sizes.

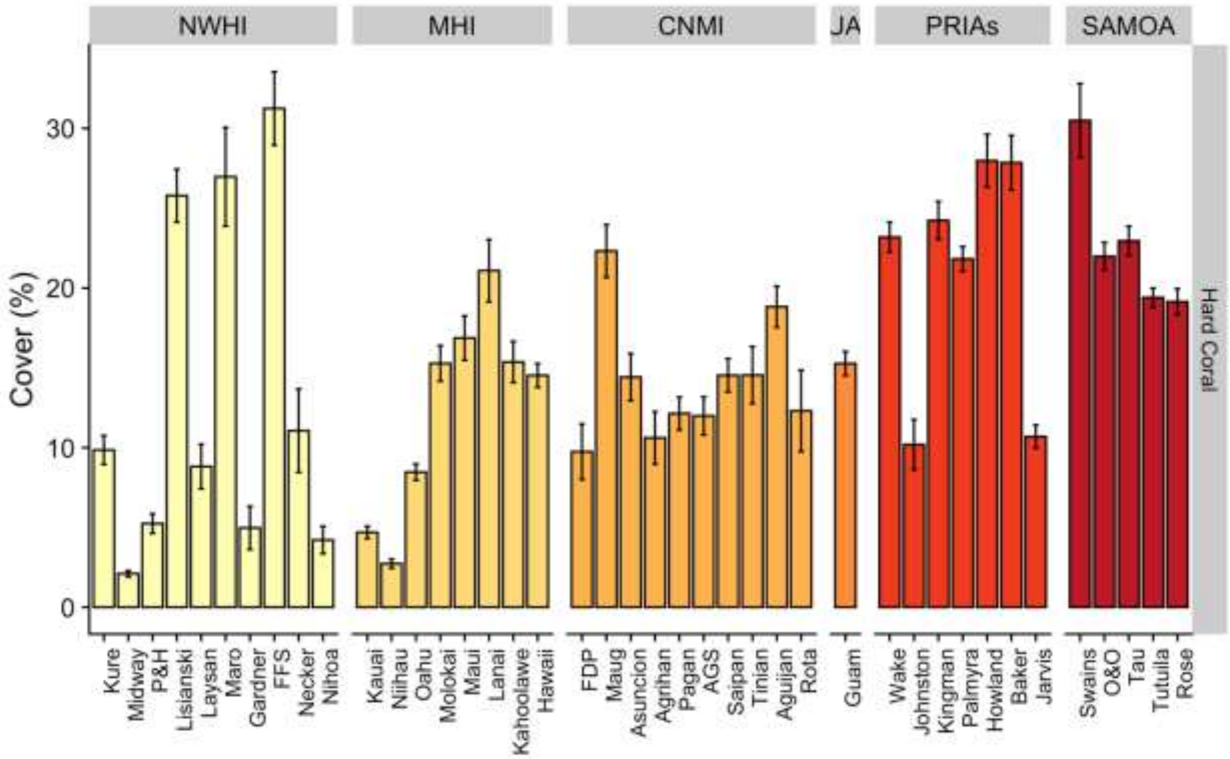


Figure 1. Mean coral cover (%) per U.S. Pacific island averaged over the years 2010-2019 by latitude

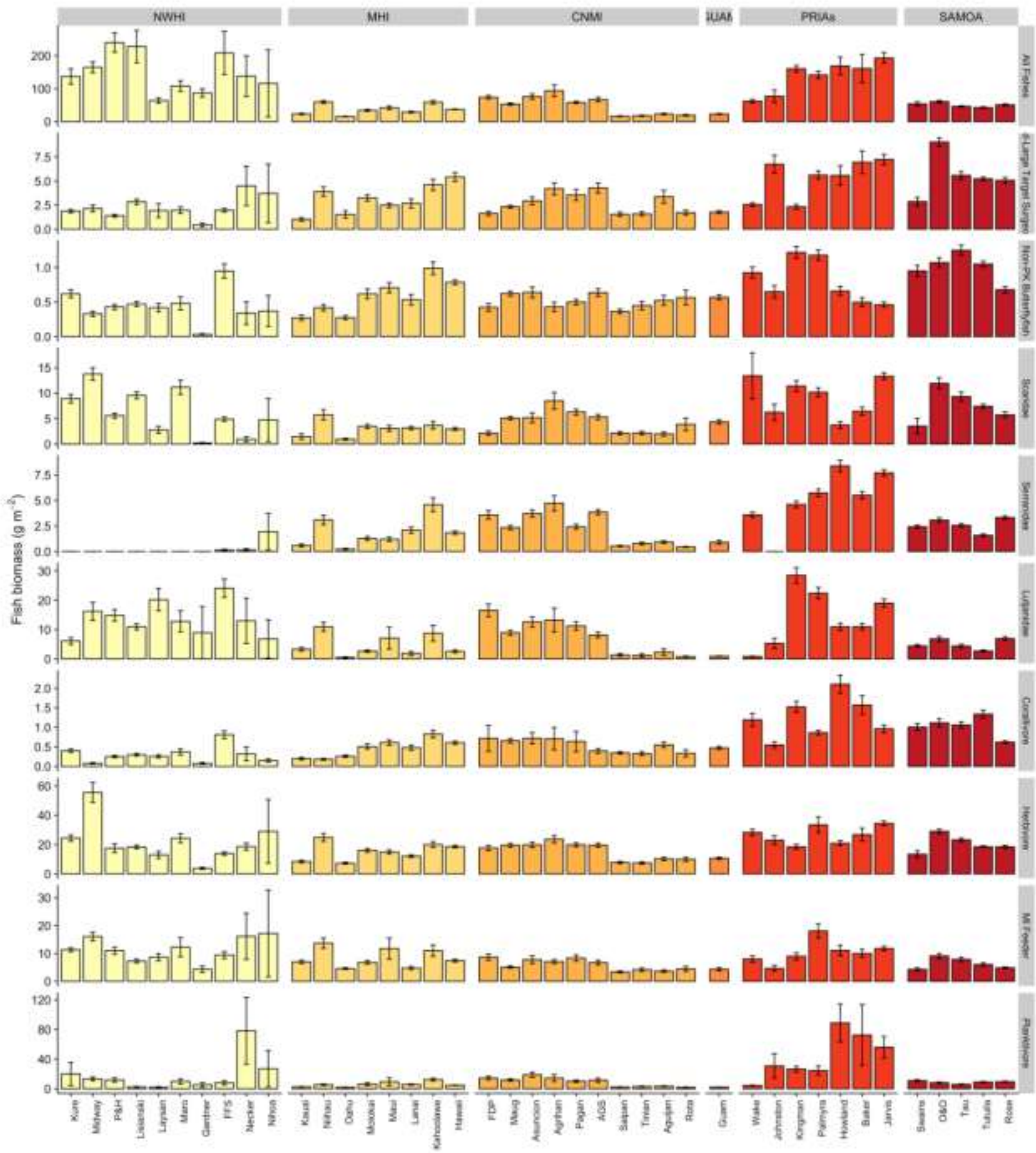


Figure 2. Mean fish biomass (g/m^2 ± standard error) of functional, taxonomic and trophic groups by U.S. Pacific reef area from the years 2010-2019 by latitude. The group Serranidae excludes planktivorous members of that family – i.e. anthias, which can by hyper-abundant in some regions. Similarly, the bumphead parrotfish, *Bolbometopon muricatum*, has been excluded from the corallivore group – as high biomass of that species at Wake overwhelms corallivore biomass at all other locations. The group 'MI Feeder' consists of fishes that primarily feed on mobile invertebrates

2.1.2 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 2019. Hard Coral cover is mean cover derived from visual estimates by divers of sites where reef fish surveys occurred.

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: PRIAs

Spatial Scale: Island

Data Source: Data used to generate biomass and cover estimates comes from visual surveys conducted by NOAA 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 2.1.1.

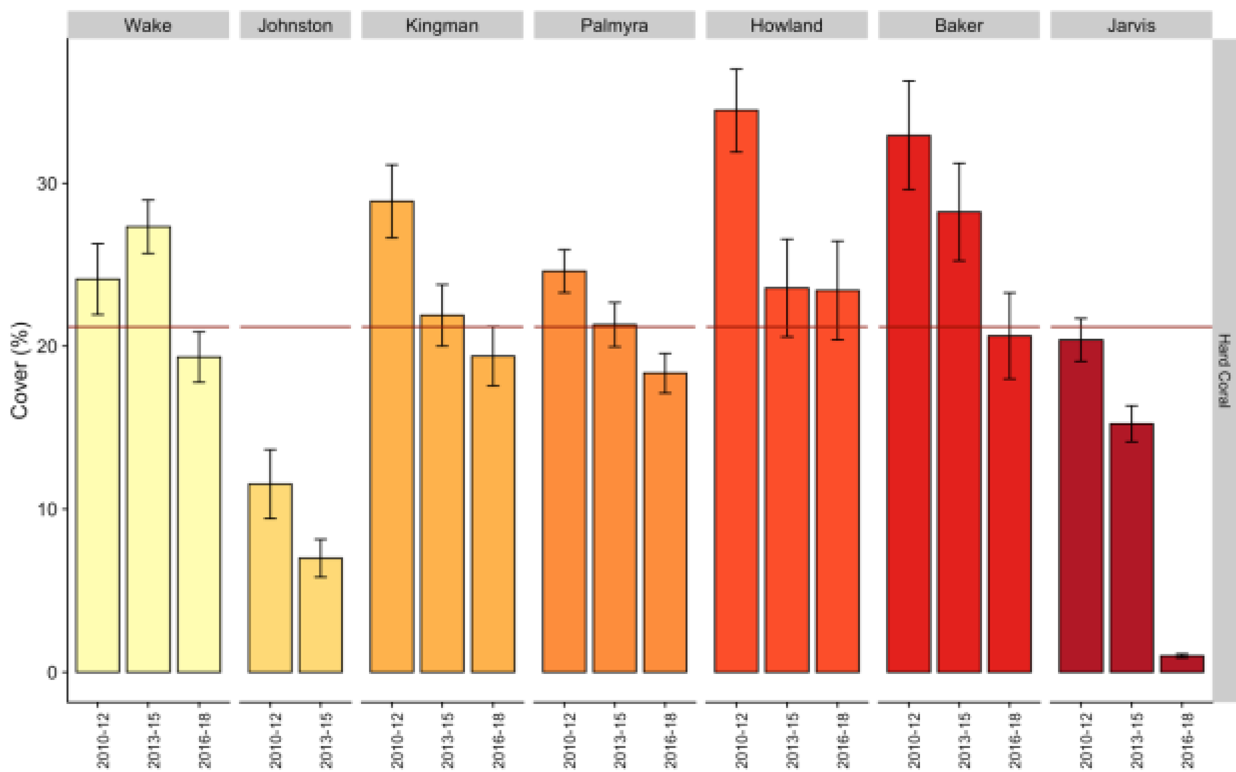


Figure 3. Mean coral cover (%) per island averaged over the years 2010-2019 by latitude with PRIA mean estimates plotted for reference (red line)

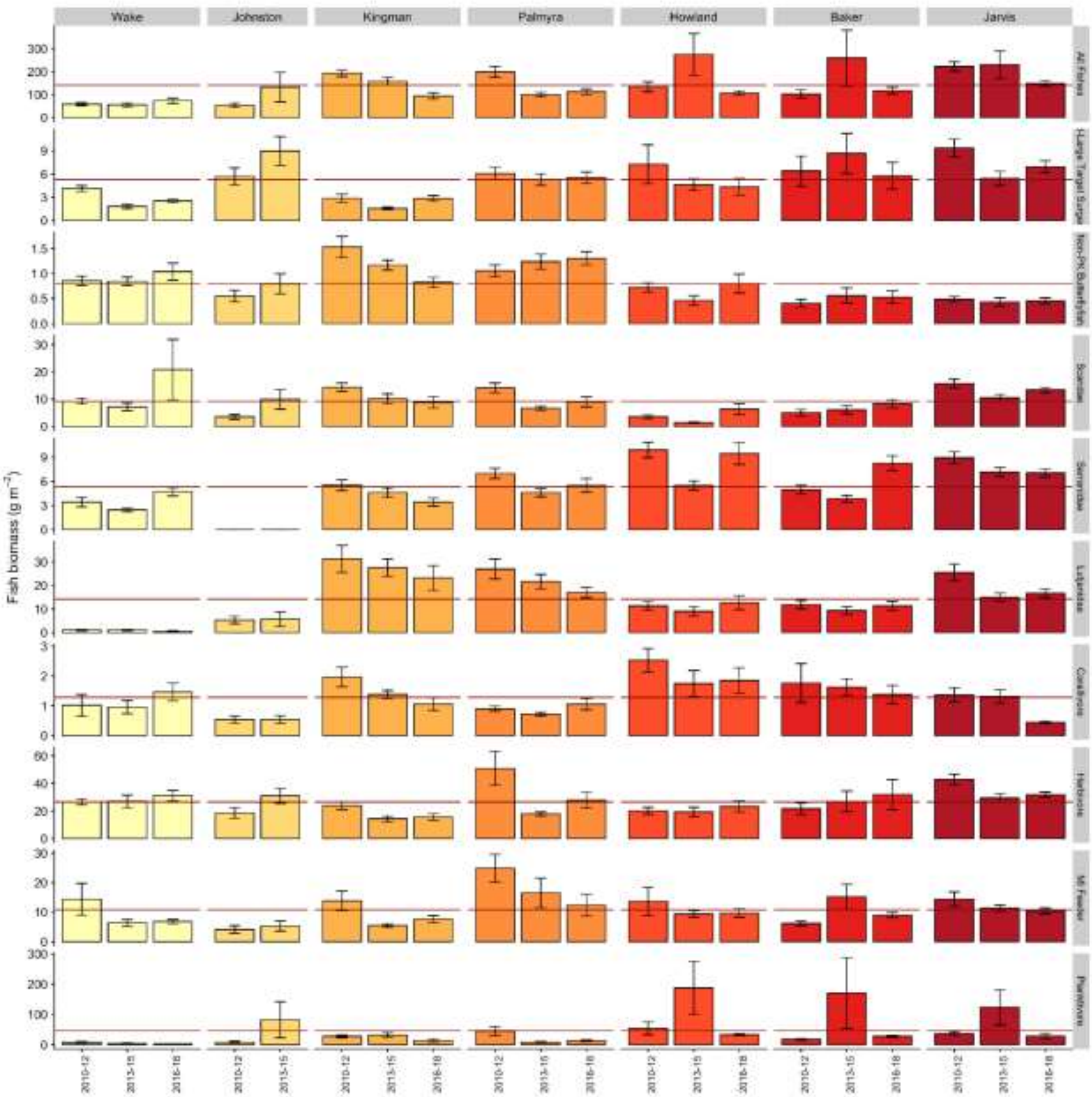


Figure 4. Mean fish biomass (g/m^2 ± standard error) of PRIA functional, taxonomic and trophic groups from the years 2010-2019 by island. The group Serranidae excludes planktivorous members of that family – i.e. anthias, which can by hyper-abundant in some regions. Similarly, the bumphead parrotfish, *Bolbometopon muricatum*, has been excluded from the corallivore group. The group 'MI Feeder' consists of fishes that primarily feed on mobile invertebrates; with PRIA mean estimates plotted for reference (red line)

2.2 PROTECTED SPECIES

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

2.2.1 Monitoring Protected Species Interactions in the PRIA FEP Fisheries

This report monitors the status of protected species interactions in the PRIA FEP fisheries using proxy indicators such as fishing effort and changes in gear types as these fisheries do not have observer coverage. Logbook programs are not expected to provide reliable data about protected species interactions due to the lack of active fisheries in these areas.

2.2.1.1 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.

2.2.1.2 ESA Consultations

ESA consultations were conducted by NMFS and the U.S. Fish and Wildlife Service (USFWS; for species under their jurisdiction) to ensure ongoing fisheries operations managed under the PRIA 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 2.

NMFS concluded on January 16, 2015 that all fisheries managed under the PRIA FEP have no effects on ESA-listed reef-building corals. NMFS concluded in an informal consultation dated February 20, 2015 that all fisheries managed under the PRIA FEP are not likely to adversely affect the Indo-West Pacific distinct population segment (DPS) of scalloped hammerhead shark.

Table 2. Summary of ESA consultations for PRIA FEP Fisheries

Fishery	Consultation Date	Consultation Type[a]	Outcome[b]	Species
Bottomfish	3/8/2002	BiOp	NLAA	Loggerhead sea turtle, leatherback sea turtle, olive ridley sea turtle, green sea turtle, hawksbill sea turtle, humpback whale, blue whale, fin whale, sei whale, sperm whale
Coral reef ecosystem	3/7/2002	LOC	NLAA	Loggerhead sea turtle, leatherback sea turtle, olive ridley sea turtle, green sea turtle, hawksbill sea turtle, humpback whale, blue whale, fin whale, 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
Crustacean	9/28/2007	LOC	NLAA	Loggerhead sea turtle, leatherback sea turtle, olive ridley sea turtle, green sea turtle, hawksbill sea turtle, humpback whale, blue whale, fin whale, sei whale, sperm whale
	9/18/2018	No effect memo	No effect	Oceanic whitetip shark, giant manta ray
Precious coral	10/4/1978	BiOp	Does not constitute threat	Sperm whale, leatherback sea turtle
	12/20/2000	LOC	NLAA	Humpback whale, green sea turtle, hawksbill sea turtle
	9/18/2018	No effect memo	No effect	Oceanic whitetip shark, giant manta ray
All fisheries	1/16/2015	No effect memo	No effect	Reef-building corals
	2/20/2015	LOC	NLAA	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 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).

Crustacean Fishery

An informal consultation completed by NMFS on September 28, 2007 concluded that PRIA 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 that PRIA crustacean fisheries will have no effect on the oceanic whitetip shark and giant manta ray.

Coral Reef Fishery

An informal consultation completed by NMFS on March 7, 2002 concluded that fishing activities conducted under the Coral Reef Ecosystems Fishery Management Plan (FMP) 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 terrestrial plants) and listed species shared with NMFS (i.e., sea turtles).

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

Precious Coral Fishery

An informal consultation completed by NMFS on December 20, 2000 concluded that PRIA precious coral fisheries are not likely to adversely affect humpback whales, green turtles, or hawksbill turtles.

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

2.2.1.3 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. PRIA fisheries are not classified under the LOF due to the lack of active commercial fisheries.

2.2.2 Status of Protected Species Interactions in the PRIA FEP Fisheries

There are currently no bottomfish, crustacean, coral reef, or precious coral fisheries operating in the PRIA and no historical observer data are available for fisheries under this FEP. No new fishing activity has been reported, and there is no other information to indicate that impacts to protected species from PRIA fisheries have changed in recent years.

2.2.3 Identification of Emerging Issues

Table 3 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 3. 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, 1/30/18)	Designation not prudent; no areas within US jurisdiction that meet definition of critical habitat (85 FR 12898, 3/5/2020)	In development; recovery planning workshops convened in 2019; draft plan anticipated in late 2020.
Giant manta ray	*Manta birostris*	Positive (81 FR 8874, 2/23/2016)	Positive, threatened (82 FRN 3694, 1/12/2017)	Listed as threatened (83 FR 2916, 1/22/18)	Designation not prudent; no areas within US 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.
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)	In development, proposed rule anticipated by July 2020	In development, expected TBA, interim recovery outline in place
Cauliflower coral	*Pocillopora meandrina*	Positive (83 FR 47592, 9/20/2018)	12-month finding anticipated by June 2020	TBD	N/A	N/A
Giant clams	*Hippopus hippopus, H. porcellanus, Tridacna costata, T. derasa, T. gigas, T. squamosa,* and *T. tevoroa*	Positive (82 FR 28946, 06/26/2017)	TBD (status review ongoing)	TBD	N/A	N/A
Green sea turtle	*Chelonia mydas*	Positive (77 FR 45571, 8/1/2012)	Identification of 11 DPSs, endangered	11 DPSs listed as endangered	In development, proposal	TBA

Species		Listing Process			Post-Listing Activity	
Common Name	**Scientific Name**	**90-Day Finding**	**12-Month Finding / Proposed Rule**	**Final Rule**	**Critical Habitat**	**Recovery Plan**
			and threatened (80 FR 15271, 3/23/2015)	and threatened (81 FR 20057, 4/6/2016)	expected TBA	
Leatherback sea turtle	*Dermochelys coriacea*	Positive 90-day finding on a petition to identify the Northwest Atlantic leatherback turtle as a DPS (82 FR 57565, 12/06/2017)	TBA (status review and 12-month finding anticipated in 2020)	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.

2.2.4 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.

2.3 SOCIOECONOMICS

This section outlines the pertinent economic, social, and community information available for assessing the successes and impacts of management measures and the achievements of the FEP for the PRIAs (WPRFMC, 2009). It meets the objective of "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, and then provides a summary of relevant studies and data for the PRIA.

In 1996, the Magnuson-Stevens Fishery Conservation and Management Act's National Standard 8 (NS8) specified that conservation and management measures need 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 United States, 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 (from 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 have a similar reliance on marine resources. Thus, fishing and seafood are integral to local community ways of life. This is reflected in the amount of seafood eaten in the region relative to the rest of the United States, as well as in the language, customs, ceremonies, and community events. The amount of available seafood can also affect seasonality in prices of fish. Because fishing is such an integral part of the culture, it is difficult to discern commercial from non-commercial fishing where 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 important. Due to changing economies and westernization, waning recruitment of younger fishermen is becoming a concern for the sustainability of fishing and fishing traditions in the region.

2.3.1 Response to Previous Council Recommendations

There were no Council recommendations related to socioeconomic considerations in the PRIAs during 2019.

2.3.2 Background

Human habitation in the PRIAs is limited. The FEP for the PRIAs provides a description of the geography, history, and socioeconomic considerations of the archipelago (WPRFMC, 2009). Grace-McCaskey (2014) provided a brief review of the importance of these areas from a cultural perspective. She noted that although the PRIAs were uninhabited when first visited by Westerners, Polynesians and Micronesians likely had been periodically visiting these islands for centuries. Many of the islands in the PRIAs were altered during World War 2, and many have subsequently become National Wildlife Refuges or part of the Pacific Remote Islands Marine National Monument (PRIMNM). Only Wake, Johnston, and Palmyra have seasonal- and year-round residents, primarily related to the U.S. military and refuge management. The surrounding reef ecosystems are considered to be some of the healthiest in the world due to their distance to areas of high human population densities, though some are experiencing residual impacts from military activity nearby. There are no designated fishing communities residing in the PRIAs. Most of the fishing effort has been concentrated around Johnston and Palmyra Atolls by members of the Hawaii fishing community.

2.3.3 Ongoing Research and Information Collection

There is currently no ongoing research specific to the PRIAs.

2.3.4 Relevant PIFSC Economics and Human Dimensions Publications: 2019

There were no relevant PIFSC publications regarding the economics or human dimensions of the PRIAs in 2019.

2.4 CLIMATE AND OCEANIC INDICATORS

2.4.1 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 2019 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 Hawai`i 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 (MPCC) Committee. 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 Fisheries Ecosystem Plan (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.

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.

2.4.1.1 Response to Previous Council Recommendations

There were no Council recommendations relevant to the climate and oceanic indicators section of the annual SAFE report in 2019.

At its 170th meeting from June 20-22, 2017, the Council directed staff to support the development of community training and outreach materials and activities on climate change. In addition, the Council directed staff to coordinate a “train-the-trainers” workshop that includes NOAA scientists who presented at the 6th Marine Planning and Climate Change Committee (MPCCC) meeting and the MPCCC committee members in preparation for community workshops on climate and fisheries. The Council and NOAA partnered to deliver the workshops in the fall of 2017 to the MPCCC members in Hawaii (with the Hawaii Regional Ecosystem Advisory Committee), as well as American Samoa, Guam, and the CNMI (with their respective Advisory Panel groups). Feedback from workshop participants has been incorporated into this year’s climate and oceanic indicator section. To prepare for community outreach, Guam-based MPCCC members conducted a climate change survey and shared the results with the MPCCC at its 7th meeting on April 10th and 11th, 2018. The Council also directed staff to explore funding avenues to support the development of additional oceanic and climate indicators, such as wind and extratropical storms. These indicators were added to this module by corresponding Plan Team members in 2018.

Prior to holding its 8th meeting, 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.

2.4.2 Conceptual Model

In developing this chapter, the Council relied on a number of recent reports conducted in the context of the U.S. National Climate Assessment including, most notably, the 2012 Pacific Islands Regional Climate Assessment 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 6).

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.

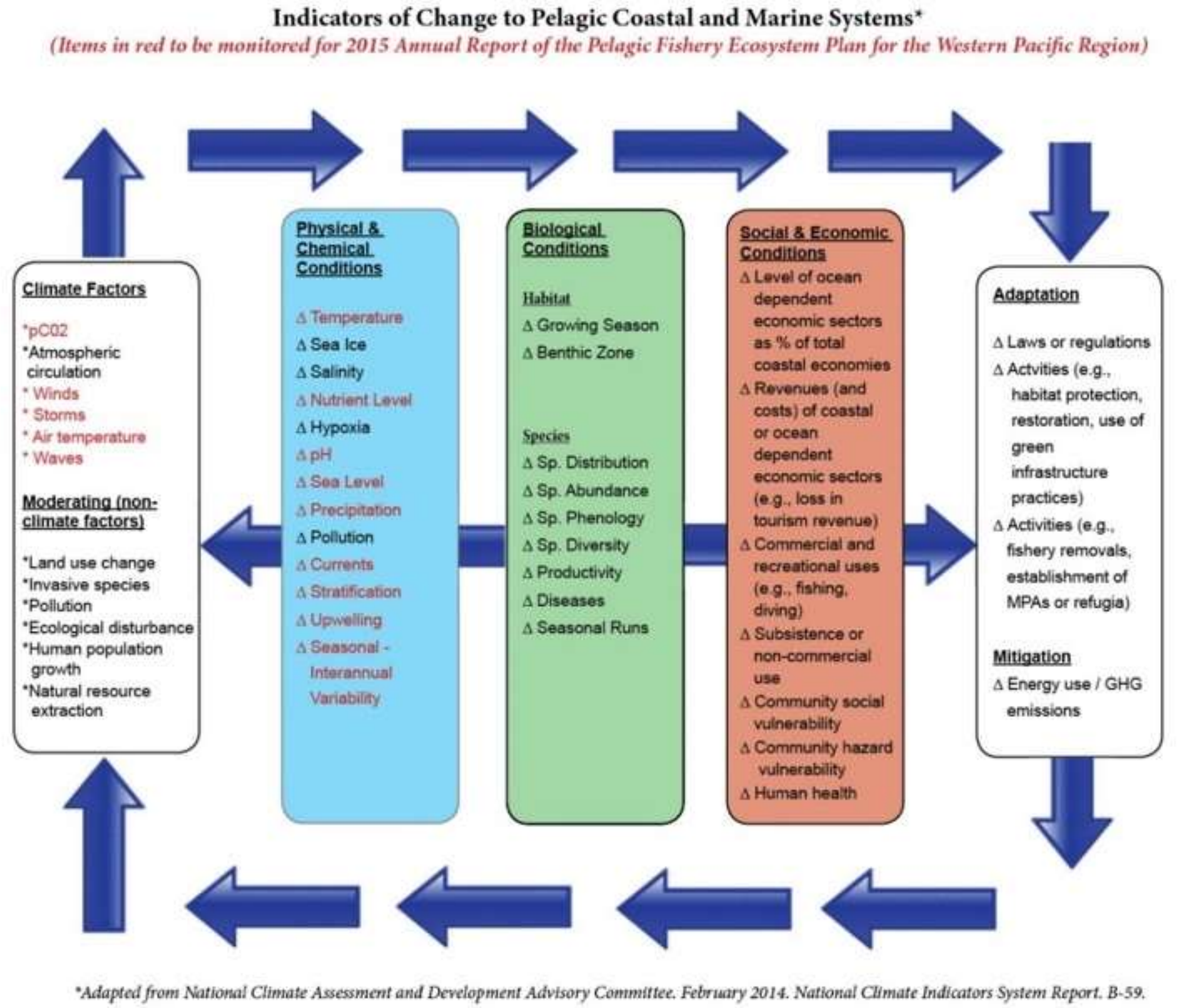


Figure 6. Indicators of change of pelagic coastal and marine systems; conceptual model

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.

2.4.3 Selected Indicators

The primary goal for selecting the indicators used in this report is to provide fisheries-related communities, resource managers, and businesses with a climate-related situational awareness. In this context, indictors were selected to:

- Be fisheries relevant and informative.
- Build intuition about current conditions in light of a changing climate;
- Provide historical context; and
- Allow for recognition of 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; and
- Sea Level (Sea Surface Height).

Figure 7 and Figure 8 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.

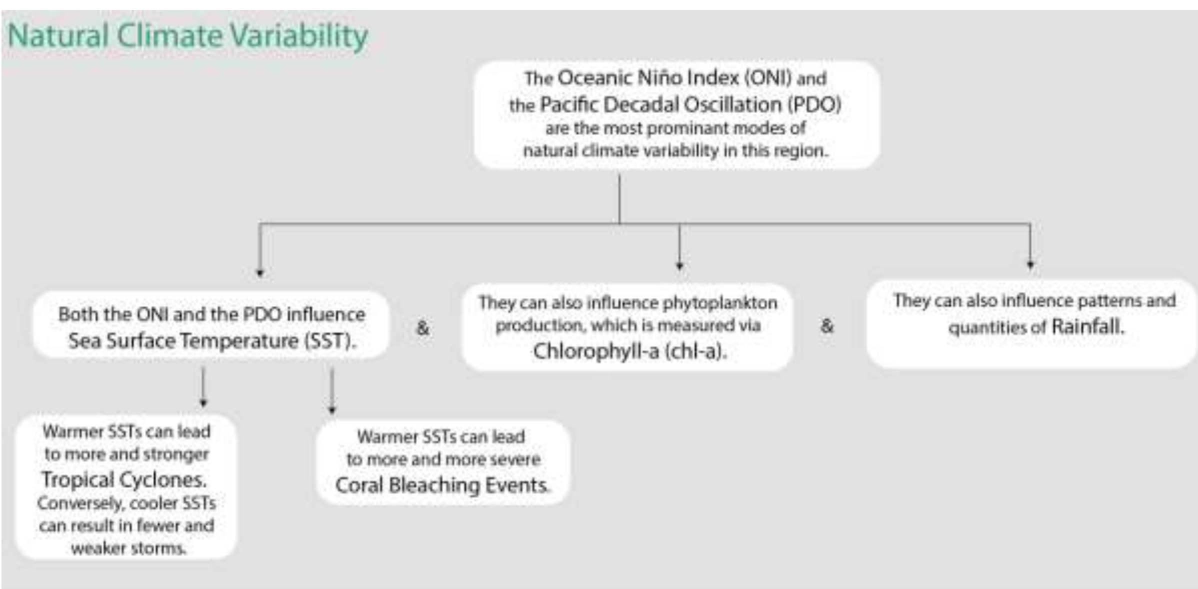


Figure 7. Schematic diagram illustrating how indicators are connected to one another and how they vary as a result of natural climate variability

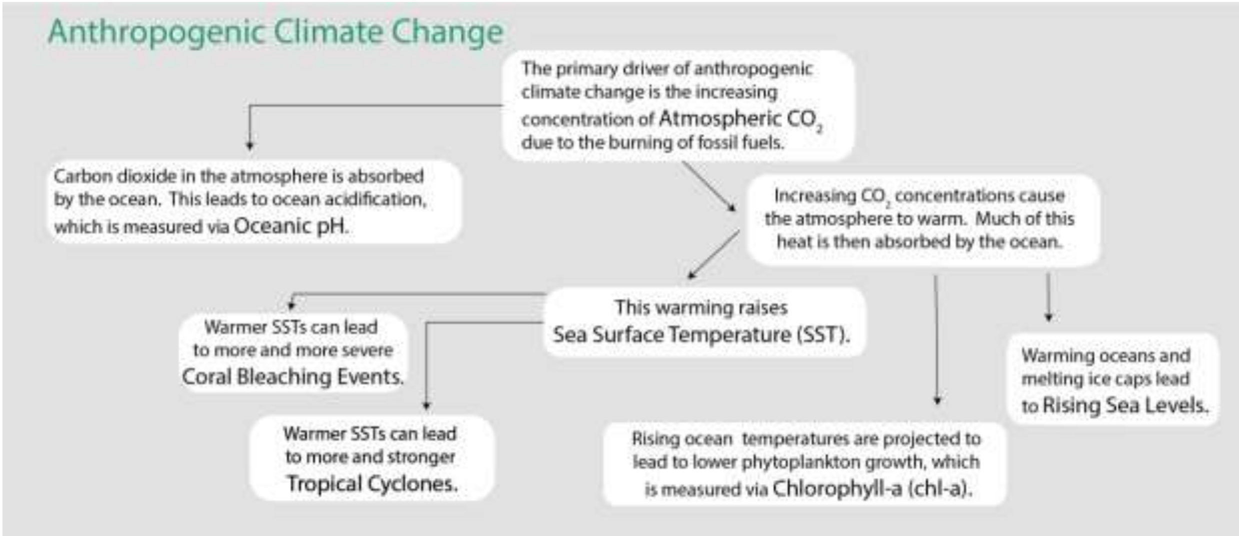


Figure 8. Schematic diagram illustrating how indicators are connected to one another and how they vary as a result of anthropogenic climate change

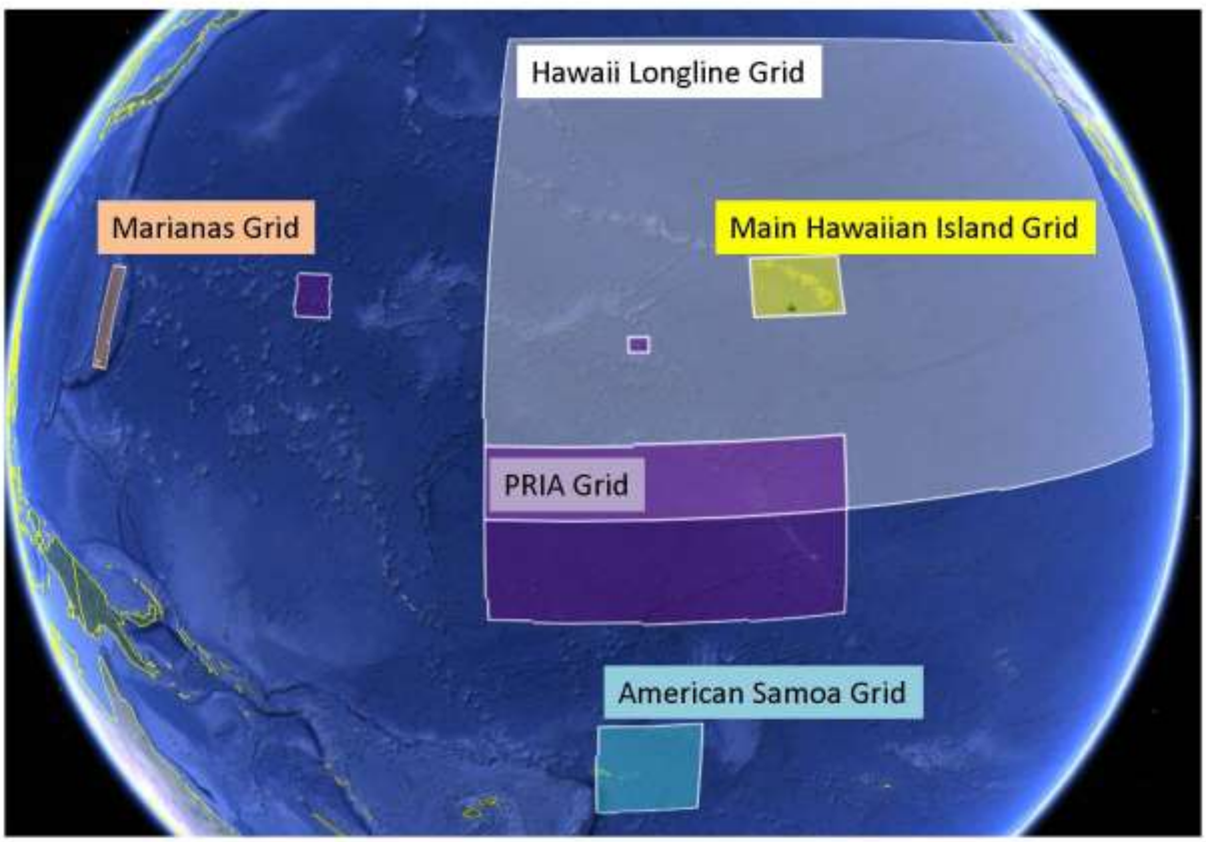


Figure 9. Regional spatial grids representing the scale of the climate change indicators being monitored

2.4.3.1 Atmospheric Concentration of Carbon Dioxide (CO_2) 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 at a faster rate each year. In 2019, the annual mean concentration of CO_2 was 411 parts per million (ppm). In 1959, the first year of the time series, it was 316 ppm. The annual mean passed 350 ppm in 1988 and 400 ppm in 2015 (NOAA, 2020a).

Description: Monthly mean atmospheric carbon dioxide (CO_2) at Mauna Loa Observatory, Hawaii in 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 about one year. The annual oscillations at Mauna Loa, Hawaii are due to the seasonal imbalance between the photosynthesis and respiration of plants on land. During the summer growing season photosynthesis exceeds respiration and CO_2 is removed from the atmosphere, whereas outside the growing season respiration exceeds photosynthesis and CO_2 is returned to the atmosphere. The seasonal cycle is strongest in the northern hemisphere because of this hemisphere's larger land mass.

Timeframe: Annual, monthly.

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

Measurement Platform: *In-situ* station.

Sourced from: Keeling et al. (1976), Thoning et al. (1989), and NOAA (2020a).

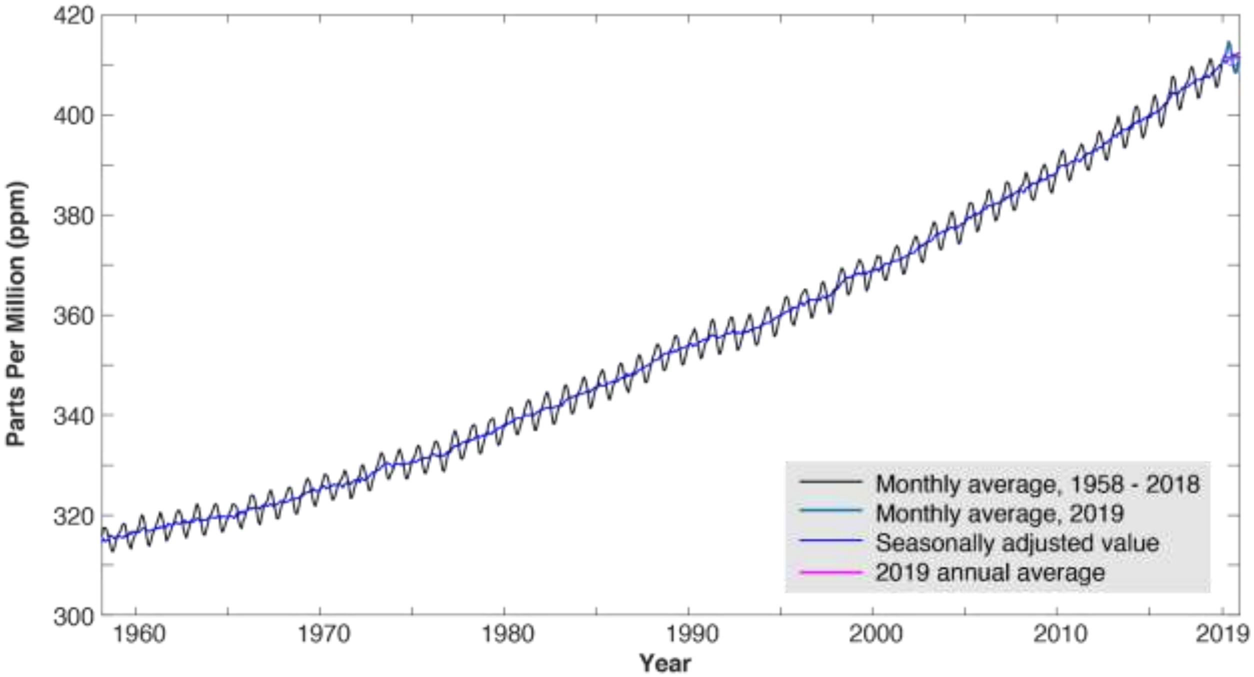


Figure 10. Monthly mean (black) and seasonally corrected (blue) atmospheric carbon dioxide at Mauna Loa Observatory, Hawai`i

2.4.3.2 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 9.7% more acidic than it was nearly 30 years ago at the start of this time series. Over this time, pH has declined by 0.0401 at a constant rate. In 2018, 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 now outside the range seen in the first year of the time series. The highest pH value reported for the most recent year (8.0743, down from a high of 8.0830 in 2017) is lower than the lowest pH value reported in the first year of the time series (8.0845).

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 2018 (2019 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.

Sourced from: Fabry et al. (2008), Feely et al. (2016). These data are based upon Hawaii Ocean Time-series observations supported by the U.S. National Science Foundation under Grant OCE-12-60164 a as described in Karl et al. (1996) and on its website (HOT, 2020).

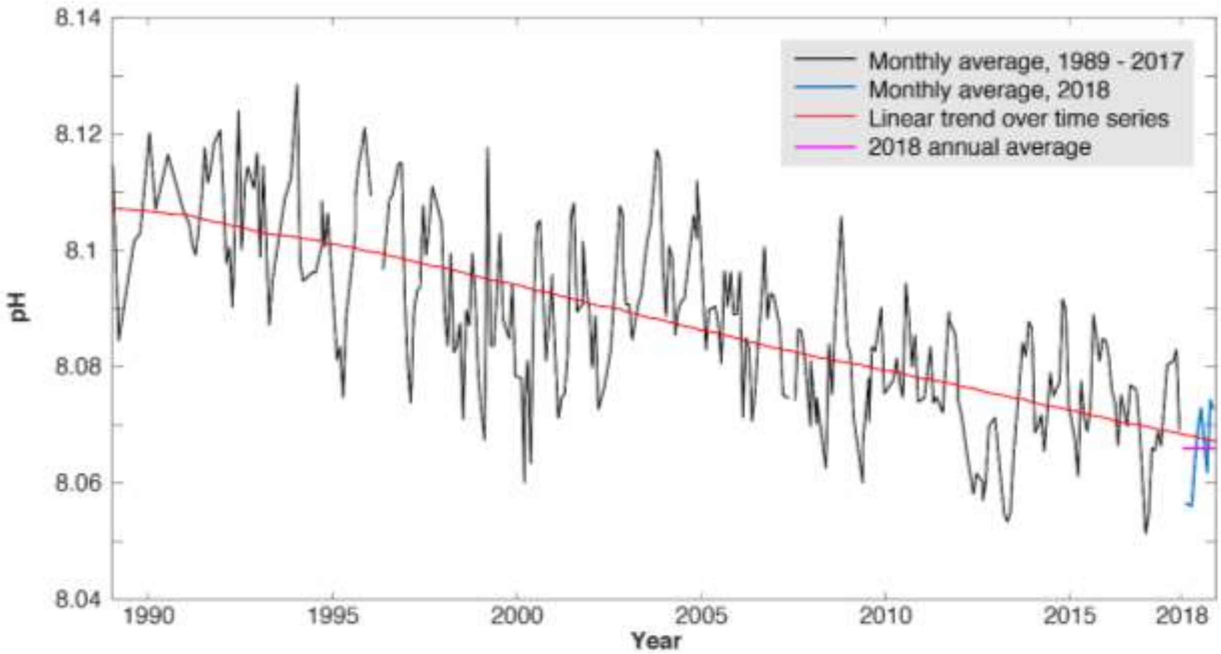


Figure 11. Oceanic pH (black) and its trend (red) at Station ALOHA from 1989-2018

2.4.3.3 Oceanic Niño Index (ONI)

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: In 2019, the ONI transitioned from a weak El Niño to neutral conditions.

Description: The three-month running mean 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 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.

Sourced from NOAA CPC (2020).

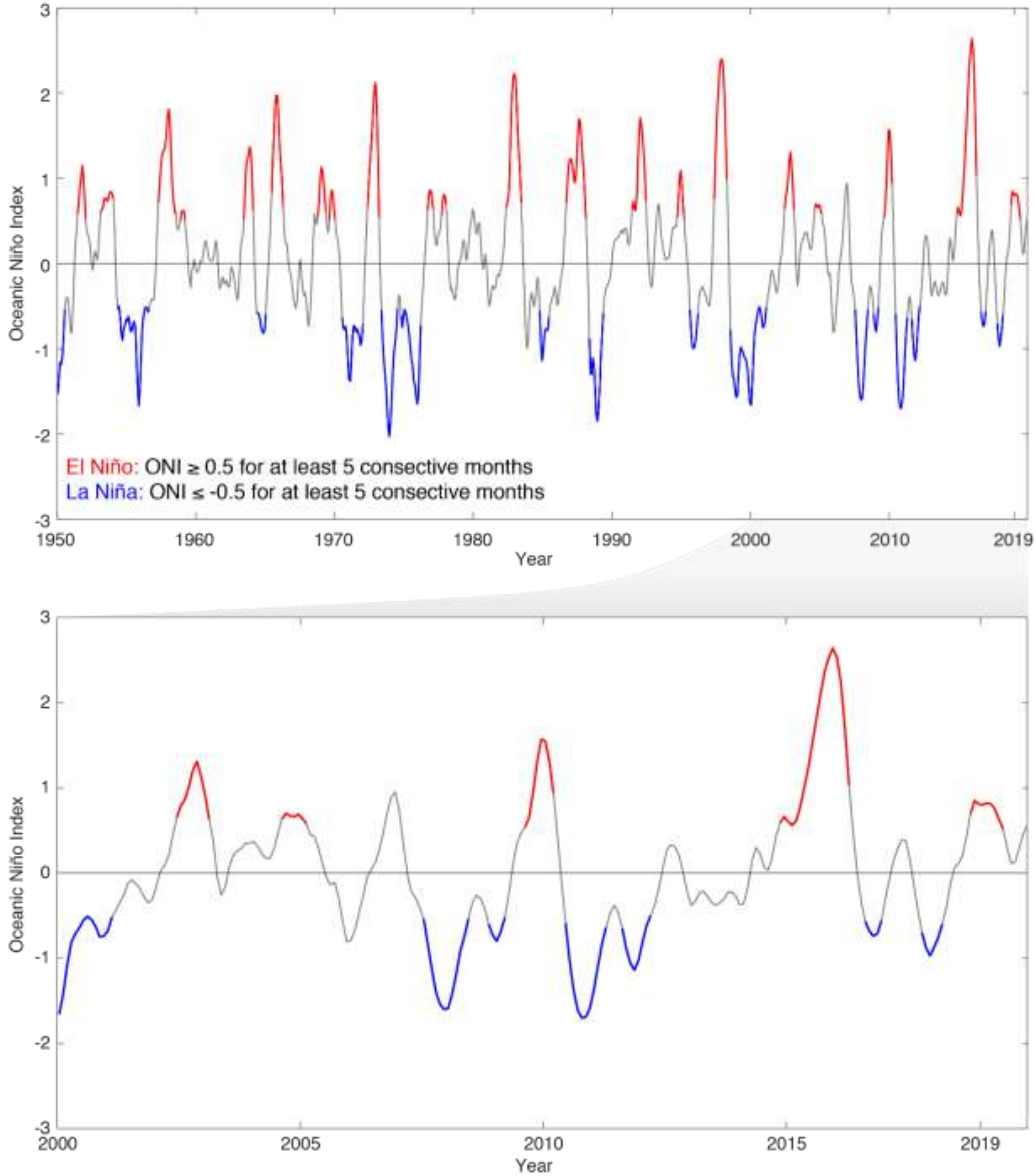


Figure 12. Oceanic Niño Index from 1950-2019 (top) and 2000–2019 (bottom) with El Niño periods in red and La Niña periods in blue

2.4.3.4 Pacific Decadal Oscillation (PDO)

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 hovered around zero in 2019. The year was nearly evenly split between values that were slightly negative (seven months) and values that were slightly positive (5 months).

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 interior 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 NOAA (2020a).

Timeframe: Annual, monthly.

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

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

Sourced from: NOAA (2020b) and Mantua (2017).

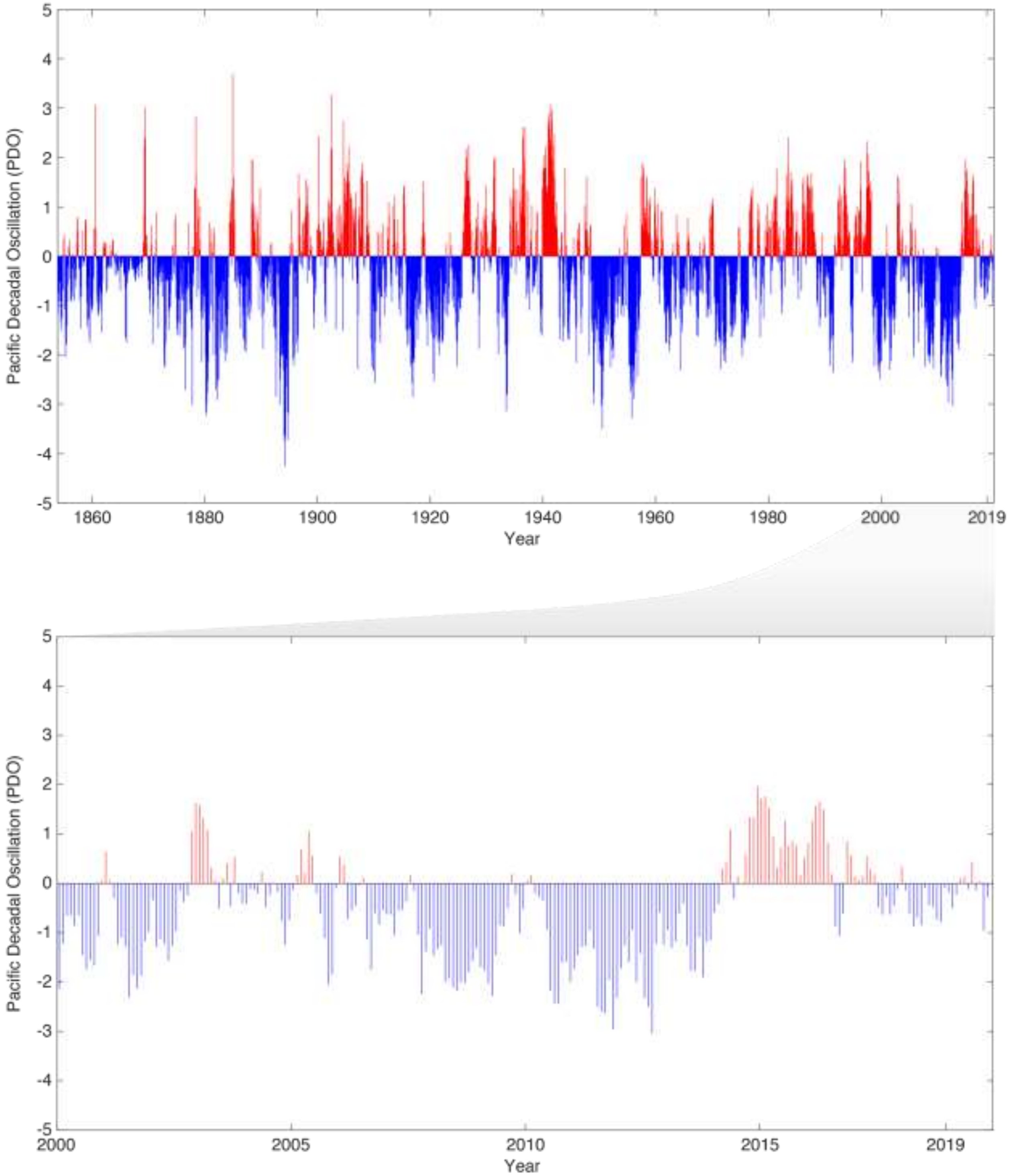


Figure 13. Pacific Decadal Oscillation from 1950–2019 (top) and 2000–2019 (bottom) with positive warm periods in red and negative cool periods in blue

2.4.3.5 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 Hawai`i 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. Overall, the 2019 eastern Pacific hurricane season featured near average activity. There were 17 named storms, of which seven became hurricanes and three became major hurricanes - category 3 or higher on the Saffir-Simpson Hurricane Wind Scale. This compares to the long-term averages of fifteen named storms, eight hurricanes, and four major hurricanes. There were also two tropical depressions that did not reach tropical storm strength. In terms of Accumulated Cyclone Energy (ACE), which measures the strength and duration of tropical storms and hurricanes, activity in the basin in 2019 was a little below the long-term mean. Summary inserted from https://www.nhc.noaa.gov/text/MIATWSEP.shtml.

Central North Pacific. Tropical cyclone activity in the central Pacific in 2019 was average. There were four named storms, of which one became a hurricane and one became a major hurricane. The ACE index was slightly below the 1981 – 2010 average of roughly 20 (x 10^4 knots^2).

Western North Pacific. Tropical cyclone activity was roughly average in the western Pacific in 2019. There were 26 named storms. Sixteen of these storms developed into typhoons, and ten of these typhoons were major. The ACE Index was below the 1981 – 2010 average. Of note was Super typhoon Hagibis. Hagibis was just the third category 5 tropical cyclone globally in 2019 (Super Typhoon Wutip and Hurricane Dorian were the others). Hagibis weakened to a category 2 storm before making landfall in Japan but was still one of the most damaging typhoons in history. The remnants of Hagibis transitioned to an extratropical cyclone that affected the Aleutian Islands and significantly altered the weather patterns over the North America in the subsequent days. Summary inserted from https://www.ncdc.noaa.gov/sotc/tropical-cyclones/201910.

South Pacific. Tropical cyclone activity was average in the south Pacific region in 2019. There were nine named storms, four of which developed into cyclones and one of which was a major cyclone. The ACE Index were below average in 2019.

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 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 a stacked time series plot 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. This plot shows the historical 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.

Sourced from: Knapp et al. (2010) and Knapp et al. (2018).

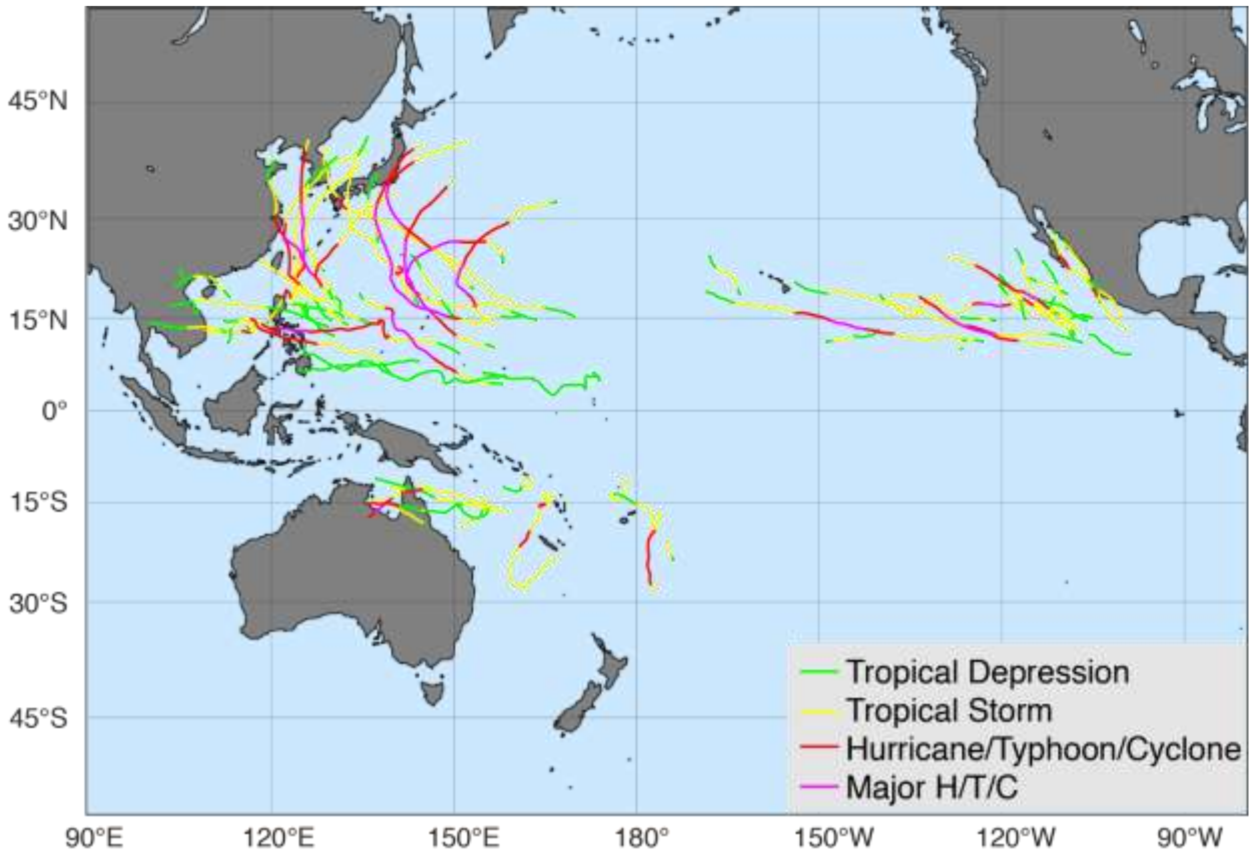


Figure 14. 2019 Pacific basin tropical cyclone tracks

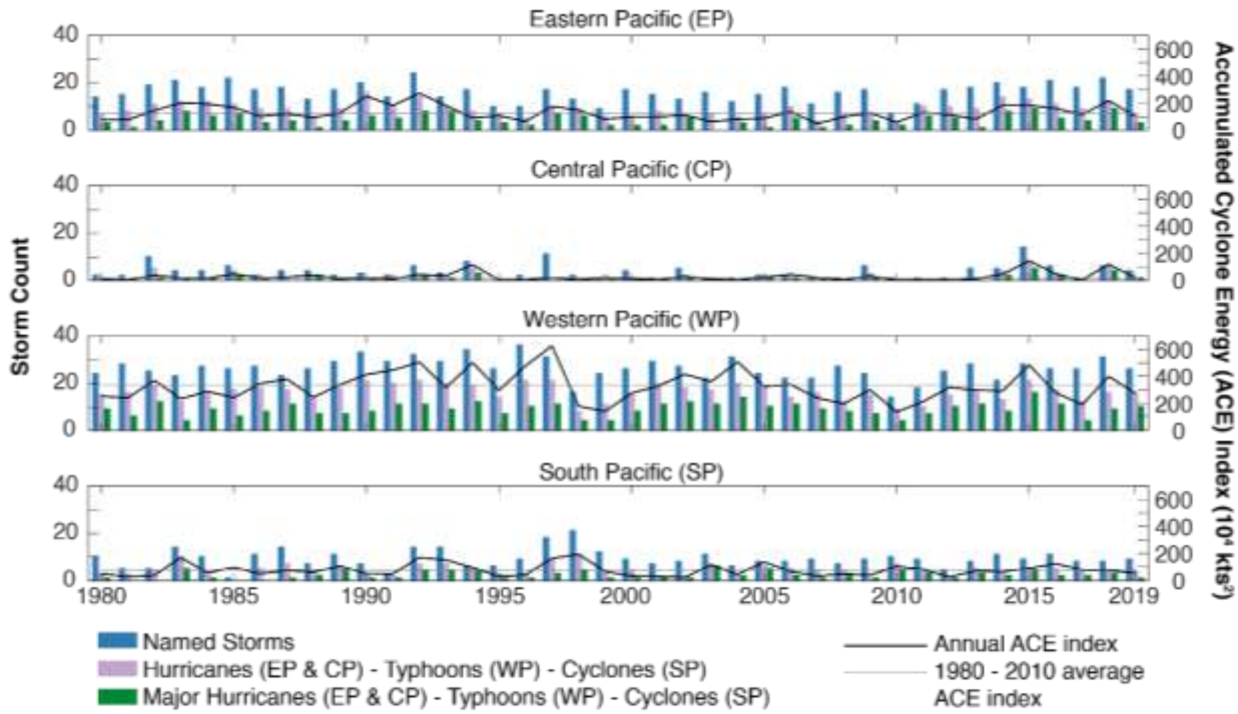


Figure 15. 2019 tropical storm totals by region

2.4.3.6 Sea Surface Temperature (SST)

Rationale: Sea surface temperature 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:

Pacific Remote Island Areas Grid: Annual mean SST was 28.90ºC in 2019. Over the period of record, monthly SST shows no significant pattern of increase or decrease. Monthly SST values in 2019 ranged from 28.43 – 29.43 ºC, within the climatological range of 25.71 – 30.09 ºC. The annual anomaly was 0.772 ºC hotter than average, with mild intensification in the southern section of the grid.

Johnston Atoll Grid: Annual mean SST was 27.28ºC in 2019. Over the period of record, annual SST has increased at a rate of 0.018 ºC yr^{-1}. Monthly SST values in 2019 ranged from 25.09 – 28.83ºC, within the climatological range of 24.56 – 29.31 ºC. The annual anomaly was 0.605ºC hotter than average, with no dramatic spatial pattern.

Wake Atoll Grid: Annual mean SST was 27.88ºC in 2019. Over the period of record, annual SST has increased at a rate of 0.029 ºC yr^{-1}. Monthly SST values in 2019 ranged from 26.2 – 29.64ºC, within the climatological range of 24.76 – 30.05 ºC. The annual anomaly was 0.329ºC hotter than average, with no dramatic spatial pattern.

Note that from the top to bottom in Figure 16, panels show climatological SST (1985-2018), 2019 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 each of the PRIA Grid (1°S – 7°N, 159° – 177°W; including Howland, Baker, Jarvis, Palmyra, Kingman Reef), Johnston Island (16° – 17°N, 168° – 170°W), and Wake Atoll (17.7° – 20.7°N, 165° – 168°W). Time series of monthly mean SST averaged over the respective grids are presented. Additionally, spatial climatology and anomalies are shown.

Timeframe: Monthly.

Region/Location: PRIA Grid (1°S – 7°N, 159° – 177°W); Johnston Atoll (16° – 17°N, 168° – 170°W), and Wake Atoll (17.7° – 20.7°N, 165° – 168°W)

Measurement Platform: Satellite.

Sourced from: NOAA OceanWatch (2020).

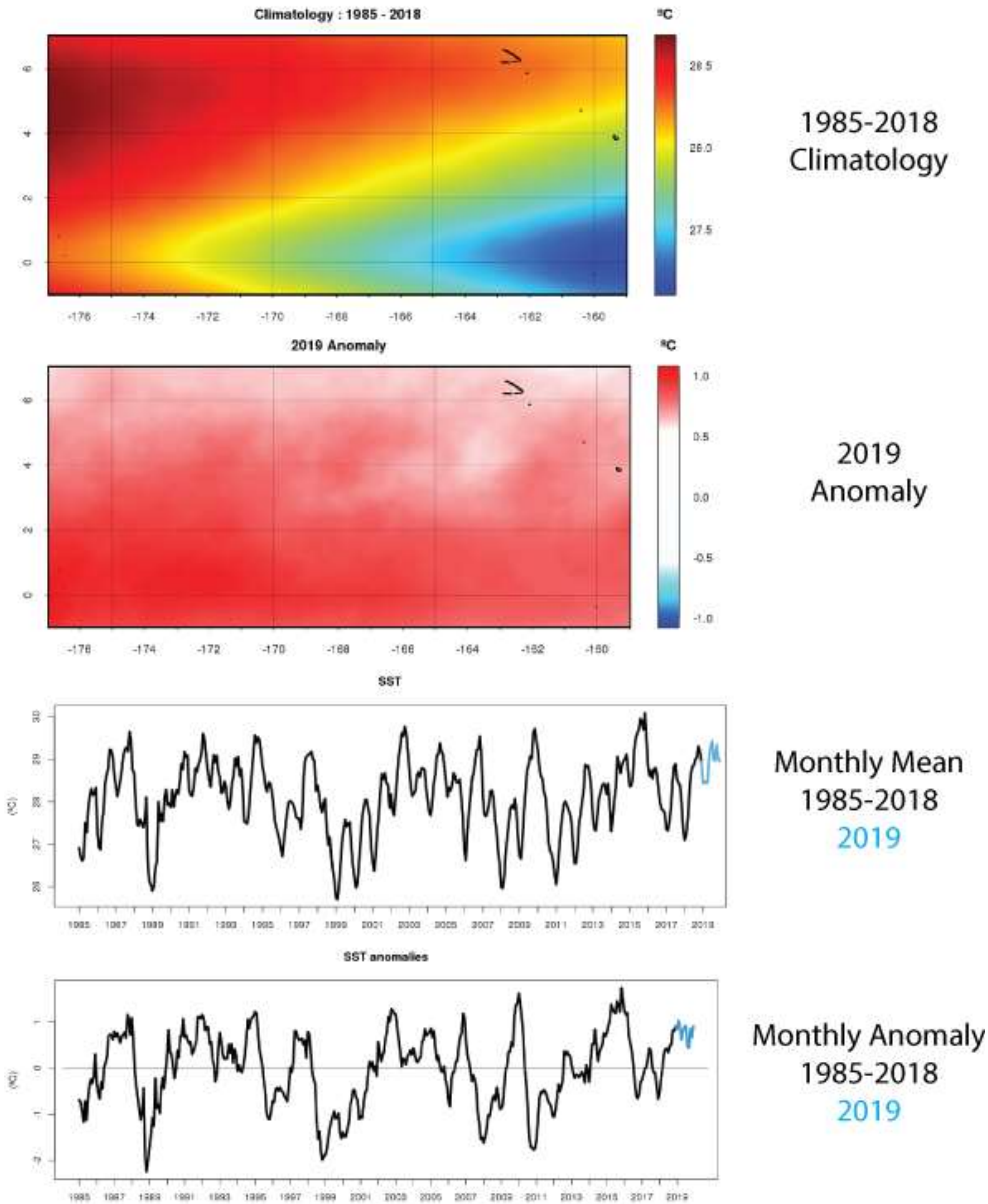


Figure 16. Sea surface temperature climatology and anomalies from the PRIA Grid

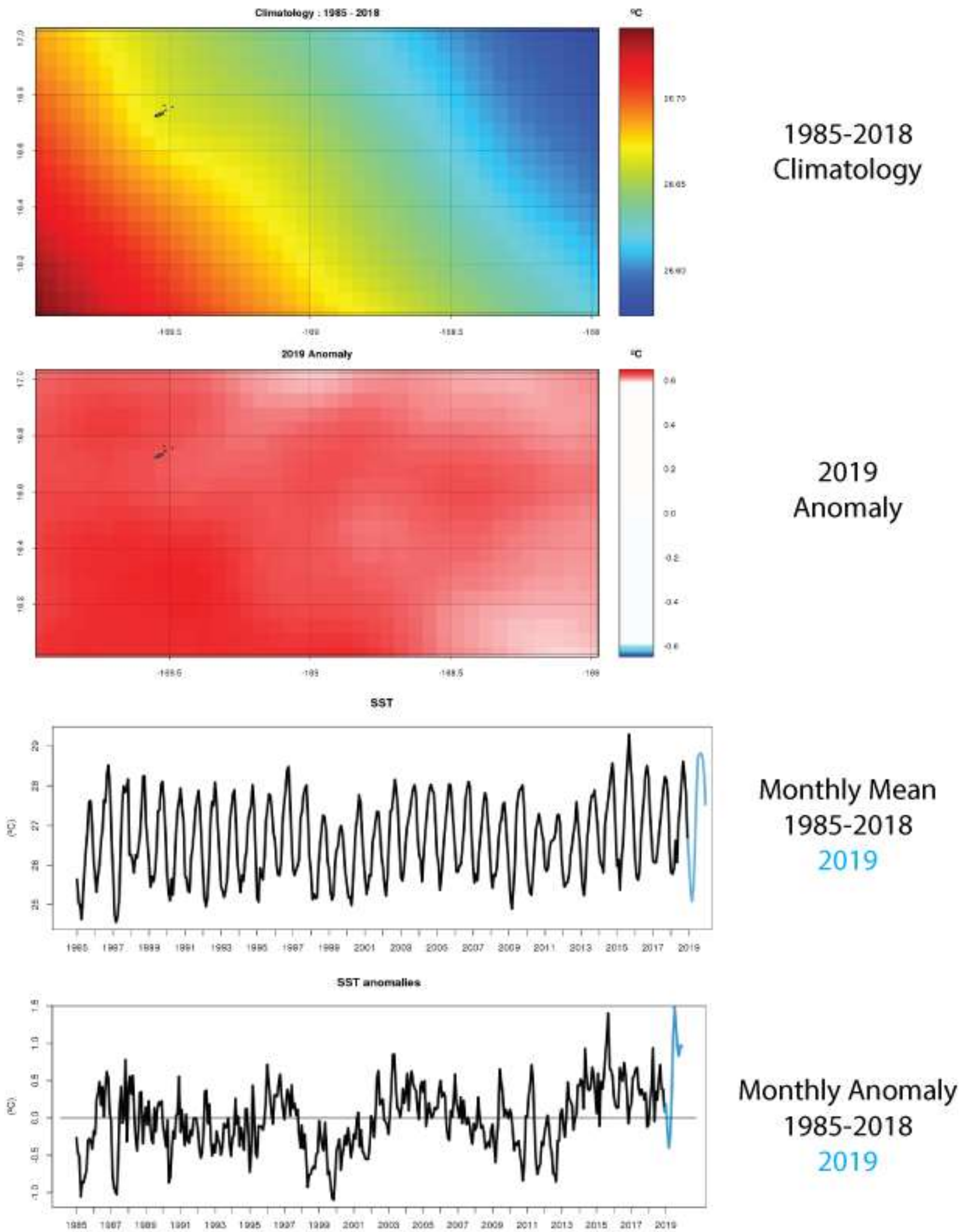


Figure 17. Sea surface temperature climatology and anomalies from Johnston Atoll Grid

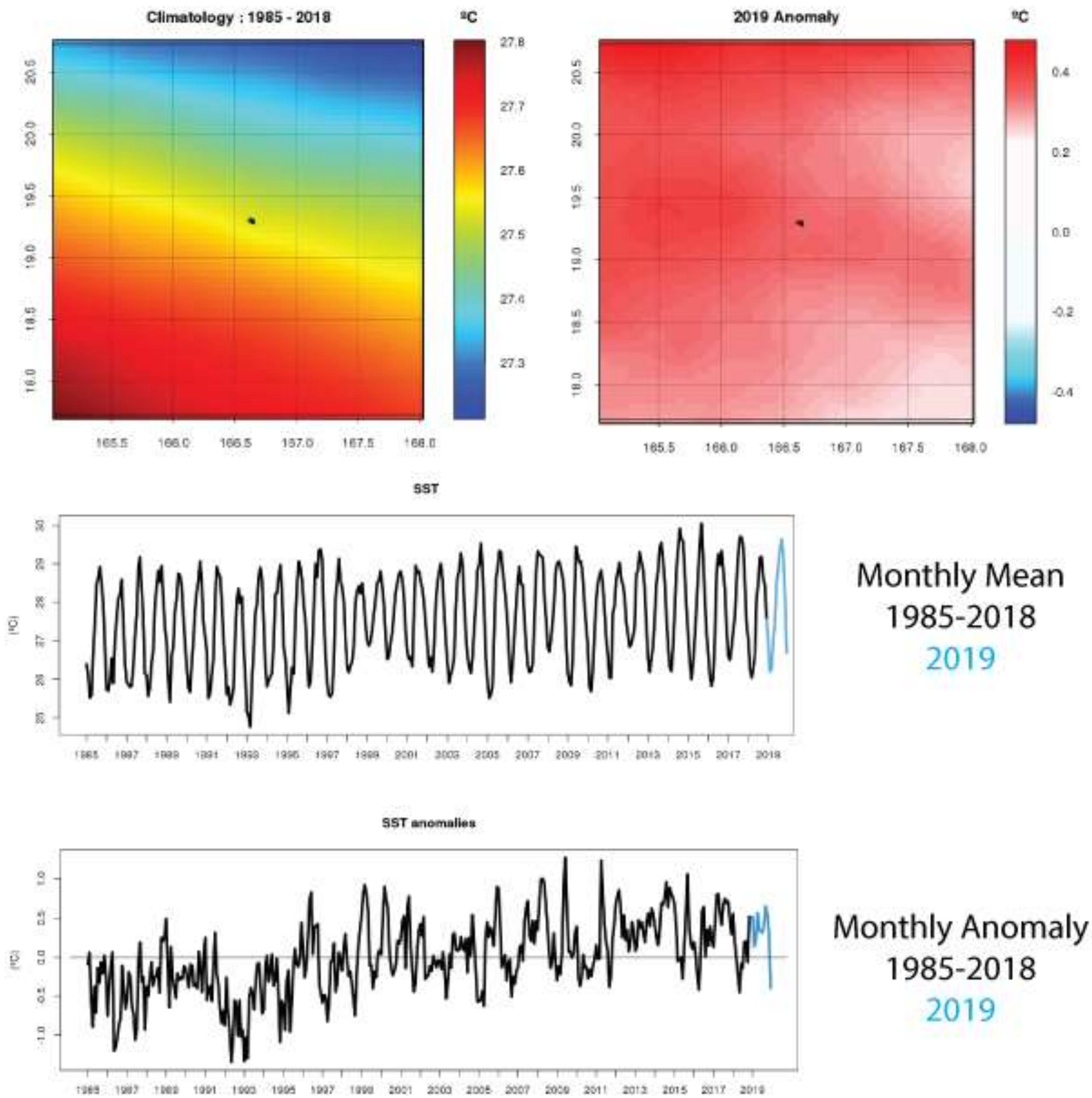


Figure 18. Sea surface temperature climatology and anomalies from Wake Atoll Grid

2.4.3.7 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.

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 a rolling sum weekly thermal anomalies over a 12-week window. Higher DHW measures imply a greater likelihood of mass coral bleaching or mortality from thermal stress.

Status: After experiencing major heat stress events in 2015 and 2016, all four virtual stations experienced another heat stress event in 2019 except for Wake Atoll where it was minor.

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 daily 5-km satellite coral bleaching 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

Timeframe: 2013-2019 daily data

Region/Location: Global

Sourced from: NOAA Coral Reef Watch (2020) at

https://coralreefwatch.noaa.gov/product/vs/timeseries/us_pacific_remote_islands.php#howland_baker

https://coralreefwatch.noaa.gov/product/vs/timeseries/polynesia.php#northern_line_islands

https://coralreefwatch.noaa.gov/product/vs/timeseries/us_pacific_remote_islands.php#johnston_atoll

https://coralreefwatch.noaa.gov/product/vs/timeseries/us_pacific_remote_islands.php#wake_atoll

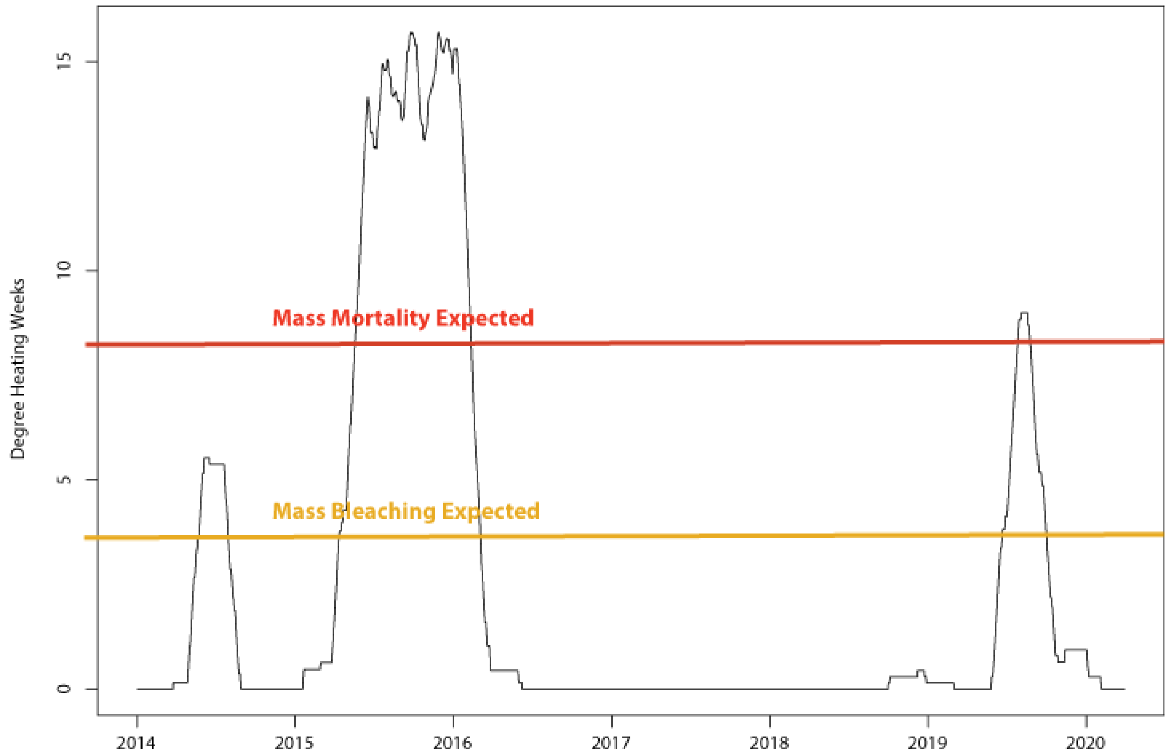


Figure 19. Coral Thermal Stress Exposure, Howland/Baker Virtual Station 2014-2019 (Coral Reef Watch Degree Heating Weeks)

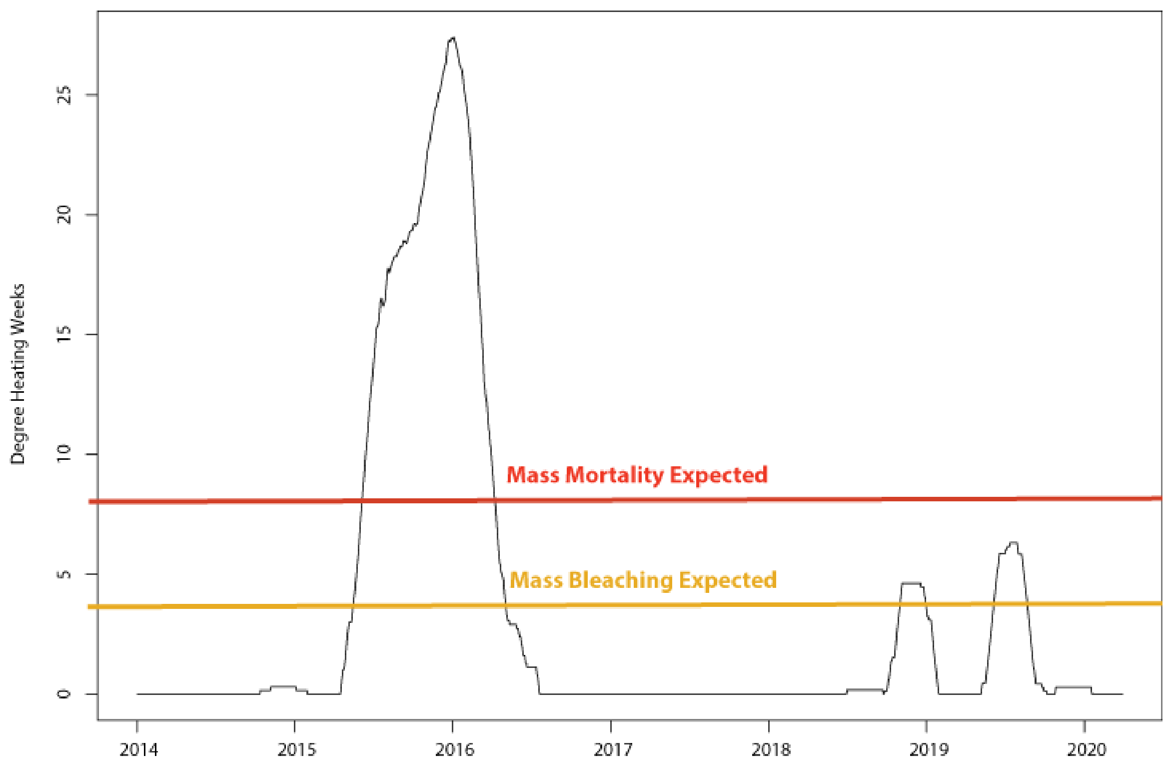


Figure 20. Coral Thermal Stress Exposure, Northern Line Islands Virtual Station 2014-2019 (Coral Reef Watch Degree Heating Weeks)

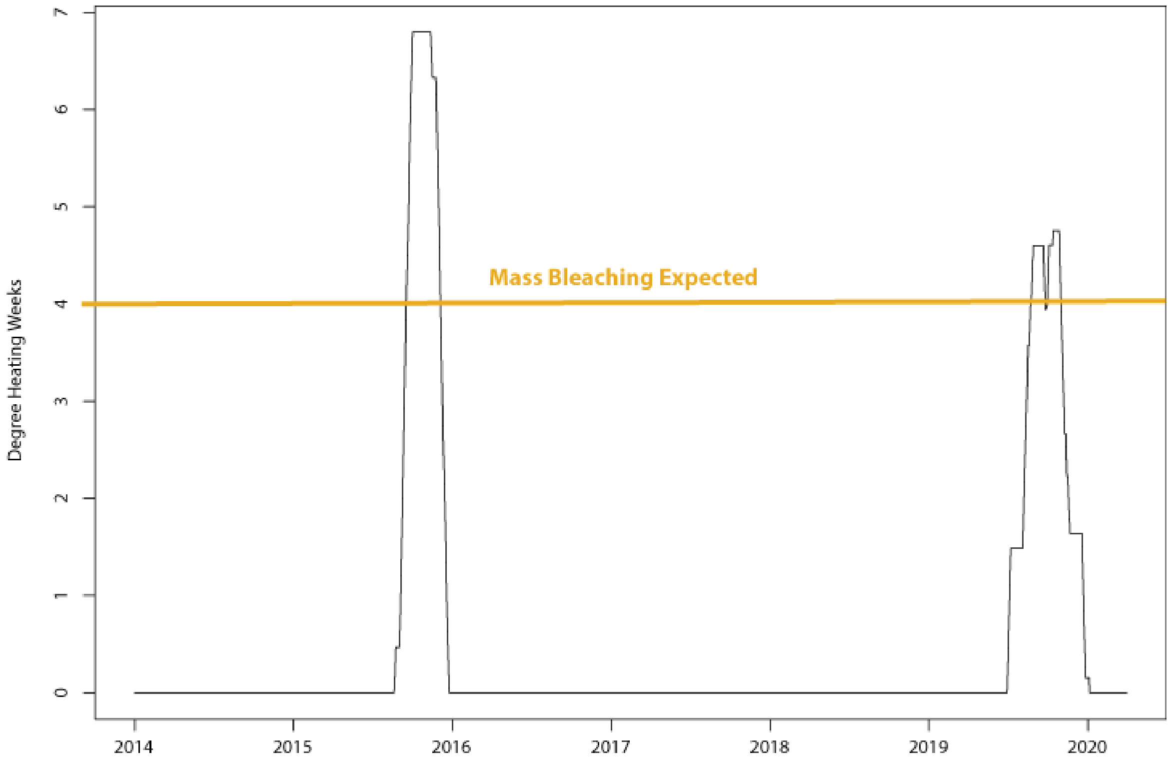


Figure 21. Coral Thermal Stress Exposure, Johnston Virtual Station 2014-2019 (Coral Reef Watch Degree Heating Weeks)

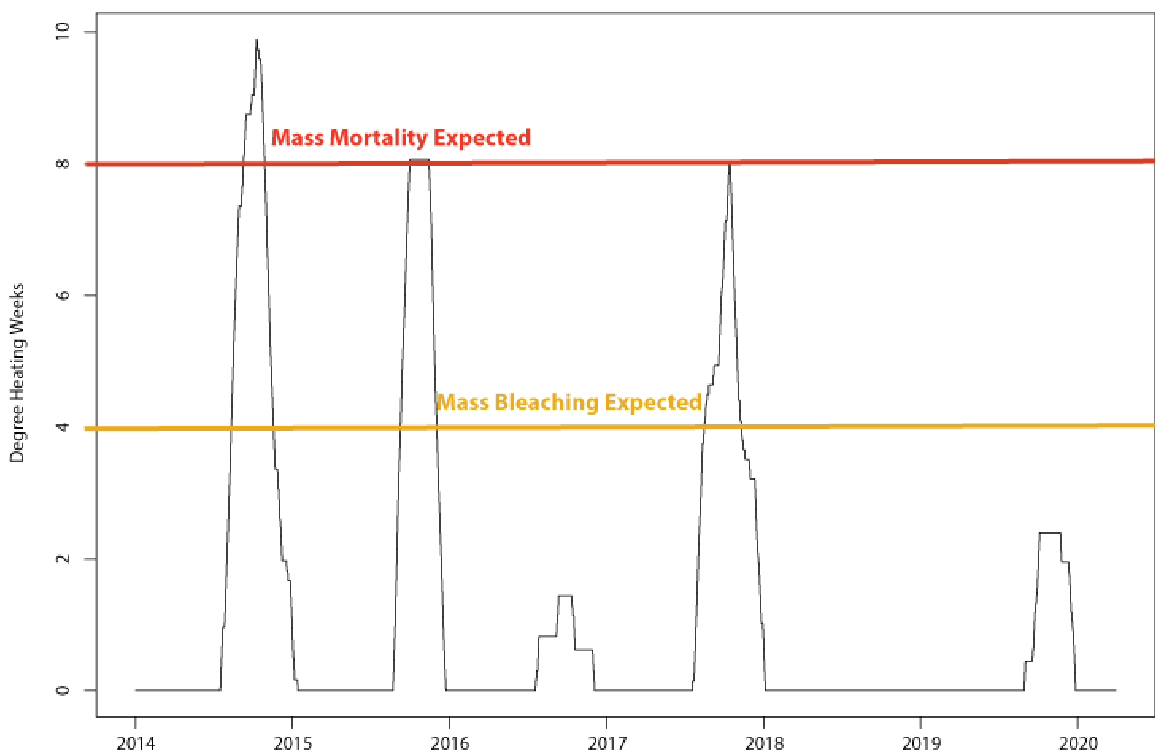


Figure 22. Coral Thermal Stress Exposure, Wake Atoll Virtual Station 2013-2018 (Coral Reef Watch Degree Heating Weeks)

2.4.3.8 Chlorophyll-A and Anomaly

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

Status:

Pacific Remote Island Areas: Annual mean Chl-A was 0.145 mg/m^3 in 2019. Over the period of record, annual Chl-A has shown a significant linear decrease at a rate of 0.00114 mg/m^3. Monthly Chl-A values in 2019 ranged from 0.111-0.176 mg/m^3, within the climatological range of 0.055 – 0.222 mg/m^3. The annual anomaly was 0.0072 mg/m^3 lower than climatological values, with higher values in the center of the region.

Johnston Atoll: Annual mean Chl-A was 0.050 mg/m^3 in 2019. Over the period of record, annual Chl-A has shown a significant linear decrease at a rate of 0.0002 mg/ m^3. Monthly Chl-A values in 2019 ranged from 0.040-0.068 mg/m^3, within the climatological range of 0.036 – 0.087 mg/m^3. The annual anomaly was 0.0034 mg/m^3 lower than climatological values, with an intensification toward the east of the atoll.

Wake Atoll: Annual mean Chl-A was 0.039 mg/m^3 in 2019. Over the period of record, annual Chl-A has shown a weakly significant linear decrease at a rate of 0.0001 mg/ m^3. Monthly Chl-A values in 2019 ranged from 0.035-0.048 mg/m^3, within the climatological range of 0.032 – 0.113 mg/m^3. The annual anomaly was 0.0058 mg/m^3 lower than climatological values.

Description: Chlorophyll-A Concentration from 1998-2019 derived from the European Space Agency (ESA) Ocean Color Climate Change Initiative dataset, v4.2. A monthly climatology was generated across the entire period (1982-2018) to provide both a 2019 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: 1998-2019, Daily data available, Monthly means shown.

Region/Location: Global.

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

Sourced from: NOAA OceanWatch (2020) Central Pacific Node at https://oceanwatch.pifsc.noaa.gov/.

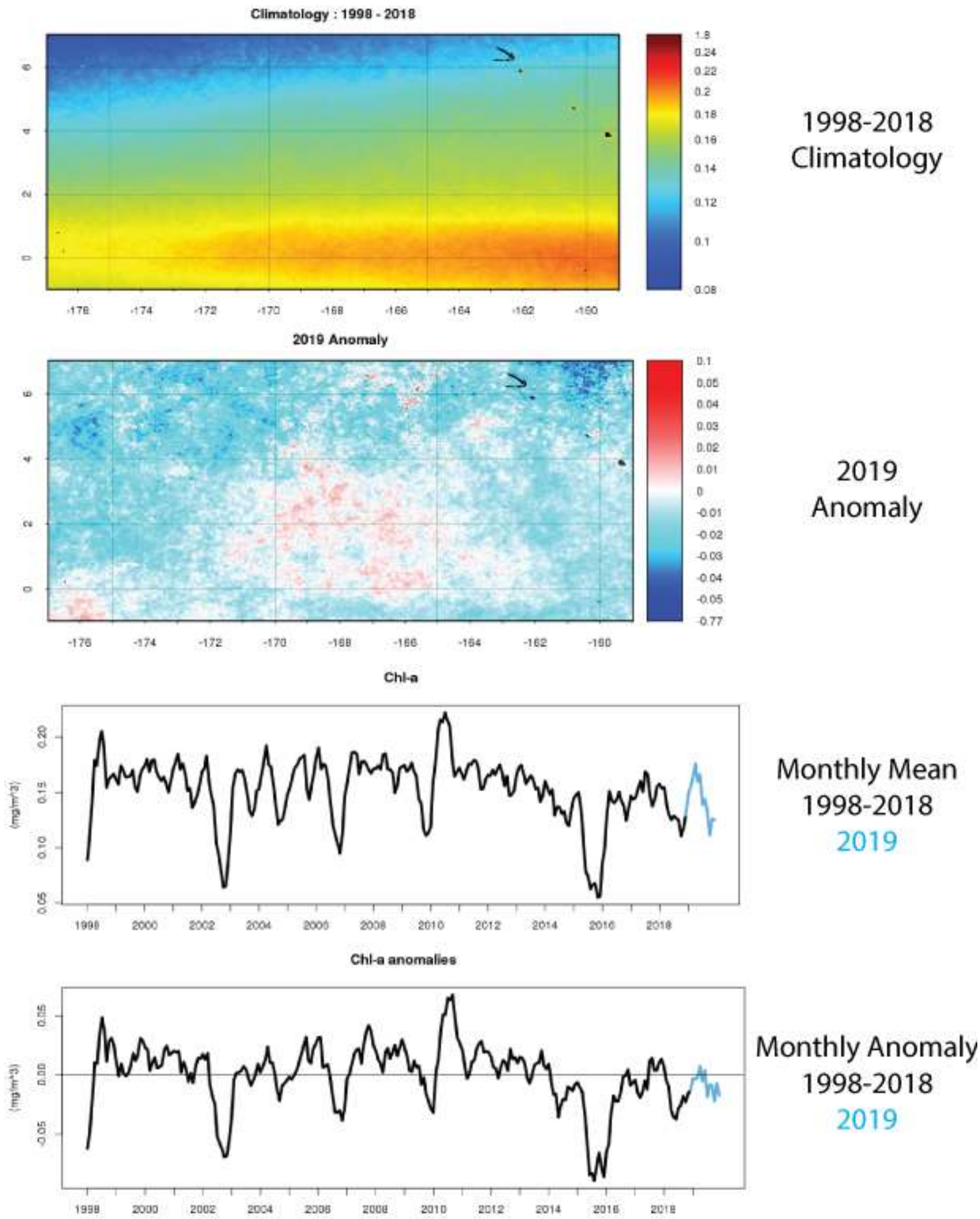


Figure 23. Chlorophyll-A (Chl-A) and Chl-A Anomaly from the PRIA Grid

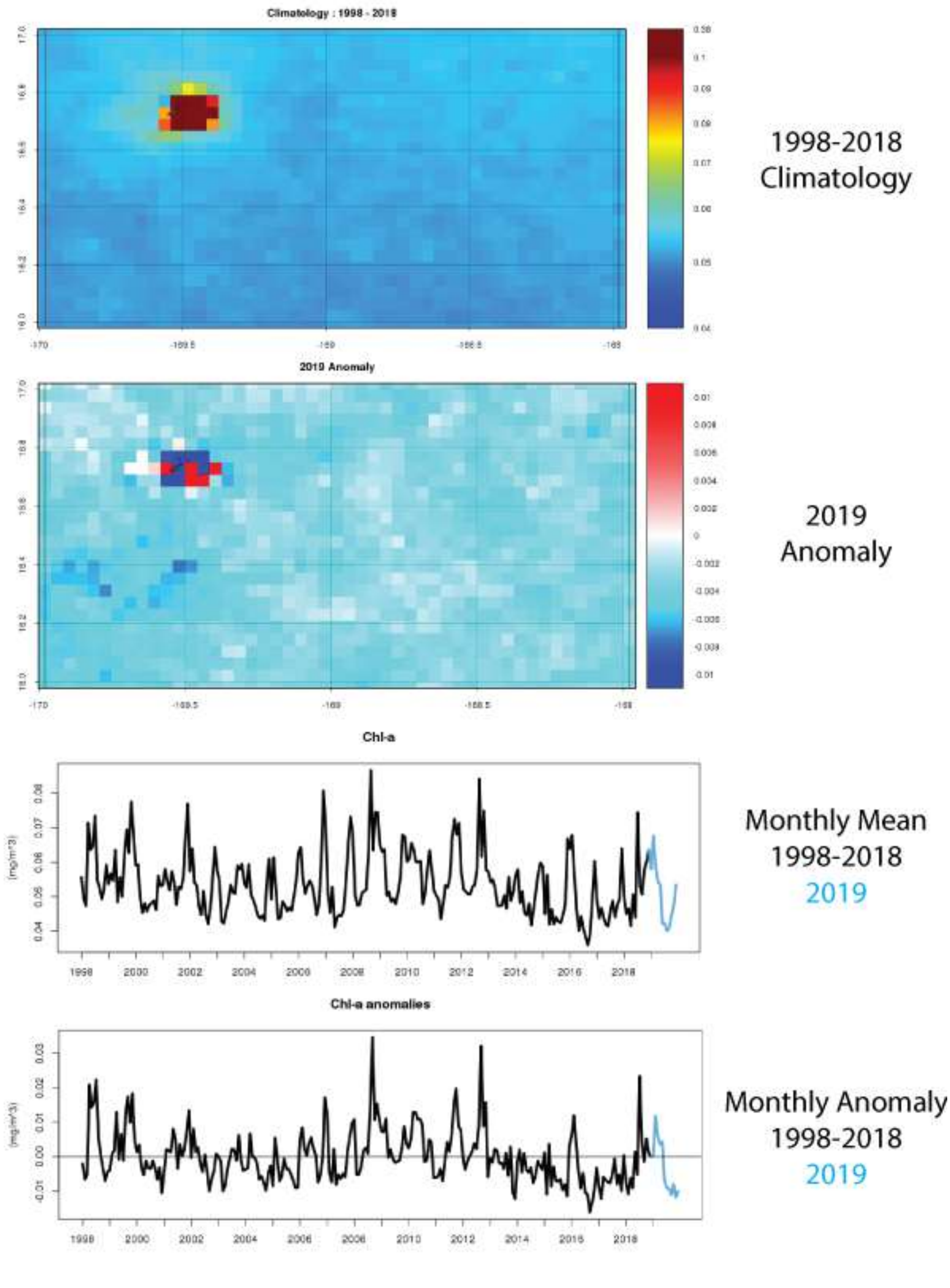


Figure 24. Chlorophyll-A (Chl-A) and Chl-A Anomaly from the Johnston Atoll Grid

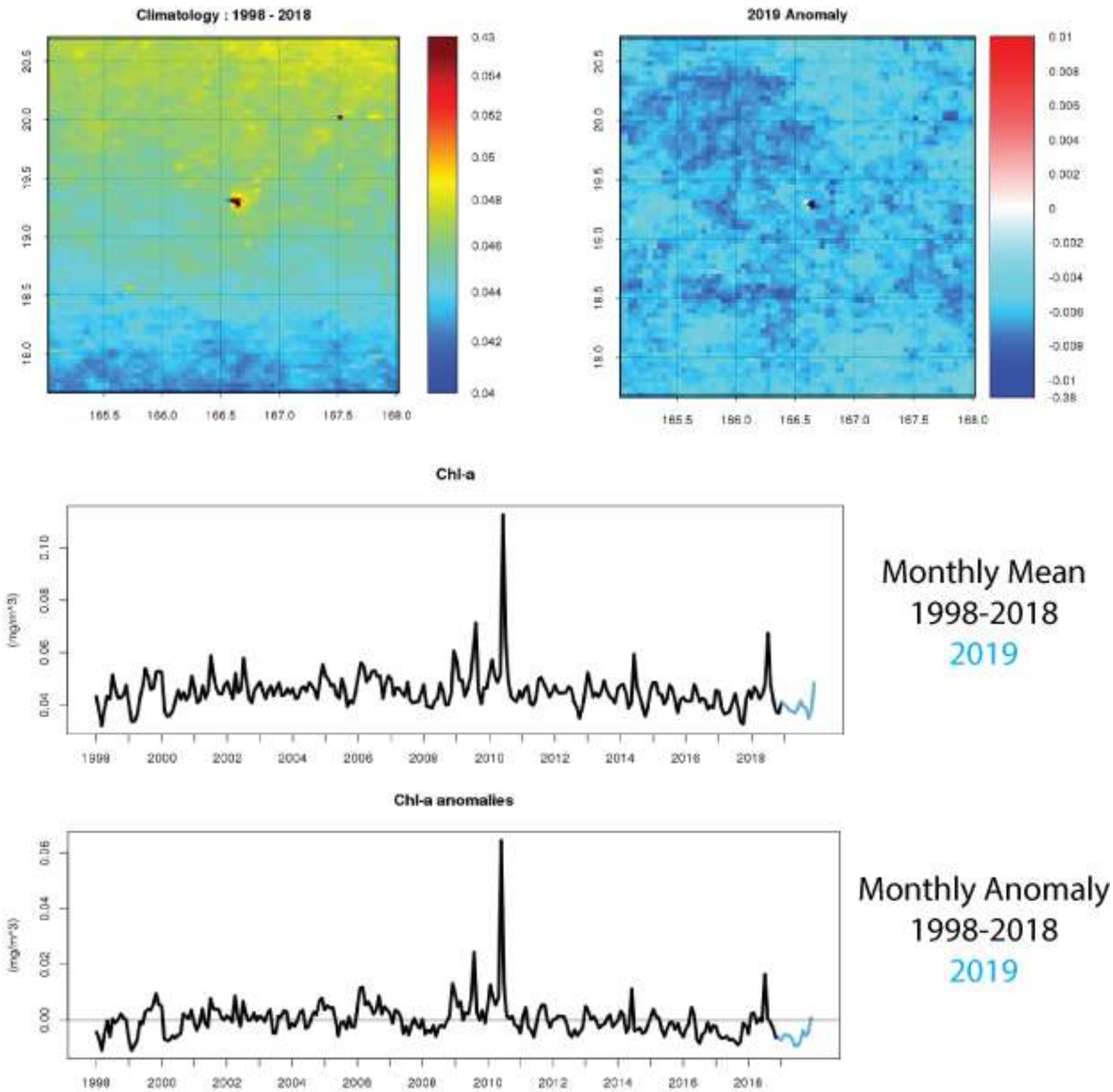


Figure 25. Chlorophyll-A (Chl-A) and Chl-A Anomaly from the Wake Atoll Grid

2.4.3.9 Rainfall (CMAP Precipitation)

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

Description: The CPC (Climate Prediction Center) 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 (infrared and microwave). The analyses are on a 2.5 x 2.5-degree latitude/longitude grid and extend back to 1979. CMAP Precipitation data provided by the NOAA Ocean and Atmospheric Research (OAR) Earth Sciences Research Laboratory (ESRL) Physical Sciences Division (PSD), Boulder, Colorado, USA, from their Web site at https://www.esrl.noaa.gov/psd/. These data are comparable (but should not be confused with) similarly combined analyses by the Global Precipitation Climatology Project which are 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 of 1987; prior to that the only microwave-derived estimates available are from the MSU algorithm (Spencer, 1993) 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 polar 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). Here the data output from step 1 is used to define the "shape" of the precipitation field and the rain gauge data are used to constrain the amplitude.

Timeframe: Monthly

Region/Location: Global

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

Source: CMAP Precipitation data provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, from their Web site at https://www.esrl.noaa.gov/psd/. NOAA (2020c).

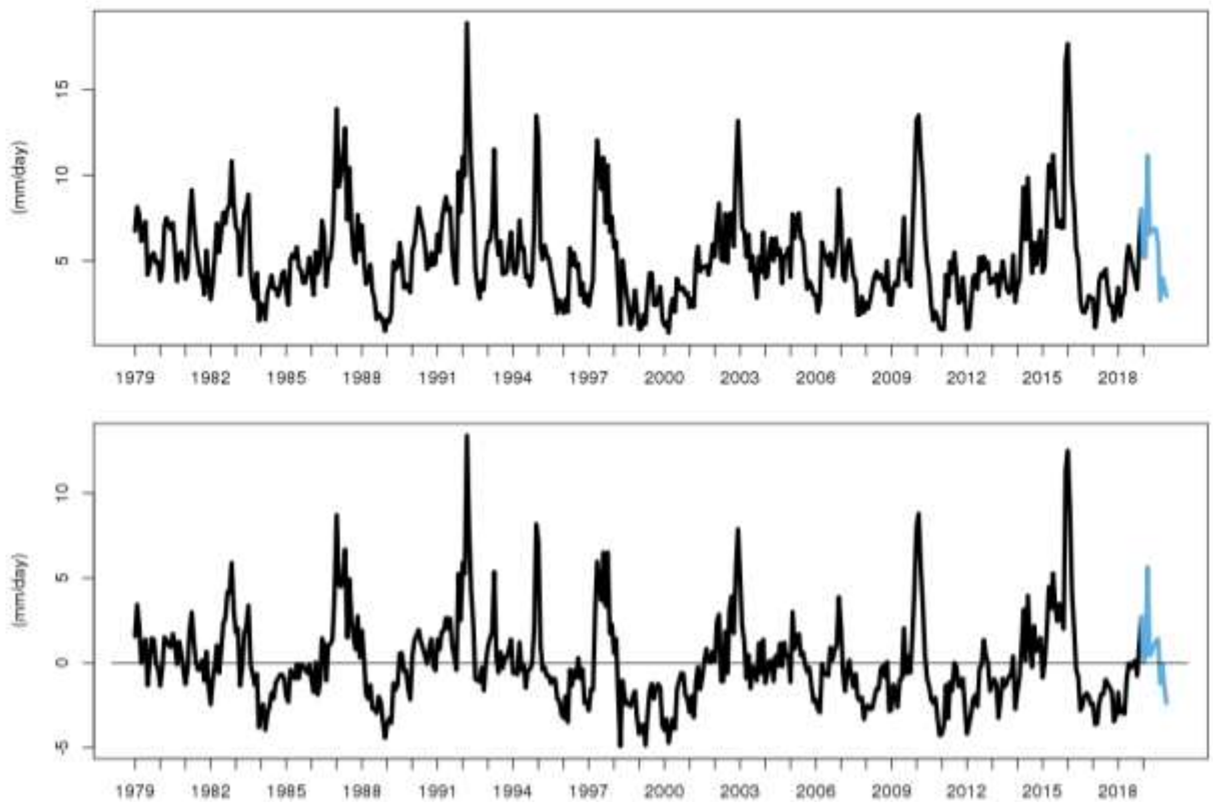


Figure 26. CMAP precipitation across the PRIA Grid with 2019 values in blue

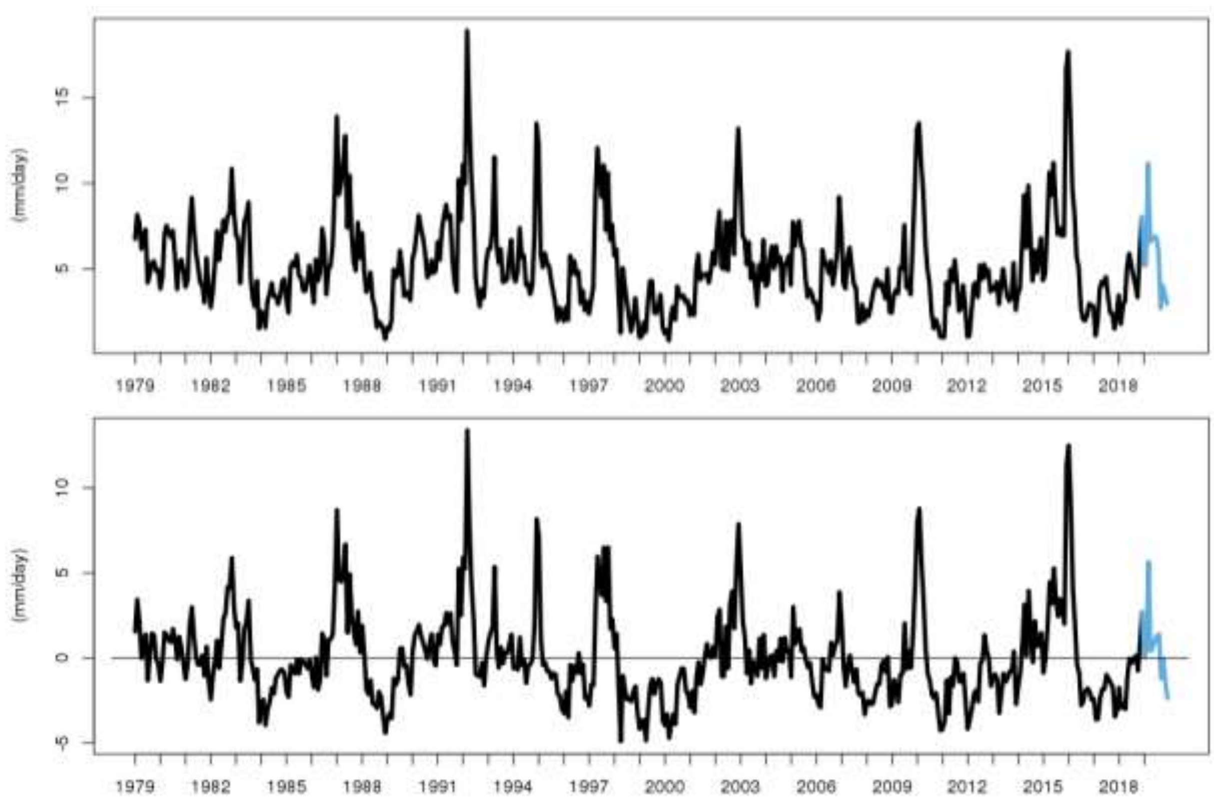


Figure 27. CMAP precipitation across the Johnston Atoll Grid with 2019 values in blue

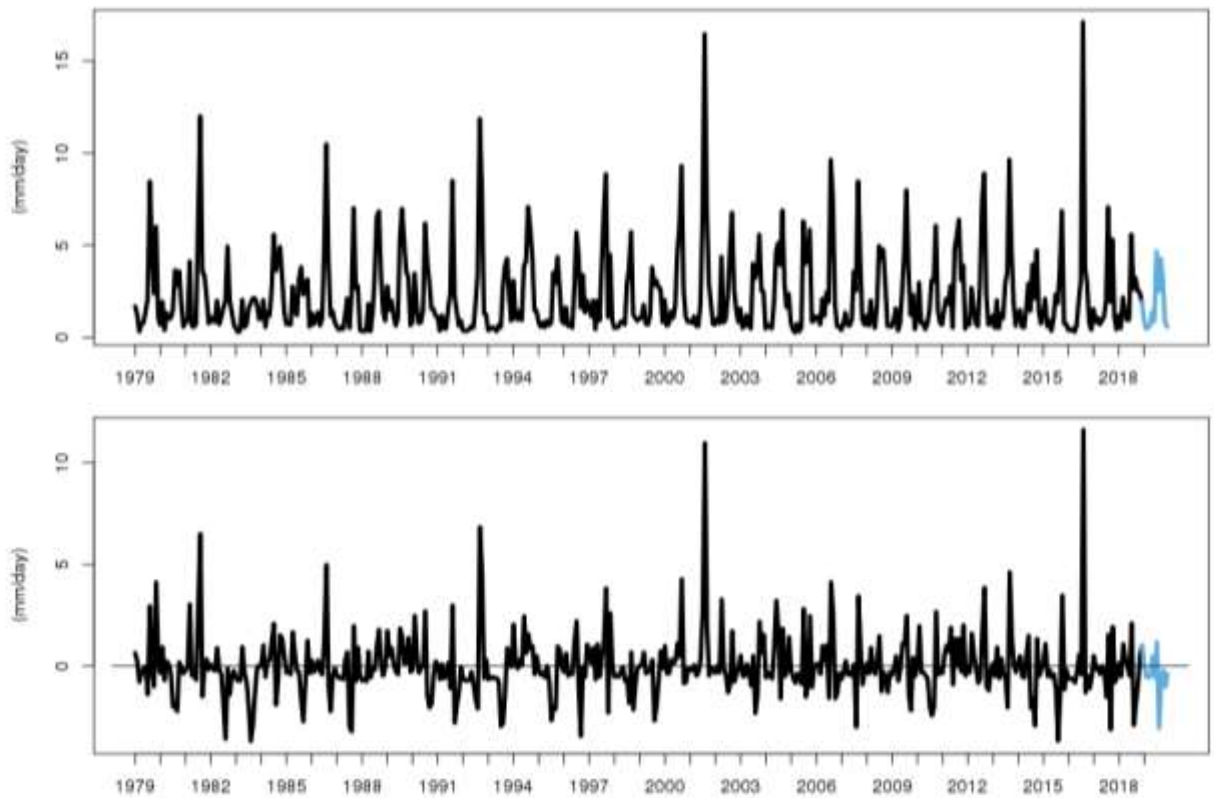


Figure 28. CMAP precipitation across the Wake Atoll Grid with 2019 values in blue

2.4.3.10 Sea Level (Sea Surface Height and Anomaly)

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

Description: Monthly mean sea level time series, including extremes

Timeframe: Monthly

Region/Location: Observations from selected sites within the Marianas Archipelago

Measurement Platform: Satellite and *in situ* tide gauges

Source: Aviso (2020) and NOAA (2020d) at https://tidesandcurrents.noaa.gov/datum_options.html.

2.4.3.10.1 Basin-Wide Perspective

This image of the mean sea level anomaly for March 2019 compared to 1993-2013 climatology from satellite altimetry provides a glimpse into how the current weak El Niño continues to affect sea level across the Pacific Basin. The image captures the fact that sea level continues to be lower in the Western Pacific and higher in the Central and Eastern Pacific (a standard pattern during El Niño events. This basin-wide perspective provides a context for the location-specific sea level/sea surface height images that follow.)

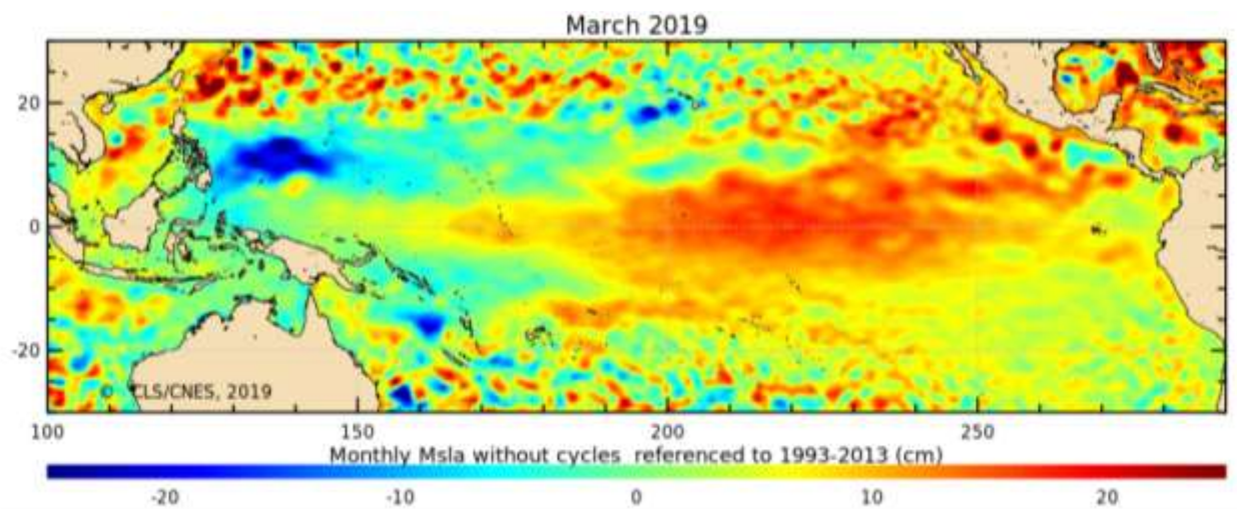


Figure 29a. Sea surface height and anomaly across the Pacific Ocean

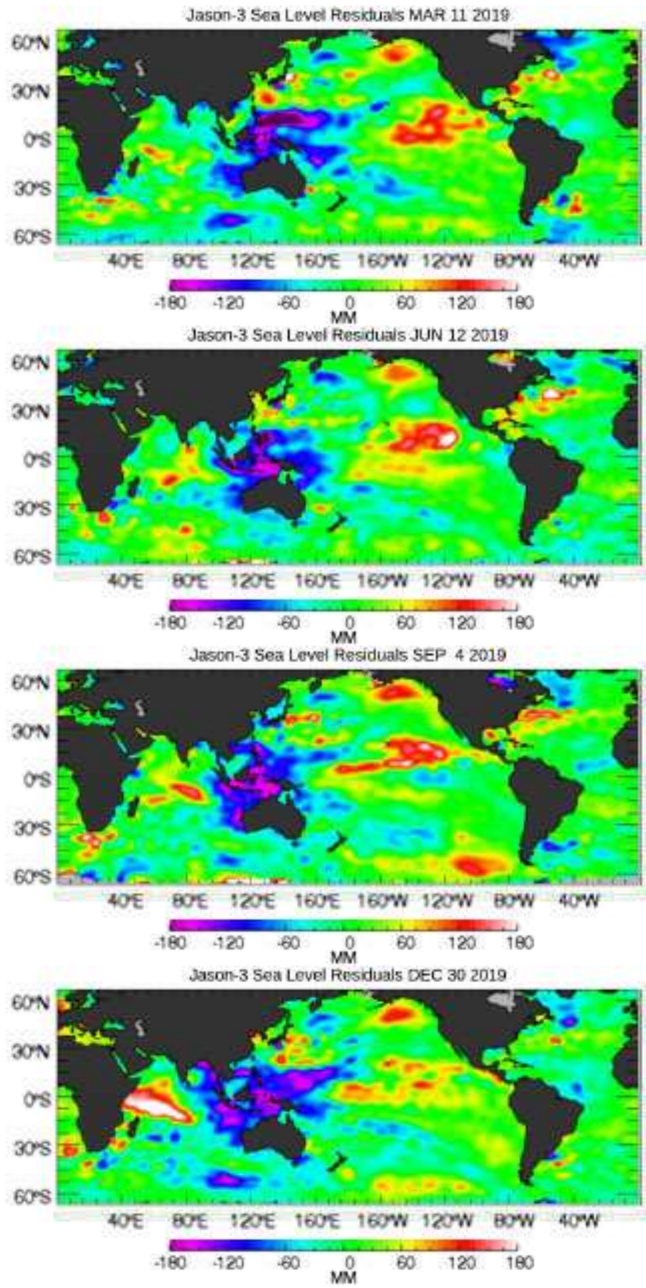
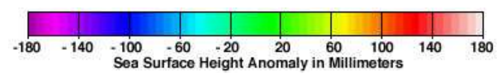


Figure 29b. Quarterly time series of mean sea level anomalies during 2019 show no pattern of El Niño throughout the year according to satellite altimetry measurements of sea level height (unlike 2015).

(https://sealevel.jpl.nasa.gov/science/elninopdo/latestdata/archive/index.cfm?y=2019.)



2.4.3.10.2 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 [COOPS]).

The following figures and descriptive paragraphs were inserted from NOAA (2020d). Figure 30 and Figure 31 show the monthly mean sea level without the regular seasonal fluctuations due to coastal ocean temperatures, salinities, winds, atmospheric pressures, and ocean currents. The long-term linear trend is also shown, including its 95% confidence interval. The plotted values are relative to the most recent Mean Sea Level datum established by CO-OPS. The calculated trends for all stations are available as a table in millimeters/year and in feet/century (0.3 meters = 1 foot). If present, solid vertical lines indicate times of any major earthquakes in the vicinity of the station and dashed vertical lines bracket any periods of questionable data or datum shift.

The relative sea level trend is 0.75 millimeters/year with a 95% confidence interval of +/- 0.56 mm/yr based on monthly mean sea level data from 1947 to 2003 which is equivalent to a change of 0.25 feet in 100 years (Figure 30).

The relative sea level trend is 2.1 millimeters/year with a 95% confidence interval of +/- 0.42 mm/yr based on monthly mean sea level data from 1950 to 2018 which is equivalent to a change of 0.69 feet in 100 years (Figure 31).

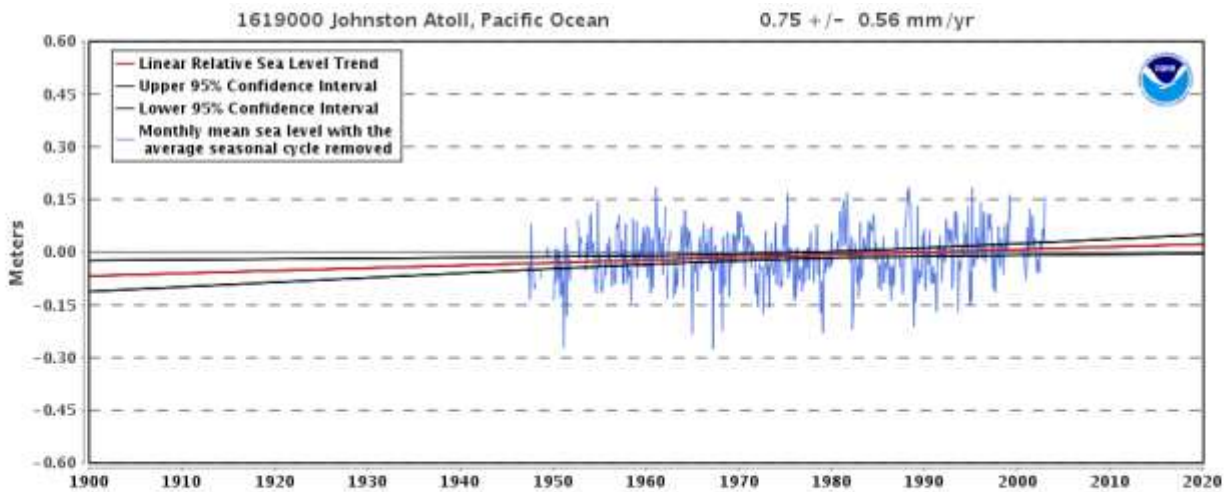


Figure 30. Monthly mean sea level without the regular seasonal fluctuations due to coastal ocean temperatures, salinities, winds, atmospheric pressures, and ocean currents at Johnston Atoll

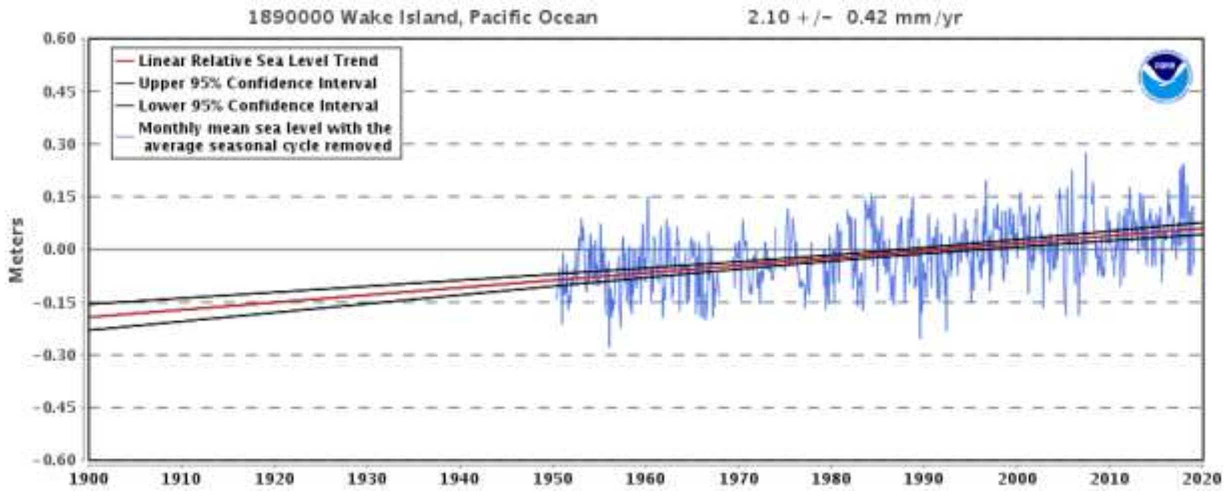


Figure 31. Monthly mean sea level without the regular seasonal fluctuations due to coastal ocean temperatures, salinities, winds, atmospheric pressures, and ocean currents at Wake Island

2.5 ESSENTIAL FISH HABITAT

2.5.1 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 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.

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 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.

2.5.1.1 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, some of which are no longer MUS: pelagic (PMUS), bottomfish (BMUS), crustaceans (CMUS), former coral reef ecosystem species (CREMUS), and precious corals (PCMUS).

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 previous SAFE reports and can be used to directly update the FEP;
- Updated EFH levels of information tables, which can be found in Section 2.5.5;
- Updated research and information needs, which can be found in Section 2.5.6 and 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 and can be developed if enough information exists to refine EFH.

2.5.1.2 Habitat Objectives of FEP

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

- 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.
- 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.

The annual reports have reviewed the precious coral EFH components, crustacean EFH component, and non-fishing impacts components. The Council's support of non-fishing activities research is monitored through the program plan and Five-Year Research Priorities, not the annual report.

2.5.1.3 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 has been developed.

2.5.2 Habitat Use by MUS and Trends in Habitat Condition

The PRIAs comprise the U.S. possessions of Baker Island, Howland Island, Jarvis Island, Johnston Atoll, Kingman Reef, Wake Island, Palmyra Atoll, and Midway Atoll (Figure 32). However, because Midway is located in the Hawaiian archipelago, it is included in the Hawaii Archipelago FEP[1]. Therefore, neither the "Pacific Remote Island Areas" nor "PRIA" include Midway Atoll, for the purpose of federal fisheries management.

[1] Midway is not administered civilly by the State of Hawaii.

Baker Island is part of the Phoenix Islands archipelago. It is located approximately 1,600 nautical miles (nm) to the southwest of Honolulu at 0° 13' N and 176° 38' W. Baker is a coral-topped seamount surrounded by a narrow-fringing reef that drops steeply very close to the shore. The total amount of emergent land area of Baker Island is 1.4 square kilometers.

Howland Island lies approximately 35 miles due north of Baker Island and is also part of the Phoenix Islands archipelago. The island, which is the emergent top of a seamount, is fringed by a relatively flat coral reef that drops off sharply. Howland Island is approximately 1.5 miles long and 0.5 miles wide. The island is flat and supports some grasses and small shrubs. The total land area is 1.6 square kilometers.

Jarvis Island, which is part of the Line Island archipelago, is located approximately 1,300 miles south of Honolulu and 1,000 miles east of Baker Island. It sits 23 miles south of the Equator at 160° 01' W. Jarvis Island is a relatively flat, sandy coral island with a 15–20-ft beach rise. Its total land area is 4.5 square kilometers. It experiences a very dry climate.

Palmyra Atoll is a low-lying coral atoll system comprised of approximately 52 islets surrounding three central lagoons. It is approximately 1,050 nm south of Honolulu and is located at 5° 53' N and 162° 05' W. It is situated about halfway between Hawaii and American Samoa. Palmyra Atoll is located in the intertropical convergence zone, an area of high rainfall.

Kingman Reef is located 33 nm northwest of Palmyra Atoll at 6° 23' N and 162° 24' W. Along with Palmyra, it is at the northern end of the Line Island archipelago. Kingman is a series of fringing reefs around a central lagoon with no emergent islets that support vegetation.

Wake Island is located at 19° 18' N and 166° 35' E and is the northernmost atoll of the Marshall Islands group, located approximately 2,100 miles west of Hawaii. Wake Island has a total land area of 6.5 square kilometers and comprises three islets: Wake, Peale, and Wilkes.

Johnston Atoll is located at 16° 44' N and 169° 31' W and is approximately 720 nm southwest of Honolulu. French Frigate Shoals in the NWHI, about 450 nm to the northwest, is the nearest land mass. Johnston Atoll is an egg-shaped coral reef and lagoon complex comprised of four small islands totaling 2.8 square kilometers. The complex resides on a relatively flat, shallow platform approximately 34 kilometers in circumference. Johnston Island, the largest and main island, is natural, but has been enlarged by dredge-and-fill operations. Sand Island is composed of a naturally formed island on its eastern portion and is connected by a narrow, man-made causeway to a dredged coral island at its western portion. The remaining two islands, North Island and East Island, are completely man-made from dredged coral.

All commercial activity is prohibited within the Pacific Remote Island Area Marine National Monument (PRIMNM), which is 50 nm surrounding Palmyra Atoll and Kingman Reef and Howland and Baker Islands, and the entire US EEZ surrounding Johnston Atoll, Wake, and Jarvis Island.

Essential fish habitat in the PRIAs for the four MUS comprises all substrate from the shoreline to the 700 m isobath (Figure 33). The entire water column is described as EFH from the shoreline to the 700 m isobath, and the water column to a depth of 400 m is described as EFH from the 700 m isobath to the limit or boundary of the exclusive economic zone (EEZ). While the coral reef ecosystems surrounding the islands in the PRIA 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 (PIBHMC).

PIFSC CRED is now the Coral Reef Ecosystem Program (CREP) within the PIFSC Ecosystem Sciences Division (ESD) whose mission is to conduct multidisciplinary research, monitoring, and analysis of integrated environmental and living resource systems in coastal and offshore waters of the Pacific Ocean. This mission includes field research activities that cover near-shore island ecosystems such as coral reefs to open ocean ecosystems on the high seas. The ESD research focus includes oceanography, coral reef ecosystem assessment and monitoring, benthic habitat mapping, and marine debris surveys and removal. This broad focus enables ESD to analyze not only the current structure and dynamics of marine environments, but also to examine potential projections of future conditions such as those resulting from climate change impacts. Because humans are a key part of the ecosystem, our research includes the social, cultural, and economic aspects of fishery and resource management decisions (PIFSC, 2020; https://www.fisheries.noaa.gov/about/pacific-islands-fisheries-science-center). The CREP continues to "provide high-quality, scientific information about the status of coral reef ecosystems of the U.S. Pacific islands to the public, resource managers, and policymakers on local, regional, national, and international levels" (PIFSC, 2011). CREP conducts comprehensive ecosystem monitoring surveys at about 50 islands, atolls, and shallow bank sites in the Western Pacific Region on a rotating schedule, based on operational capabilities. CREP coral reef monitoring reports provide the most comprehensive description of nearshore habitat quality in the region.

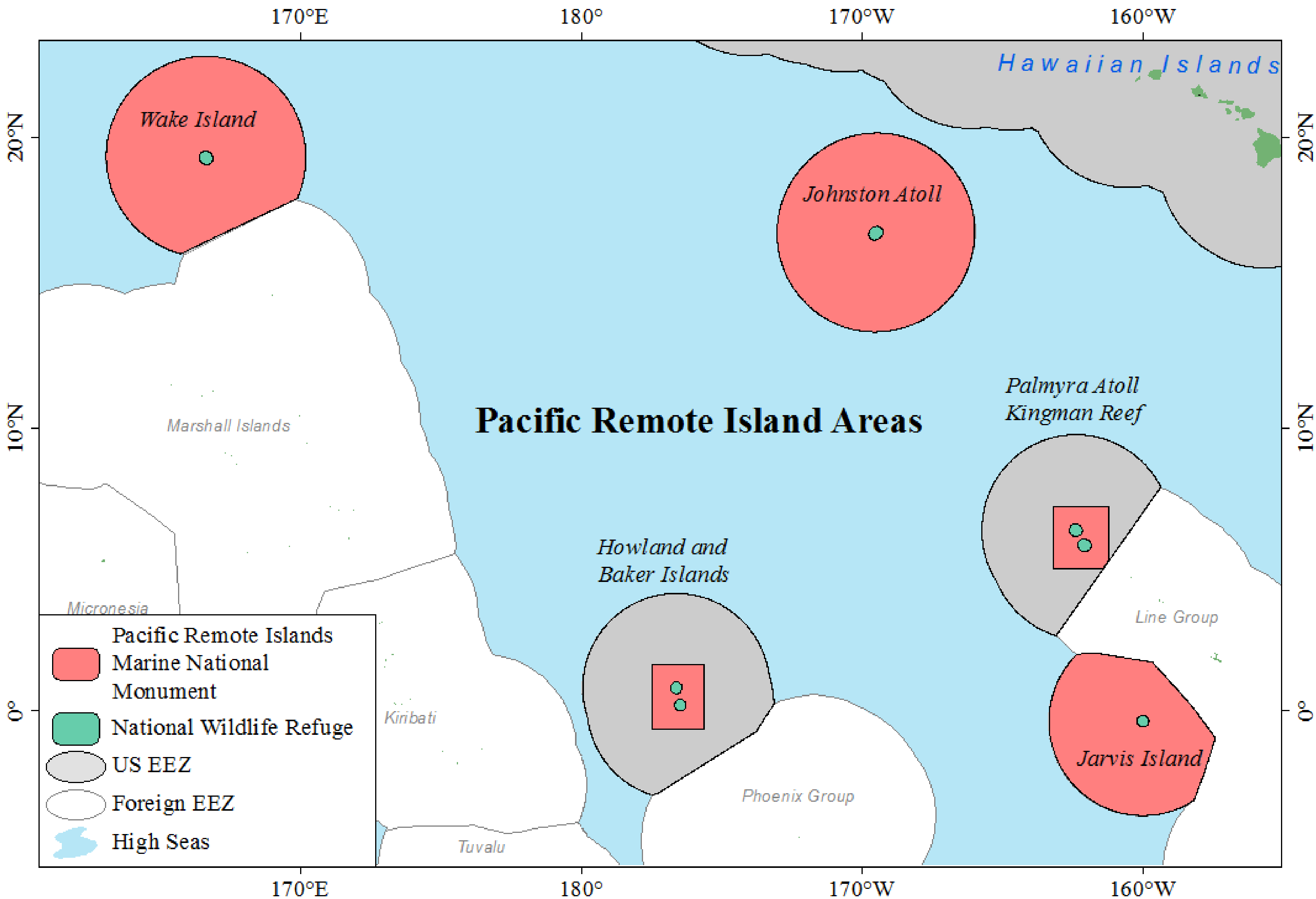


Figure 32. Pacific Remote Island Areas and the associated Pacific Remote Islands Marine National Monument

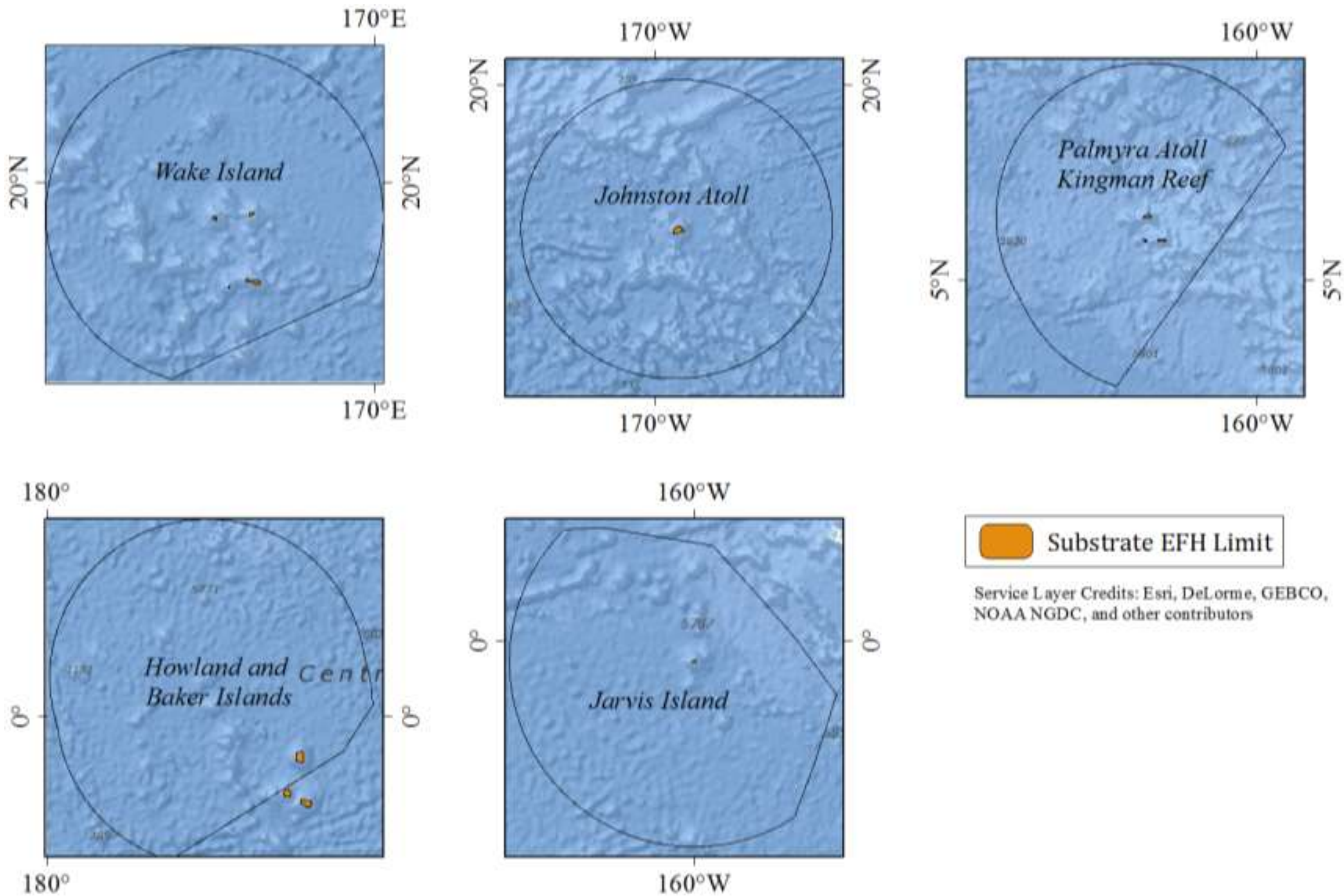


Figure 33. The Substrate EFH Limit and 700-meter isobath around the PRIAs (from Ryan et al. 2009)

2.5.2.1 Habitat Mapping

Mapping products for the PRIA are available from the Pacific Islands Benthic Habitat Mapping Center and are listed in Table 4.

Table 4. Summary of habitat mapping in the PRIA

Depth Range	Timeline/Mapping Product	Progress	Source
0-30 m	IKONOS Benthic Habitat Maps	Palmyra only	Miller et al. (2011)
	2000-2010 Bathymetry	67%	DesRochers (2016)
	2011-2015 Multibeam Bathymetry		DesRochers (2016)
	2011-2015 Satellite Worldview 2 Bathymetry	Wake, Baker, and Howland Islands, Johnston and Palmyra Atolls, and Kingman Reef	Pers. Comm. DesRochers, March 19, 2018
30-150 m	2000-2010 Bathymetry	79%	DesRochers (2016)
	2011-2015 Multibeam Bathymetry	Howland and Baker updated with data collected in a few small areas in 2015	Pers. Comm., DesRochers, March 19, 2018
15 to 2500 m	Multibeam bathymetry	Complete at Jarvis, Howland, and Baker Islands	Pacific Islands Benthic Habitat Mapping Center
	Derived Products	Backscatter available for all Geomorphology products for Johnston, Howland, Baker, Wake	Pacific Islands Benthic Habitat Mapping Center

The land and seafloor area surrounding the islands and atolls of the PRIAs are reproduced from Miller et al. (2011) and shown in Figure 34 alongside other physical data.

ISLAND CODE	WAK	JOH	KIN	PAL	HOW	BAK	JAR
SHAPE & RELATIVE SIZE							
LAND AREA (km^2)	7	3	<1	2	2	2	4
SEA FLOOR AREA 0-30 m (km^2)	19	194	48	53	3	4	4
SEA FLOOR AREA 30-150 m (km^2)	3	49	37	9	2	2	3
BATHYMETRY 0-30 m (km^2)	1	185	17	11	<1	2	2
BATHYMETRY 30-150 m (km^2)	2	49	17	8	2	2	3
OPTICAL COVERAGE 0-30 m (km)	46	55	54	66	24	21	29
OPTICAL COVERAGE 30-150 m (km)	0	1	0	<1	2	1	0

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

Figure 34. PRIA Land and Seafloor Primary Data Coverage (from Miller et al., 2011)

2.5.2.2 Benthic Habitat

Juvenile and adult life stages of former CREMUS and crustaceans including spiny and slipper lobsters and Kona crab extends from the shoreline to the 100 m isobath (64 FR 19067, 19 April 1999). All benthic habitat is considered EFH for crustacean species (64 FR 19067, 19 April 1999), while the type of bottom habitat varies by family for coral reef species (69 FR 8336, 24 February 2004). Juvenile and adult bottomfish EFH extends from the shoreline to the 400 m isobath (64 FR 19067, 19 April 1999), and juvenile and adult deepwater shrimp habitat extends from the 300 m isobath to the 700 m isobath (73 FR 70603, 21 November 2008). Table 5 shows the depths of geologic features, the occurrence of MUS EFH at that feature, and the availability of long-term monitoring data at diving depths.

Table 5. Occurrence of EFH by feature in the PRIAs

Feature	Summit Minimum Depth	Coral Reef/Crustaceans (w/o Deepwater Shrimp)	Bottomfish	Deepwater Shrimp	CRED Long Term Monitoring
Johnston Atoll	Emergent	✓	✓	✓	✓
Palmyra	Emergent	✓	✓	✓	✓
Kingman Reef	Emergent	✓	✓	✓	✓
Extensive banks 80 km SW of Kingman		?	?	?	
Jarvis Island	Emergent	✓	✓	✓	✓
Howland Island	Emergent	✓	✓	✓	✓
Baker Island	Emergent	✓	✓	✓	✓
Southeast of Baker	?	?	?	✓	
Wake Island	Emergent	✓	✓	✓	✓
South of Wake	?	?	?	✓	

2.5.2.2.1 RAMP Indicators

Benthic percent cover of coral, macroalgae, and crustose coralline algae from PIFSC are found in the following tables. PIFSC has used the benthic towed-diver survey method to monitor changes in benthic composition. In this method, a pair of scuba divers (one collecting fish data, the other collecting benthic data) is towed about one m above the reef roughly 60 m behind a small boat at a constant speed of about 1.5 kt. Each diver maneuvers a tow board platform, which is connected to the boat by a bridle and towline and is outfitted with a communications telegraph and various survey equipment, including a downward-facing digital SLR camera. The benthic towed diver records general habitat complexity and type (e.g., spur and groove, pavement), percent cover by functional-group (hard corals, stressed corals, soft corals, macroalgae, crustose coralline algae, sand, and rubble) and for macroinvertebrates (crown-of-thorns sea stars, sea cucumbers, free and boring urchins, and giant clams; PIFSC, 2016).

Towed-diver surveys are typically 50 minutes long and cover about two to three kilometers of habitat. Each survey is divided into five-minute segments, with data recorded separately per segment to allow for later location of observations within the ~200-300 m length of each segment. Throughout each survey, latitude and longitude of the survey track are recorded on the small boat using a GPS; and after the survey, diver tracks are generated with the GPS data and a layback algorithm that accounts for position of the diver relative to the boat" (McCoy et al., 2017). The most recent data collected were in 2016 and described by McCoy et al. (2017), however the method was retired in 2016 and no new data will be appended to the time series.

Table 6. Mean percent cover of live coral from RAMP sites collected from towed-diver surveys in the PRIA

Year	2001	2002	2004	2005	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016
Baker	35.37	49.47	38.78		32.95		41.20		47.44		42.10		34.48	
Howland	29.06	42.53	36.75		34.69		44.47		50.74		43.26		23.20	
Jarvis	24.22	26.19	30.63		28.54		27.70		26.92		25.38		39.75	
Johnston			5.01		22.95		18.38		7.94		10.89		7.46	
Kingman	39.77	49.51	38.35		24.59		33.13		35.56		37.11		41.92	
Palmyra	24.95	31.99	35.07		22.66		25.02		35.35		31.11		42.77	
Wake				31.98		19.29		22.56		31.40		32.34		

Table 7. Mean percent cover of macroalgae from RAMP sites collected from towed-diver surveys in the PRIA

Year	2001	2002	2004	2005	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016
Baker	12.33	2.11	12.63		9.29		8.09		1.60		8.05		2.15	
Howland	2.58	5.34	13.01		3.57		6.14		0.64		6.07		1.08	
Jarvis	28.75	10.88	25.03		38.14		24.01		7.35		7.58		3.94	
Johnston			25.06		6.90		8.82		1.57		8.49		2.49	
Kingman	4.36	5.36	27.04		7.81		7.31		3.97		5.05		2.04	
Palmyra	13.28	10.45	23.14		15.17		11.98		4.76		8.94		4.35	
Wake				22.88		18.74		12.00		8.30		6.80		

Table 8. Mean percent cover of crustose coralline algae from RAMP sites collected from towed-diver surveys in the PRIA

Year	2001	2002	2004	2005	2006	2007	2008	2009	2010	2011	2012	2014	2015	2016
Baker	31.66	37.57	39.61		33.43		23.09		23.40		24.03		32.80	
Howland	36.60	27.40	34.26		22.60		22.59		15.73		18.12		21.25	
Jarvis	29.11	29.56	34.76		24.23		11.82		30.29		24.20		27.48	
Johnston			30.54		19.50		16.07		17.13		17.49		17.45	
Kingman	33.04	16.4	17.49		23.50		13.45		9.20		8.45		9.64	
Palmyra	38.46	24.46	27.26		26.30		18.02		13.87		17.09		10.28	
Wake				1.01		6.43		3.87		4.15		1.13		

2.5.2.3 Oceanography and Water Quality

The water column is also designated as EFH for selected MUS life stages at various depths. For larval stages of all species except deepwater shrimp, the water column is EFH from the shoreline to the EEZ. Coral reef species egg and larval EFH is to a depth of 100 m; crustaceans, 150m; and bottomfish, 400 m. Please see the Climate and Oceanic Indicators section (Section 2.4) for information related to oceanography and water quality.

2.5.3 Report on Review of EFH Information

There were no EFH reviews completed in 2019 for the PRIAs, however a review of the biological components of crustacean EFH in Guam and Hawaii was finalized in 2019. This review can be found in the 2019 Archipelagic SAFE Reports for the Mariana and Hawaii Archipelagos. The non-fishing impacts and cumulative impacts components were reviewed in 2016 through 2017, which can be found in Minton (2017).

2.5.4 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. In subsequent SAFE reports, each fishery section will include the description of EFH method used to assess the value of the habitat to the species, description of data sources used if there was analysis, and description of method for analysis.

Levels of EFH Information are presented in this section first with databases that include observations of multiple species, separated by depth, and then by current or former MUS grouping.

The Hawaii Undersea Research Laboratory (HURL) is a center operating under the School of Ocean and Earth Sciences and Technology at the University of Hawaii and NOAA's Office of Ocean Exploration and Research. The unique deep-sea research operation runs the Pisces IV and V manned submersibles and remotely operated vehicles (ROVs) for investigating the undersea environment through hypothesis driven projects that address gaps in knowledge or scientific needs. HURL maintains a comprehensive video database, which includes biological and substrate data extracted from their dive video archives. Submersible and ROV data are collected from depths deeper than 40 m. Observations from the HURL video archives are considered Level 1 EFH information for deeper bottomfish and precious coral species which exist in the database though cannot be considered to observe absence of species. Survey effort is low compared to the range of species observed.

2.5.4.1 Precious Corals

EFH for precious corals was originally designated in Amendment 4 to the Precious Corals Fishery Management Plan (64 FR 19067, 19 April 1999) using the level of data found in Table 9.

Table 9. Level of EFH information available for the Western Pacific precious coral MUS

Species	Pelagic Phase (Larval Stage)	Benthic Phase	Source(s)
Pink Coral (*Corallium*)			
Pleurocorallium secundum (prev. *Corallium secundum*)	0	1	Figueroa and Baco (2014); HURL database
C. regale	0	1	HURL database
Hemicorallium laauense (prev. *C. laauense)*	0	1	HURL database
Gold Coral			
Kulamanamana haumeaae	0	1	Sinniger et al. (2013); HURL database
Callogorgia gilberti	0	1	HURL database
Narella spp.	0	1	HURL database
Bamboo Coral			
Lepidisis olapa	0	1	HURL database
Acanella spp.	0	1	HURL database
Black Coral			
Antipathes griggi (prev. *Antipathes dichotoma*)	0	1	Opresko (2009); HURL database
A. grandis	0	1	HURL database
Myriopathes ulex (prev. *A. ulex*)	0	1	Opresko (2009); HURL database

2.5.4.2 Bottomfish and Seamount Groundfish

EFH for bottomfish and seamount groundfish was originally designated in Amendment 6 to the Bottomfish and Seamount Groundfish FMP (64 FR 19067, 19 April 1999) using the level of data found in Table 10.

Table 10. Level of EFH information available for the Western Pacific BMUS and seamount groundfish MUS complex

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 ignoblis (giant trevally/jack)	0	0	1	1
C. lugubris (black trevally/jack)	0	0	0	1

Life History Stage	Eggs	Larvae	Juvenile	Adult
Epinephelus faciatus (blacktip grouper)	0	0	0	1
E. quernus (sea bass)	0	0	1	1
Etelis carbunculus (red snapper)	0	0	1	1
E. coruscans (red snapper)	0	0	1	1
Lethrinus amboinensis (ambon emperor)	0	0	0	1
L. rubrioperculatus (redgill emperor)	0	0	0	1
Lutjanus kasmira (blueline snapper)	0	0	1	1
Pristipomoides auricilla (yellowtail snapper)	0	0	0	1
P. filamentosus (pink snapper)	0	0	1	1
P. flavipinnis (yelloweye snapper)	0	0	0	1
P. seiboldi (pink snapper)	0	0	1	1
P. zonatus (snapper)	0	0	0	1
Pseudocaranx dentex (thicklip trevally)	0	0	1	1
Seriola dumerili (amberjack)	0	0	0	1
Variola louti (lunartail grouper)	0	0	0	1
Beryx splendens (alfonsin)	0	1	2	2
Hyperoglyphe japonica (ratfish/butterfish)	0	0	0	1
Pseudopentaceros richardsoni (armorhead)	0	1	1	3

2.5.4.3 Crustaceans

EFH for crustaceans MUS was originally designated in Amendment 10 to the Crustaceans FMP (64 FR 19067, 19 April 1999) using the level of data found in Table 11. EFH definitions were also approved for deepwater shrimp through an amendment to the Crustaceans FMP in 2008 (73 FR 70603, 21 November 2008).

Table 11. Level of EFH information available for the Western Pacific CMUS complex

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

2.5.5 Research and Information Needs

The Council has identified the following scientific data needs to more effectively address the EFH provisions:

2.5.5.1 All FMP Fisheries

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

2.5.5.2 Bottomfish Fishery

- Inventory of marine habitats in the EEZ of the Western Pacific region.
- Data to obtain a better SPR estimate for American Samoa's bottomfish complex.
- Baseline (virgin stock) parameters (catch per unit effort [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.

2.5.5.3 Crustaceans Fishery

- Identification of post-larval settlement habitat of all CMUS.
- Identification of "source/sink" relationships in the NWHI and other regions (i.e. relationships between spawning sites settlement using circulation models, genetic techniques, etc.).
- Establish baseline parameters (e.g., CPUE) for the Guam and Northern Marinas crustacean populations.
- Research to determine habitat-related densities for all CMUS life history stages in American Samoa, Guam, Hawaii, and CNMI.
- High resolution mapping of bottom topography, bathymetry, currents, substrate types, algal beds, habitat relief.

2.5.5.4 Precious Corals Fishery

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

2.6 MARINE PLANNING

2.6.1 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*, 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, Hawai`i, 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 (BRFAs), military installations, NWHI restrictions, and Marine Life Conservation Districts (MLCDs).
b. Establish effective spatially based fishing zones.
c. Consider modifying or removing spatial-based fishing restrictions that are no longer necessary or effective in meeting their management objectives.
d. As needed, periodically evaluate the management effectiveness of existing spatial-based fishing zones in Federal waters.

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 not tracked in this report.

To meet the EFH and National Environmental Policy Act (NEPA) mandates, this annual 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 EFH cumulative impacts section of the FEP.

2.6.1.1 Response to Previous Council Recommendations

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

2.6.1.2 MMAs established under FMPs

Council-established MMAs were compiled from 50 CFR § 665, Western Pacific Fisheries, the Federal Register, and Council amendment documents. All regulated fishing areas and large MMAs, including the PRIMNM, are shown in Figure 35.

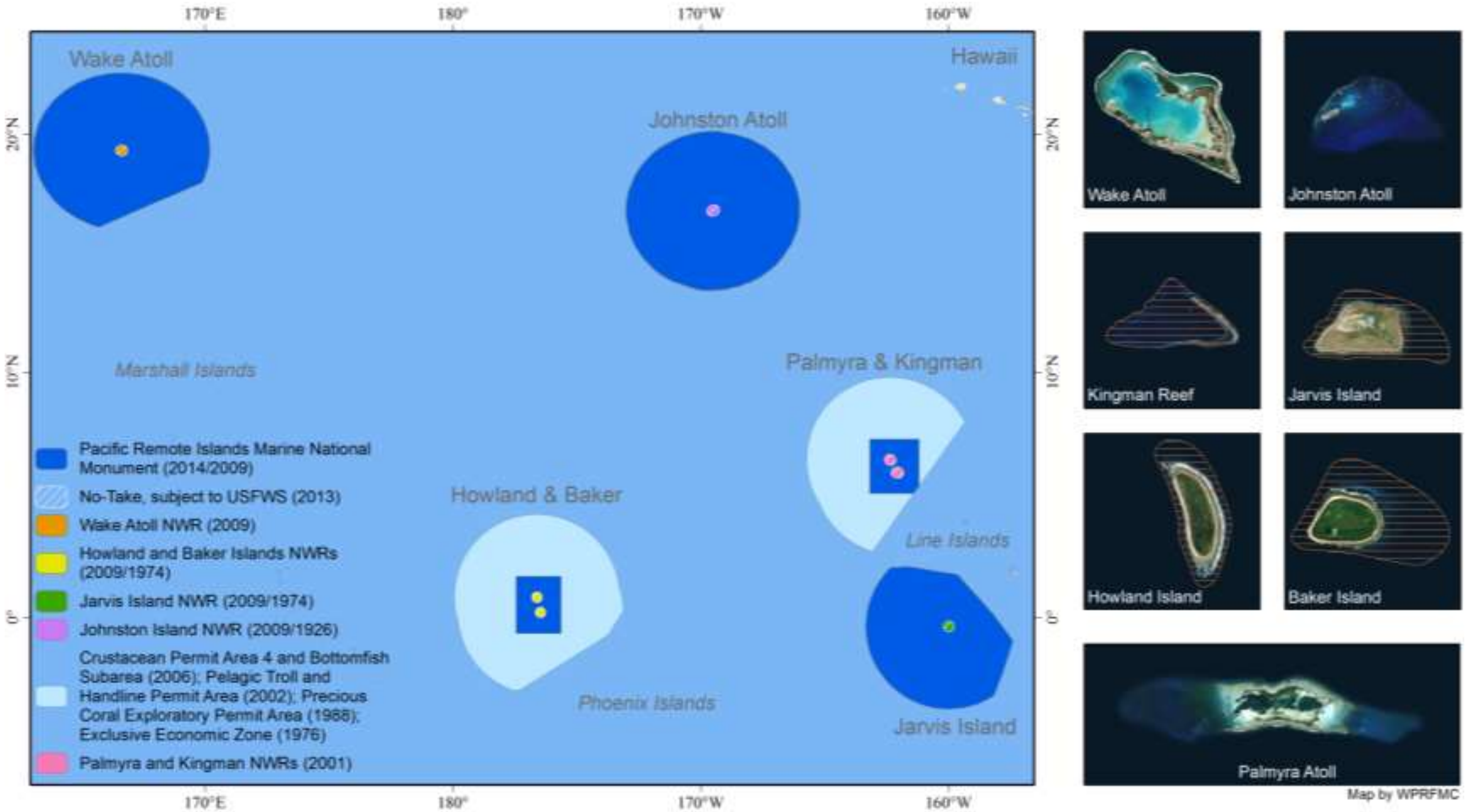


Figure 35. Regulated fishing areas of the PRIAs

Table 12. MMAs established under FEPs from 50 CFR § 665

Name	FEP	Island	50 CFR /FR /Amendment Reference	Marine Area (km^2)	Fishing Restriction	Goals	Most Recent Evaluation	Review Deadline
Howland Island No-Take MPA/PRIMNM	PRIA/ Pelagic	Howland Island	665.599 and 665.799(a)(1) 69 FR 8336 Coral Reef Ecosystem Fishery Management Plan (FMP) 78 FR 32996 PRIA FEP Am. 2	-	All Take Prohibited	Minimize adverse human impacts on coral reef resources; commercial fishing prohibited within 12 nm.	2013	-
Jarvis Island No-Take MPA/PRIMNM	PRIA/ Pelagic	Jarvis Island	665.599 and 665.799(a)(1) 69 FR 8336 Coral Reef Ecosystem FMP 78 FR 32996 PRIA FEP Am. 2	-	All Take Prohibited	Minimize adverse human impacts on coral reef resources; commercial fishing prohibited within 12 nm.	2013	-
Baker Island No-Take MPA/PRIMNM	PRIA/ Pelagic	Baker Island	665.599 and 665.799(a)(1) 69 FR 8336 Coral Reef Ecosystem FMP 78 FR 32996 PRIA FEP Am. 2	-	All Take Prohibited	Minimize adverse human impacts on coral reef resources; commercial fishing prohibited within 12 nm.	2013	-

Name	FEP	Island	50 CFR /FR /Amendment Reference	Marine Area (km^2)	Fishing Restriction	Goals	Most Recent Evaluation	Review Deadline
Kingman Reef No-Take MPA/PRIMNM	PRIA/ Pelagic	Kingman Reef	665.599 and 665.799(a)(1) 69 FR 8336 Coral Reef Ecosystem FMP 78 FR 32996 PRIA FEP Am. 2	-	All Take Prohibited	Minimize adverse human impacts on coral reef resources; all fishing prohibited within 12 nm.	2013	-
Johnston Atoll Low-Use MPA/ PRIMNM	PRIA/ Pelagic	Johnston Atoll	69 FR 8336 Coral Reef Ecosystem FMP 78 FR 32996 PRIA FEP Am. 2	-	Special Permit Only	Minimize adverse human impacts on coral reef resources; superseded by prohibiting fishing within 12 nm in Am. 2.	2013	-
Palmyra Atoll Low-Use MPAs/ PRIMNM	PRIA/ Pelagic	Palmyra Atoll	69 FR 8336 Coral Reef Ecosystem FMP 78 FR 32996 PRIA FEP Am. 2	-	Special Permit Only	Minimize adverse human impacts on coral reef resources; superseded by prohibiting fishing within 12 nm in Am. 2.	2013	-
Wake Island Low-Use MPA/ PRIMNM	PRIA/ Pelagic	Wake Island	69 FR 8336 Coral Reef Ecosystem FMP 78 FR 32996 PRIA FEP Am. 2	-	Special Permit Only	Minimize adverse human impacts on coral reef resources; superseded by prohibiting fishing within 12 nm in Am. 2.	2013	-

2.6.2 Activities and Facilities

There are no aquaculture facilities, alternative energy facilities, or military training and testing activities occurring in the US EEZ around the PRIAs at this time. The Plan Team will add to this section as new facilities or activities are proposed and/or built.

2.6.3 Pacific Islands Regional Planning Body Report

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 revoked EO 13547. The new EO eliminated the mandate for the federal government to participate in ocean planning at a regional level and eliminated the regional planning bodies. As such, the Pacific Islands Regional Planning Body (RPB) no longer exists and ocean planning will now occur at a local level led by Hawaii and the territories.

However, EO 13840 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. The intent is for it to be expanded to include the Marianas, PRIAs, and Hawaii, and be titled the Pacific Islands Regional Marine Planner.

3 DATA INTEGRATION

The purpose of this section ("Chapter 3") of the annual SAFE report is to identify and evaluate potential fishery ecosystem relationships between fishery parameters and ecosystem variables to assess how changes in the ecosystem can affect fisheries across the Western Pacific region. "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., temperature, precipitation, current velocity) that may contribute to observed trends or act as potential indicators of the status of prominent stocks in the fishery. Data integration 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 and were first incorporated in the 2017 versions of the annual SAFE reports.

To support the development of Chapter 3 of the annual SAFE report, staff from the Council, NMFS PIFSC and PIRO, and Triton Aquatics (consultants), held a SAFE Report Data Integration Workshop (hereafter, "the Workshop") on November 30, 2016 to identify potential fishery ecosystem relationships relevant to local policy in the Western Pacific region 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 (Table 13). It is important to note that these lists were developed before the ecosystem component FEP amendments were developed.

Table 13. List of brainstormed potential archipelagic island fishery relationships scored and ranked from highest to lowest priority

Relationships	FEP	Score	Rank
Bottomfish catch/effort/CPUE/species composition and benthos/substrate (i.e., depth, structure)	All	22	3
Bottomfish catch/effort/ CPUE /species composition and Pacific Decadal Oscillation	All	20	3
Coral reef fish/fishery/biomass and temperature-derived variable	All	20	3
Akule/opelu and precipitation (MHI and Guam)	HI	20	3
Bottomfish catchability and wind speed	All	19	3
Coral reef fish/fishery/biomass and chlorophyll-*a* (with phase lag)	All	19	3
Bottomfish Catch /CPUE and lunar cycle/moon phase	All	19	3
Bottomfish catch/effort/ CPUE /species composition and sea-level height (eddy feature)	All	18	2
Coral reef fish/fishery/biomass and Pacific Decadal Oscillation	All	18	2
Green/red spiny lobster catch/CPUE and vertical relief	HI	18	2
Green/red spiny lobster catch/CPUE and Pacific Decadal Oscillation	HI	18	2

Relationships	FEP	Score	Rank
Bottomfish catchability and fishing conditions (i.e. surface, subsurface current, speed, and direction)	All	17	2
Coral reef fish/fishery/biomass and moon phase	All	17	2
Coral reef fish/fishery/biomass and Oceanic Niño Index	All	17	2
Coral reef fish/fishery/biomass and sea-level height	All	17	2
Coral reef fish/fishery/biomass and pH	All	17	2
Bottomfish catch/effort/ CPUE /species composition and temperature-derived variable (e.g. temperature at depth)	All	16	2
Bottomfish catch/effort/ CPUE /species composition and chlorophyll-*a* (with phase lag)	All	16	2
Bottomfish catch/effort/ CPUE /species composition and precipitation	All	16	2
Coral reef fish/fishery/biomass and structural complexity /benthic habitat	All	16	2
Bottomfish catch/effort/ CPUE /species composition and dissolved oxygen	All	15	2
Coral reef fish/fishery/biomass and precipitation	All	14	2
Bottomfish catch/effort/ CPUE /species composition and pH	All	13	2
Bottomfish catch/effort/ CPUE /species composition and predator abundance	All	12	2
Coral reef fish/fishery/biomass and salinity	All	12	2
Coral reef fish/fishery/biomass and dissolved oxygen	All	12	2
Bottomfish catch/effort/ CPUE /species composition and salinity	All	10	1

The data integration chapter of this report is not fully developed due to the absence of consistent fisheries data in the PRIAs. The archipelagic data integration chapter is meant to explore 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. The Workshop produced a long list of fishery and ecosystem variable combinations that comprise a significant workload that the participants could not take on without sufficient data coverage. Though a contractor completed exploratory evaluations for the MHI, Guam, CNMI, and American Samoa in 2017 for inclusion in the 2017 Annual SAFE Reports, no explicit analyses were conducted for the PRIAs.

3.1 RECENT RELEVANT ABSTRACTS

In this section, abstracts from primary journal articles published in 2019 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.

Darling, E.S., McClanahan, T.R., Maina, J. et al., 2019. Social–environmental drivers inform strategic management of coral reefs in the Anthropocene. *Natural Ecology and Evolution*, *3*, pp. 1341-1350

Without drastic efforts to reduce carbon emissions and mitigate globalized stressors, tropical coral reefs are in jeopardy. Strategic conservation and management requires identification of the environmental and socioeconomic factors driving the persistence of scleractinian coral assemblages—the foundation species of coral reef ecosystems. Here, we compiled coral abundance data from 2,584 Indo-Pacific reefs to evaluate the influence of 21 climate, social and environmental drivers on the ecology of reef coral assemblages. Higher abundances of framework-building corals were typically associated with: weaker thermal disturbances and longer intervals for potential recovery; slower human population growth; reduced access by human settlements and markets; and less nearby agriculture. We therefore propose a framework of three management strategies (protect, recover or transform) by considering: (1) if reefs were above or below a proposed threshold of >10% cover of the coral taxa important for structural complexity and carbonate production; and (2) reef exposure to severe thermal stress during the 2014–2017 global coral bleaching event. Our findings can guide urgent management efforts for coral reefs, by identifying key threats across multiple scales and strategic policy priorities that might sustain a network of functioning reefs in the Indo-Pacific to avoid ecosystem collapse.

Heenan, A., Williams, G.J., and I.D. Williams, 2019. Natural variation in coral reef trophic structure across environmental gradients. *Frontiers in Ecology and the Environment*, *18*(2), pp. 69-75.

Policies designed to address current challenges to the sustainability of fisheries generally use an ecosystem-based approach – one that incorporates interactions between fishes, fishers, and the environment. Fishing alters the trophic structure among coral reef fish but properly assessing those impacts requires an understanding of how and why that structure varies naturally across scales. Using a combination of small- and large-scale surveys, we generated biomass pyramids for 20 uninhabited Pacific islands, and found that (1) the distribution of reef fish biomass across trophic levels is highly scale dependent: trophic structures that appear top-heavy at small scales can take a variety of different states when data are integrated across the broader seascape; (2) reefs can have the greatest biomass at intermediate consumer levels, which we describe as "middle-driven" systems; and (3) in unfished coral reef systems, trophic structure is strongly predicted by energy into the base and middle of the food web, as well as by the interacting effect of water temperature.

McClanahan, T.R., Schroeder, R.E., Friedlander, A.M., Vigliola, L. et al., 2019. Global baselines and benchmarks for fish biomass: comparing remote reefs and fisheries closures. *Marine Ecology Progress Series*, *612*, pp. 167-192.

Baselines and benchmarks (B&Bs) are needed to evaluate the ecological status and fisheries potential of coral reefs. B&Bs may depend on habitat features and energetic limitations that constrain biomass within the natural variability of the environment and fish behaviors. To evaluate if broad B&Bs exist, we compiled data on the biomass of fishes in ~1000 reefs with no recent history of fishing in 19 ecoregions. These reefs spanned the full longitude and latitude of Indian and Pacific Ocean reefs and included older high-compliance fisheries closures (>15 yr closure) and remote reef areas (>9 h travel time from fisheries markets). There was no significant change in biomass over the 15 to 48 yr closure period but closures had only ~40% of the biomass

(740 kg ha^{-1}, lower confidence interval [LCI] = 660 kg ha-1, upper confidence interval [UCI] = 810 kg ha^{-1}, n = 157) of remote tropical reefs (1870 [1730, 2000] kg ha^{-1}, n = 503). Remote subtropical reefs had lower biomass (950 [860, 1040] kg ha^{-1}, n = 329) than tropical reefs. Closures and remote reef fish biomass responded differently to environmental variables of coral cover, net primary productivity, and light, indicating that remote reefs are more limited by productivity and habitat than closures. Closures in fished seascapes are unlikely to achieve the biomass and community composition of remote reefs, which suggests fisheries benchmarks will differ substantially from wilderness baselines. A fishery benchmark (B_0) of ~1000 kg ha^{-1} adjusted for geography is suggested for fisheries purposes. For ecological purposes, a wilderness baseline of ~1900 kg ha^{-1} is appropriate for including large and mobile species not well protected by closures.

Taylor, B.M., Choat, J.H., DeMartini, E.E., Hoey, A.S., Marshell, A., Priest, M.A., Rhodes, K.L., and M.G Meekan, 2019. *Journal of Animal Ecology*, *88*(12), pp. 1888-1900.

Variation in life-history characteristics is evident within and across animal populations. Such variation is mediated by environmental gradients and reflects metabolic constraints or tradeoffs that enhance reproductive outputs. While generalizations of life-history relationships across species provide a framework for predicting vulnerability to overexploitation, deciphering patterns of intraspecific variation may also enable recognition of peculiar features of populations that facilitate ecological resilience. This study combines age-based biological data from geographically disparate populations of bluespine unicornfish (*Naso unicornis*) - the most commercially-valuable reef-associated species in the insular Indo-Pacific - to explore the magnitude and drivers of variation in life span and examine the mechanism s enabling peculiar mortality schedules. Longevity and mortality schedules were investigated across eleven locations encompassing a range of latitudes and exploitation levels. The presence of different growth types was examined using back-calculated growth histories from otoliths. Growth-type dependent mortality (mortality rates associated with particular growth trajectories) was corroborated using population models that incorporated size-dependent competition. We found a threefold geographic variation in life span that was strongly linked to temperature, but not to anthropogenic pressure or ocean productivity. All populations consistently displayed a two - phase mortality schedule, with higher than expected natural mortality rates in earlier stages of post-settlement life. Reconstructed growth histories and population models demonstrated that variable growth types within populations can yield this peculiar biphasic mortality schedule, where fast growers enjoy early reproductive outputs at the expense of greater mortality, and benefit s for slow growers derive from extended reproductive outputs over a greater number of annual cycles. This promotes population resilience because individuals can take advantage of cycles of environmental change operating at both short and long-term scales. Our results highlight a prevailing, fundamental misperception when comparing the life histories of long - lived tropical ectotherms: the seemingly incongruent combination of extended life spans with high mortality rates was enabled by coexistence of variable growth types in a population. Thus a demographic profile incorporating contrasting growth and mortality strategies obscures the demographic effects of harvest across space or time in *N. unicornis* and possibly other ectotherms with the combination of longevity and asymptotic growth.

Vargas-Angel, B., Huntington, B., Brainard, R., Venegas, R., Oliver, T., Barkley, H. and A. Cohen, 2019. El Niño-associated catastrophic coral mortality at Jarvis Island, central Equatorial Pacific. *Coral Reefs*. *10*.

The 2014–2017 Global Coral Bleaching Event is the longest, most widespread, and impactful on record. Rapid ecological assessment surveys by NOAA's Pacific Reef Assessment and Monitoring Program reported widespread coral mortality at Jarvis Island in the aftermath of the 2015–2016 super-El Niño warming event; hard coral cover declined from 18.7% in April 2015 (pre-bleaching) to 0.4% in May 2016 (post-bleaching), representing a catastrophic > 98% decline. Between 2015 and 2016, corals at Jarvis experienced maximum heat stress of 22.25 °C-weeks exceeding the bleaching threshold (28.72 °C) for 66 consecutive weeks. Mass coral bleaching was observed in November 2015, which resulted in mass mortality across all coral taxa, depths, and island sectors. The bleaching event altered the benthic community composition including the coral assemblage. In the 2 yrs post-bleaching, the benthic community has transitioned from a short-lived increase of encrusting macroalgae to a more recent near-recovery of crustose coralline algae. Coral cover had not recovered by 2017 and could be potentially delayed by fast-growing turf algae. Within the coral community, the pre-bleaching dominant genus Montipora exhibited extreme mortality and only a handful of colonies of this taxon were enumerated in the 2016 surveys and none in 2017. Some coral taxa have persisted in low densities, including the ESA-threatened Acropora retusa and colonies of encrusting Pavona, Psammocora, and the free living Fungia. As the frequency and intensity of these high-temperature events is projected to increase in coming years, it is essential to track how remote ecosystems normally undisturbed by human influence, such as Jarvis, respond to a climate change.

Venegas, R.M., Oliver, T., Liu, G., Heron, S.F., Clark, J., Pomeroy, N., Young, C., Eakin, M., and R.E. Brainard, 2019. The Rarity of Depth Refugia from Coral Bleaching Heat Stress in the Western and Central Pacific Islands. *Scientific Reports*, *9,* 19710.

Some researchers have suggested that corals living in deeper reefs may escape heat stress experienced by shallow corals. We evaluated the potential of deep coral reef refugia from bleaching stress by leveraging a long record of satellite-derived sea surface temperature data with a temporal, spatial, and depth precision of *in situ* temperature records. We calculated an *in situ* stress metric using a depth bias-adjusted threshold for 457 coral reef sites among 49 islands in the western and central Pacific Ocean over the period 2001–2017. Analysis of 1,453 heating events found no meaningful depth refuge from heat stress down to 38 m, and no significant association between depth and subsurface heat stress. Further, the surface metric underestimated subsurface stress by an average of 39.3%, across all depths. Combining satellite and *in situ* temperature data can provide bleaching-relevant heat stress results to avoid misrepresentation of heat stress exposure at shallow reefs.

Williams, I.D., Kindinger, T.L., Couch, C.S., Walsh, W.J., Dwayne, M., and T.A. Oliver, 2019. Can Herbivore Management Increase the Persistence of Indo-Pacific Coral Reefs? *Frontiers in Marine Science*, *6*, p. 557.

Due to climate change, coral reefs have experienced mass bleaching, and mortality events in recent years. Although coral reefs are unlikely to persist in their current form unless climate change can be addressed, local management can have a role to play by extending the time frame over which there are functional reef systems capable of recovery. Here we consider the potential application of one form of local management – management of herbivorous fishes. The premise behind this approach is that increased herbivory could shift reef algal assemblages to states that are benign or beneficial for corals, thereby increasing corals' ability to recover from destructive events such as bleaching and to thrive in periods between events. With a focus on Indo-Pacific coral reefs, we review what is known about the underlying processes of herbivory and coral-algal competition that ultimately affect the ability of corals to grow, persist, and replenish themselves. We then critically assess evidence of effectiveness or otherwise of herbivore management within marine protected areas (MPAs) to better understand why many MPAs have not improved outcomes for corals, and more importantly to identify the circumstances in which that form of management would be most likely to be effective. Herbivore management is not a panacea, but has the potential to enhance coral reef persistence in the right circumstances. Those include that: (i) absent management, there is an "algal problem" – i.e., insufficient herbivory to maintain algae in states that are benign or beneficial for corals; and (ii) management actions are able to increase net herbivory. As increased corallivory is a potentially widespread negative consequence of management, we consider some of the circumstances in which that is most likely to be a problem as well as potential solutions. Because the negative effects of certain algae are greatest for coral settlement and early survivorship, it may be that maintaining sufficient herbivory is particularly important in promoting recovery from destructive events such as mass bleaching. Thus, herbivore management can have a role to play as part of a wider strategy to manage and reduce the threats that currently imperil coral reefs.

4 REFERENCES

50 CFR § 665. Fisheries in the Western Pacific. Title 50 *Code of Federal Regulations*, Pt. 665. Electronic Code of Federal Regulations data current as of February 28, 2020. Viewed at http://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&SID=b28abb7da3229173411daf43959fcbd1&n=50y13.0.1.1.2&r=PART&ty=HTML#_top.

64 FR 19067. Fisheries Off West Coast States and in the Western Pacific; Pelagic Fisheries, Amendment 8; Crustacean Fisheries, Amendment 10; Bottomfish and Seamount Groundfish Fisheries, Amendment 6; Precious Corals Fisheries, Amendment 4, Rule. *Federal Register* 64 (19 April 1999): 19067-19069. Downloaded from http://www.wpcouncil.org/precious/Documents/FMP/Amendment4-FR-FinalRule.pdf.

69 FR 8336. Fisheries off West Coast States and in the Western Pacific; Coral Reef Ecosystems Fishery Management Plan for the Western Pacific, Final Rule. *Federal Register* 69 (24 February 2004): 8336-8349. Downloaded from http://www.wpcouncil.org/precious/Documents/FMP/Amendment5-FR-FinalRule.pdf.

73 FR 70603. Fisheries in the Western Pacific; Crustacean Fisheries; Deepwater Shrimp, Final Rule. *Federal Register* 73 (21 November 2008): 70603-70605. Downloaded from https://www.govinfo.gov/content/pkg/FR-2008-11-21/pdf/E8-27773.pdf.

78 FR 32996. Western Pacific Fisheries; Fishing in the Marianas Trench, Pacific Remote Islands, and Rose Atoll Marine National Monuments, Final Rule. *Federal Register* 78 (3 June 2013): 32996-33007. Downloaded from http://www.wpcouncil.org/precious/Documents/FMP/Amendment5-FR-FinalRule.pdf.

Aviso, 2020. El Niño Bulletin – Latest plots. Ocean indicator products, Center for Topographic Studies of the Ocean and Hydrosphere, Centre National D'études Spatiales. Available at https://www.aviso.altimetry.fr/en/data/products/ocean-indicators-products/el-nino-bulletin.html. Updated March 2020.

Ayotte, P., McCoy, K., Heenan, A., Williams, I., and J. Zamzow, 2015. Coral Reef Ecosystem Division standard operating procedures: data collection for Rapid Ecological Assessment fish surveys. PIFSC Administrative Report H-15-07. 33 p. Retrieved from https://repository.library.noaa.gov/view/noaa/9061.

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

Fabry, V.J., Seibel, B.A., Feely, R.A., and J.C. Orr, 2008. Impacts of ocean acidification on marine fauna and ecosystem processes. *ICES Journal of Marine Science*, *65*, pp. 414-432.

Feely, R.A., Alin, S.R., Carter, B., Bednarsek, N., Hales, B., Chan, F., Hill, T.M., Gaylord, B., Sanford, E., Byrne, R.H., Sabine, C.L., Greeley, D., and L. Juranek, 2016. Chemical and biological impacts of ocean acidification along the west coast of North America. *Estuarine, Coastal and Shelf Science*, *183*, pp. 260-270. doi: 10.1016/j.ecss.2016.08.043.

Figueroa, D.F. and A.R. Baco, 2014. Complete mitochondrial genomes elucidate phylogenetic relationships of the deep-sea octocoral families Coralliidae and Paragorgiidae. *Deep Sea Research Part II: Topical Studies in Oceanography*, *99*, pp.83-91.

Grace-McCaskey, C., 2014. Examining the potential of using secondary data to better understand human-reef relationships across the Pacific. Pacific Islands Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96818-5007. Pacific Islands Fish. Sci. Cent. Admin. Rep. H-14-01, 69 p. https://www.pifsc.noaa.gov/library/pubs/admin/PIFSC_Admin_Rep_14-01.pdf

HOT, 2020. Hawaii Ocean Time Series. School of Ocean and Earth Science and Technology, University of Hawaii Manoa. Accessed from http://hahana.soest.hawaii.edu/hot/.

Huffman, G.J., Adler, R.F., Arkin, P., Chang, A., Ferraro, R., Gruber, A., Janowiak, J., McNab, A., Rudolf, B. and U. Schneider, 1997. The global precipitation climatology project (GPCP) combined precipitation dataset. *Bulletin of the American Meteorological Society*, *78*(1), pp.5-20.

Karl, D.M. and R. Lukas, 1996. The Hawaii Ocean Time-series (HOT) program: Background, rationale and field implementation. *Deep Sea Research Part II: Topical Studies in Oceanography*, *43*(2-3), pp.129-156.

Keeling, C.D., Bacastow, R.B., Bainbridge, A.E., Ekdahl, C.A., Guenther, P.R., and L.S. Waterman, 1976. Atmospheric carbon dioxide variations at Mauna Loa Observatory, Hawaii. *Tellus*, *28*, pp. 538-551.

Knapp, K.R., M.C. Kruk, D.H. Levinson, H.J. Diamond, and C.J. Neumann, 2010. The International Best Track Archive for Climate Stewardship (IBTrACS): Unifying tropical cyclone best track data. *Bulletin of the American Meteorological Society*, *91*, pp. 363-376. doi:10.1175/2009BAMS2755.1.

Knapp, K. R., H. J. Diamond, J. P. Kossin, M. C. Kruk, and C. J. Schreck, 2018: International Best Track Archive for Climate Stewardship (IBTrACS) Project, Version 4. NOAA National Centers for Environmental Information. https://doi.org/10.25921/82ty-9e16

Mantua, N., 2017. The Pacific Decadal Oscillation. Available at http://research.jisao.washington.edu/pdo/.

McCoy, K., Heenan, A., Asher, J., Ayotte, P., Gorospe, K., Gray, A., Lino, K., Zamzowm J., and I. Williams, 2017. Pacific Reef Assessment and Monitoring Program Data Report: Ecological monitoring 2016 - reef fishes and benthic habitats of the main Hawaiian Islands, Northwestern Hawaiian Islands, Pacific Remote Island Areas, and American Samoa. NOAA Pacific Islands Fisheries Science Center. PIFSC Data Report DR-17-001. 66 pp.

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

Minton, D., 2017. Non-fishing effects that may adversely affect essential fish habitat in the Pacific Islands region, Final Report. NOAA National Marine Fisheries Service, Contract AB-133F-15-CQ-0014. 207 pp.

NOAA, 2002. CPC Merged Analysis of Precipitation. National Weather Service, National Centers for Environmental Prediction, Climate Prediction Center. Available at https://www.cpc.ncep.noaa.gov/products/global_precip/html/wpage.cmap.html. Updated 25 September 2002.

NOAA, 2020a. Full Mauna Loa CO_2 Record. Trends in Atmospheric Carbon Dioxide. Earth System Research Laboratory, Global Monitoring Division. Accessed from https://www.esrl.noaa.gov/gmd/ccgg/trends/full.html.

NOAA, 2020b. Climate Indices: Monthly Atmospheric and Oceanic Time-Series. Earth System Research Laboratory, Physical Sciences Division. Accessed from https://www.esrl.noaa.gov/psd/data/correlation/pdo.data

NOAA, 2020c. CPC Merged Analysis of Precipitation (CMAP). National Centers for Environmental Prediction. Accessed from https://www.esrl.noaa.gov/psd/data/gridded/data.cmap.html.

NOAA, 2020d. Sea level Trends. NOAA Tides & Currents. Available at https://tidesandcurrents.noaa.gov/sltrends/sltrends.html.

NOAA Climate Prediction Center (CPC), 2020. Oceanic Nino Index. Accessed from https://www.cpc.ncep.noaa.gov/data/indices/oni.ascii.txt

NOAA Coral Reef Watch, 2020. https://coralreefwatch.noaa.gov/product/vs/.

NOAA OceanWatch, 2020. Conditions in the Hawaii longline fishing ground. OceanWatch Central Pacific Node. Accessed from http://oceanwatch.pifsc.noaa.gov/indicators-longline.html.

Opresko, D.M., 2009. A New Name for the Hawaiian Antipatharian Coral Formerly Known as *Antipathes dichotoma* (Cnidaria: Anthozoa: Antipatharia) 1. *Pacific Science*, *63*(2), pp. 277-292.

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

PIFSC, 2016. Ecosystem Sciences. Coral Reef Ecosystem Survey Methods. Benthic Monitoring. http://www.pifsc.noaa.gov/cred/survey_methods.php. Updated 1 April 2016.

PIFSC, 2020. Pacific Islands Fisheries Science Center. About Us. Ecosystem Sciences. https://www.fisheries.noaa.gov/about/pacific-islands-fisheries-science-center

Reynolds, R.W., 1988. A real-time global sea surface temperature analysis. *Journal of Climate*, *1*(1), pp. 75-87.

Ryan, W.B.F., S.M. Carbotte, S.M., Coplan, J.O., O'Hara, S., Melkonian, A., Arko, R., Weissel, R.A., Ferrini, V., Goodwillie, A., Nitsche, F., Bonczkowski, J., and R. Zemsky, 2009. Global Multi-Resolution Topography synthesis, *Geochem. Geophys. Geosyst.*, *10*, Q03014.

Sinniger, F., Ocana, O.V., and A.R. Baco, 2013. Diversity of zoanthids (Anthozoa: Hexacorallia) on Hawaiian seamounts: description of the Hawaiian gold coral and additional zoanthids. *PloS one*, *8*(1), p.e52607.

Smith, S.G., Ault, J.S., Bohnsack, J.A., Harper, D.E., Luo, J.G., and D.B. McClellan, 2011. Multispecies survey design for assessing reef-fish stocks, spatially explicit management performance, and ecosystem condition. *Fisheries Research*, *109*(1), p. 25-41. http://doi.org/10.1016/j.fishres.2011.01.012.

Spencer, R.W., 1993. Global oceanic precipitation from the MSU during 1979—91 and comparisons to other climatology. *Journal of Climate*, *6*(7), pp.1301-1326.

Thoning, K.W., Tans, P.P., and W.D. Komhyr, 1989. Atmospheric carbon dioxide at Mauna Loa Observatory 2. Analysis of the NOAA GMCC data, 1974-1985. *Journal of Geophysical Research*, *94*, pp. 8549-8565.

WPRFMC. Fishery Management Plan and Fishery Ecosystem Plan Amendments available from http://www.wpcouncil.org/fishery-plans-policies-reports/.

WPRFMC, 2001. Fishery Management Plan for Coral Reef Ecosystems of the Western Pacific Region. Western Pacific Regional Fishery Management Council, Honolulu, HI.

WPRFMC, 2009. Fishery Ecosystem Plan for the Pacific Remote Island Area. Western Pacific Regional Fishery Management Council, Honolulu, HI. 193 pp.

WPRFMC, 2013. Amendment 2 to Fishery Ecosystem Plan of the Pacific Remote Island Areas. Western Pacific Regional Fishery Management Council, Honolulu, HI. RIN 0648-BA98. 234 pp.

WPRFMC, 2019. Annual Stock Assessment and Fishery Evaluation Report: Pacific Remote Island Area Fishery Ecosystem Plan 2018. Sabater, M., Ishizaki, A., Remington, T., Spalding, S. (Eds.) Western Pacific Regional Fishery Management Council. Honolulu, Hawaii 96813 USA.

Xie, P. and P.A. Arkin, 1997. Global precipitation: A 17-year monthly analysis based on gauge observations, satellite estimates, and numerical model outputs. *Bulletin of the American Meteorological* Society, *78*(11), pp. 2539-2558.

APPENDIX A: LIST OF MANAGEMENT UNIT SPECIES

The PRIA species list and Fish Stock Sustainability Index (FSSI) status will be made available in subsequent reports as resources allow. Please see the PRIA FEP and implementing regulations for the list of managed species.

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 Hawai`i shallow-set longline waters

Common name	Scientific name	ESA listing status	MMPA status	Occurrence	References
Seabirds					
Laysan Albatross	*Phoebastria immutabilis*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Black-Footed Albatross	*Phoebastria nigripes*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Short-Tailed Albatross	*Phoebastria albatrus*	Endangered	N/A	Breeding visitor in the NWHI	35 FR 8495, 65 FR 46643, Pyle & Pyle 2009
Northern Fulmar	*Fulmarus glacialis*	Not Listed	N/A	Winter resident	Pyle & Pyle 2009
Kermadec Petrel	*Pterodroma neglecta*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Herald Petrel	*Pterodroma arminjoniana*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Murphy's Petrel	*Pterodroma ultima*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Mottled Petrel	*Pterodroma inexpectata*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Juan Fernandez Petrel	*Pterodroma externa*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Hawaiian Petrel	*Pterodroma sandwichensis (Pterodroma phaeopygia sandwichensis)*	Endangered	N/A	Breeding visitor in the MHI	32 FR 4001, Pyle & Pyle 2009
White-Necked Petrel	*Pterodroma cervicalis*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Bonin Petrel	*Pterodroma hypoleuca*	Not Listed	N/A	Breeding visitor in the NWHI	Pyle & Pyle 2009
Black-Winged Petrel	*Pterodroma nigripennis*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Cook Petrel	*Pterodroma cookii*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Stejneger Petrel	*Pterodroma longirostris*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Pycroft Petrel	*Pterodroma pycrofti*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Bulwer Petrel	*Bulweria bulwerii*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Flesh-Footed Shearwater	*Ardenna carneipes*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Wedge-Tailed Shearwater	*Ardenna pacifica*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Buller's Shearwater	*Ardenna bulleri*	Not Listed	N/A	Migrant	Pyle & Pyle 2009

Common name	Scientific name	ESA listing status	MMPA status	Occurrence	References
Sooty Shearwater	*Ardenna grisea*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Short-Tailed Shearwater	*Ardenna tenuirostris*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Christmas Shearwater	*Puffinus nativitatis*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Newell's Shearwater	*Puffinus newelli (Puffinus auricularis newelli)*	Threatened	N/A	Breeding visitor	40 FR 44149, Pyle & Pyle 2009
Wilson's Storm-Petrel	*Oceanites oceanicus*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Leach's Storm-Petrel	*Oceanodroma leucorhoa*	Not Listed	N/A	Winter resident	Pyle & Pyle 2009
Band-Rumped Storm-Petrel	*Oceanodroma castro*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Tristram Storm-Petrel	*Oceanodroma tristrami*	Not Listed	N/A	Breeding visitor in the NWHI	Pyle & Pyle 2009
White-Tailed Tropicbird	*Phaethon lepturus*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Red-Tailed Tropicbird	*Phaethon rubricauda*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Masked Booby	*Sula dactylatra*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Brown Booby	*Sula leucogaster*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Red-Footed Booby	*Sula sula*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Great Frigatebird	*Fregata minor*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Lesser Frigatebird	*Fregata ariel*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Laughing Gull	*Leucophaeus atricilla*	Not Listed	N/A	Winter resident in the MHI	Pyle & Pyle 2009
Franklin Gull	*Leucophaeus pipixcan*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Ring-Billed Gull	*Larus delawarensis*	Not Listed	N/A	Winter resident in the MHI	Pyle & Pyle 2009
Herring Gull	*Larus argentatus*	Not Listed	N/A	Winter resident in the NWHI	Pyle & Pyle 2009
Slaty-Backed Gull	*Larus schistisagus*	Not Listed	N/A	Winter resident in the NWHI	Pyle & Pyle 2009
Glaucous-Winged Gull	*Larus glaucescens*	Not Listed	N/A	Winter resident	Pyle & Pyle 2009
Brown Noddy	*Anous stolidus*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Black Noddy	*Anous minutus*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Blue-Gray Noddy	*Procelsterna cerulea*	Not Listed	N/A	Breeding visitor in the NWHI	Pyle & Pyle 2009
White Tern	*Gygis alba*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009

Common name	Scientific name	ESA listing status	MMPA status	Occurrence	References
Sooty Tern	*Onychoprion fuscatus*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Gray-Backed Tern	*Onychoprion lunatus*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Little Tern	*Sternula albifrons*	Not Listed	N/A	Breeding visitor in the NWHI	Pyle & Pyle 2009
Least Tern	*Sternula antillarum*	Not Listed	N/A	Breeding visitor in the NWHI	Pyle & Pyle 2009
Arctic Tern	*Sterna paradisaea*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
South Polar Skua	*Stercorarius maccormicki*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Pomarine Jaeger	*Stercorarius pomarinus*	Not Listed	N/A	Winter resident in the MHI	Pyle & Pyle 2009
Parasitic Jaeger	*Stercorarius parasiticus*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Long-Tailed Jaeger	*Stercorarius longicaudus*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Sea turtles					
Green Sea Turtle	*Chelonia mydas*	Threatened (Central North Pacific DPS)	N/A	Most common turtle in the Hawaiian Islands, much more common in nearshore state waters (foraging grounds) than offshore federal waters. Most nesting occurs on French Frigate Shoals in the NWHI. Foraging and haul out in the MHI.	43 FR 32800, 81 FR 20057, Balazs et al. 1992, Kolinski et al. 2001
Green Sea Turtle	*Chelonia mydas*	Threatened (East Pacific DPS)	N/A	Nest primarily in Mexico and the Galapagos Islands. Little known about their pelagic range west of 90°W, but may range as far as the Marshall Islands. Genetic testing confirmed that they are incidentally taken in the HI DSLL fishery.	43 FR 32800, 81 FR 20057, WPRFMC 2009, Cliffton et al. 1982, Karl & Bowen 1999
Hawksbill Sea Turtle	*Eretmochelys imbricata*	Endangered[a]	N/A	Small population foraging around Hawai`i and low level nesting on Maui and Hawai`i Islands. Occur worldwide in tropical and subtropical waters.	35 FR 8491, NMFS & USFWS 2007, Balazs et al. 1992, Katahira et al. 1994
Leatherback Sea Turtle	*Dermochelys coriacea*	Endangered[a]	N/A	Regularly sighted in offshore waters, especially at the southeastern end of the archipelago.	35 FR 8491, NMFS & USFWS 1997

Common name	Scientific name	ESA listing status	MMPA status	Occurrence	References
Loggerhead Sea Turtle	*Caretta caretta*	Endangered (North Pacific DPS)	N/A	Rare in Hawai`i. Found worldwide along continental shelves, bays, estuaries and lagoons of tropical, subtropical, and temperate waters.	43 FR 32800, 76 FR 58868, Dodd 1990, Balazs 1979
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 in Hawai`i. Occurs worldwide in tropical and warm temperate ocean waters.	43 FR 32800, Pitman 1990, Balacz 1982
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	Acoustically recorded off of Oahu and Midway Atoll, small number of sightings around Hawai`i. Considered extremely rare, generally occur in winter and summer.	35 FR 18319, Bradford et al. 2013, Northrop et al. 1971, Thompson & Friedl 1982, Stafford et al. 2001
Bottlenose Dolphin	*Tursiops truncatus*	Not Listed	Non-strategic	Distributed worldwide in tropical and warm-temperate waters. Pelagic stock distinct from island-associated stocks.	Perrin et al. 2009, Martien et al. 2012
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 year round in Hawaiian waters.	McSweeney et al. 2007
Dall's Porpoise	*Phocoenoides dalli*	Not Listed	Non-strategic	Range across the entire north Pacific Ocean.	Hall 1979
Dwarf Sperm Whale	*Kogia sima*	Not Listed	Non-strategic	Most common in waters between 500 m and 1,000 m in depth. Found worldwide in tropical and warm-temperate waters.	Nagorsen 1985, Baird et al. 2013

Common name	Scientific name	ESA listing status	MMPA status	Occurrence	References
False Killer Whale	*Pseudorca crassidens*	Not Listed	Non-strategic	Found worldwide in tropical and warm-temperate waters. Pelagic stock tracked to within 11 km of Hawaiian islands.	Stacey et al. 1994, Baird et al. 2012, Bradford et al. 2015
Fin Whale	*Balaenoptera physalus*	Endangered	Strategic	Infrequent sightings in Hawai`i waters. Considered rare in Hawai`i, though may migrate into Hawaiian waters during fall/winter based on acoustic recordings.	35 FR 18319, Hamilton et al. 2009, Thompson & Friedl 1982
Fraser's Dolphin	*Lagenodelphis hosei*	Not Listed	Non-strategic	Found worldwide in tropical waters.	Perrin et al. 2009
Guadalupe Fur Seal	*Arctocephalus townsendi*	Threatened	Strategic	Extremely rare sightings. Little known about their pelagic distribution. Breed mainly on Isla Guadalupe, Mexico.	50 FR 51252, Gallo-Reynoso et al. 2008, Fleischer 1987
Hawaiian Monk Seal	*Neomonachus schauinslandi*	Endangered[a]	Strategic	Endemic tropical seal. Occurs throughout the archipelago. MHI population spends some time foraging in federal waters during the day.	41 FR 51611, Baker at al. 2011
Humpback Whale	*Megaptera novaeangliae*	Delisted Due to Recovery (Hawai`i DPS)	Strategic	Migrate through the archipelago and breed during the winter. Common during winter months, when they are generally found within the 100 m isobath.	35 FR 18319, 81 FR 62259, Childerhouse et al. 2008, Wolman & Jurasz 1976, Herman & Antinoja 1977, Rice & Wolman 1978
Killer Whale	*Orcinus orca*	Not Listed	Non-strategic	Rare in Hawai`i. Prefer colder waters within 800 km of continents.	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. Rare in Hawai`i.	Dalebout 2003, Baird et al. 2013
Melon-Headed Whale	*Peponocephala electra*	Not Listed	Non-strategic	Found in tropical and warm-temperate waters worldwide, found primarily in equatorial waters. Uncommon in Hawai`i.	Perryman et al. 1994, Barlow 2006, Bradford et al. 2013

Common name	Scientific name	ESA listing status	MMPA status	Occurrence	References
Minke Whale	*Balaenoptera acutorostrata*	Not Listed	Non-strategic	Occur seasonally around Hawai`i	Barlow 2003, Rankin & Barlow 2005
North Pacific Right Whale	*Eubalaena japonica*	Endangered[a]	Strategic	Extremely rare in Hawai`i waters	35 FR 18319, 73 FR 12024, Rowntree et al. 1980, Herman et al. 1980
Northern Elephant Seal	*Mirounga angustirostris*	Not Listed	Non-strategic	Females migrate to central North Pacific to feed on pelagic prey.	Le Beouf et al. 2000
Northern Fur Seal	*Callorhinus ursinus*	Not Listed	Non-strategic	Occur throughout the North Pacific Ocean.	Gelatt et al. 2015
Pacific White-Sided Dolphin	*Lagenorhynchus obliquidens*	Not Listed	Non-strategic	Endemic to temperate waters of North Pacific Ocean. Occur both on the high seas and along continental margins.	Brownell et al. 1999
Pantropical Spotted Dolphin	*Stenella attenuata attenuata*	Not Listed	Non-strategic	Common and abundant throughout the Hawaiian archipelago. Pelagic stock occurs outside of insular stock areas (20 km for Oahu and 4-island stocks, 65 km for Hawai`i Island stock).	Baird et al. 2013, Oleson et al. 2013
Pygmy Killer Whale	*Feresa attenuata*	Not Listed	Non-strategic	Small resident population in Hawaiian waters. Found worldwide in tropical and subtropical waters.	McSweeney et al. 2009, Ross & Leatherwood 1994
Pygmy Sperm Whale	*Kogia breviceps*	Not Listed	Non-strategic	Found worldwide in tropical and warm-temperate waters.	Caldwell & Caldwell 1989
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	Non-strategic	Found in tropical to warm-temperate waters worldwide. Occasionally found offshore of Hawai`i.	Perrin et al. 2009, Baird et al. 2013, Barlow 2006, Bradford et al. 2013
Sei Whale	*Balaenoptera borealis*	Endangered	Strategic	Rare in Hawai`i. Generally found in offshore temperate waters.	35 FR 18319, Barlow 2003, Bradford et al. 2013

Common name	Scientific name	ESA listing status	MMPA status	Occurrence	References
Short-Finned Pilot Whale	*Globicephala macrorhynchus*	Not Listed	Non-strategic	Found in tropical to warm-temperate waters worldwide. Commonly observed around MHI and present around NWHI.	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. Sighted off the NWHI and the MHI.	35 FR 18319, Rice 1960, Lee 1993, Barlow 2006, Mobley et al. 2000, Shallenberger 1981
Spinner Dolphin	*Stenella longirostris*	Not Listed	Non-strategic	Found worldwide in tropical and warm-temperate waters. Pelagic stock found outside of island-associated boundaries (10 nm).	Perrin et al. 2009
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 shark	*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
Scalloped hammerhead shark	*Sphyrna lewini*	Endangered (Eastern Pacific DPS)	N/A	Found in coastal areas from southern California to Peru.	Compagno 1984, Baum et al. 2007, Bester 2011
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					

Common name	Scientific name	ESA listing status	MMPA status	Occurrence	References
N/A	*Acropora globiceps*	Threatened	N/A	Not confirmed in Hawai`i waters. Occur on upper reef slopes, reef flats, and adjacent habitats in depths ranging from 0 to 8 m	Veron 2014
N/A	*Acropora jacquelineae*	Threatened	N/A	Not confirmed in Hawai`i waters. 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 depth range is 10 to 35 m.	Veron 2014
N/A	*Acropora retusa*	Threatened	N/A	Not confirmed in Hawai`i waters. Occur in shallow reef slope and back-reef areas, such as upper reef slopes, reef flats, and shallow lagoons, and depth range is 1 to 5 m.	Veron 2014
N/A	*Acropora speciosa*	Threatened	N/A	Not confirmed in Hawai`i waters. 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	Not confirmed in Hawai`i waters. 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	Not confirmed in Hawai`i waters. Found in shallow, high-wave energy environments, from low tide to at least 12 meters deep, and have been reported from mesophotic depths (less than 50 m depth).	Veron 2014

Common name	Scientific name	ESA listing status	MMPA status	Occurrence	References
N/A	*Seriatopora aculeata*	Threatened	N/A	Not confirmed in Hawai`i waters. Found in broad range of habitats including, but not limited to, upper reef slopes, mid-slope terraces, lower reef slopes, reef flats, and lagoons, and depth ranges from 3 to 40 m.	Veron 2014
Invertebrates					
Chambered nautilus	*Nautilus pompilius*	Threatened	N/A	Found in small, isolated populations throughout the Indo-Pacific on steep-sloped forereefs with sandy, silty, or muddy bottom substrates from depths of 100 m to 500 m.	83 FR 48948, CITES 2016

[a] These species have critical habitat designated under the ESA. See Table B-4.

Table B-2. Protected species found or reasonably believed to be found near or in Hawai`i deep-set longline waters.

Common name	Scientific name	ESA listing status	MMPA status	Occurrence	References
Seabirds					
Laysan Albatross	*Phoebastria immutabilis*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Black-Footed Albatross	*Phoebastria nigripes*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Short-Tailed Albatross	*Phoebastria albatrus*	Endangered	N/A	Breeding visitor in the NWHI	35 FR 8495, 65 FR 46643, Pyle & Pyle 2009
Northern Fulmar	*Fulmarus glacialis*	Not Listed	N/A	Winter resident	Pyle & Pyle 2009
Kermadec Petrel	*Pterodroma neglecta*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Herald Petrel	*Pterodroma arminjoniana*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Murphy's Petrel	*Pterodroma ultima*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Mottled Petrel	*Pterodroma inexpectata*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Juan Fernandez Petrel	*Pterodroma externa*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Hawaiian Petrel	*Pterodroma sandwichensis (Pterodroma phaeopygia sandwichensis)*	Endangered	N/A	Breeding visitor in the MHI	32 FR 4001, Pyle & Pyle 2009
White-Necked Petrel	*Pterodroma cervicalis*	Not Listed	N/A	Migrant	Pyle & Pyle 2009

Common name	Scientific name	ESA listing status	MMPA status	Occurrence	References
Bonin Petrel	*Pterodroma hypoleuca*	Not Listed	N/A	Breeding visitor in the NWHI	Pyle & Pyle 2009
Black-Winged Petrel	*Pterodroma nigripennis*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Cook Petrel	*Pterodroma cookii*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Stejneger Petrel	*Pterodroma longirostris*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Pycroft Petrel	*Pterodroma pycrofti*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Bulwer Petrel	*Bulweria bulwerii*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Wedge-Tailed Shearwater	*Ardenna pacifica*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Buller's Shearwater	*Ardenna bulleri*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Sooty Shearwater	*Ardenna grisea*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Short-Tailed Shearwater	*Ardenna tenuirostris*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Christmas Shearwater	*Puffinus nativitatis*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Newell's Shearwater	*Puffinus newelli (Puffinus auricularis newelli)*	Threatened	N/A	Breeding visitor	40 FR 44149, Pyle & Pyle 2009
Wilson's Storm-Petrel	*Oceanites oceanicus*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Leach's Storm-Petrel	*Oceanodroma leucorhoa*	Not Listed	N/A	Winter resident	Pyle & Pyle 2009
Band-Rumped Storm-Petrel	*Oceanodroma castro*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Tristram Storm-Petrel	*Oceanodroma tristrami*	Not Listed	N/A	Breeding visitor in the NWHI	Pyle & Pyle 2009
White-Tailed Tropicbird	*Phaethon lepturus*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Red-Tailed Tropicbird	*Phaethon rubricauda*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Masked Booby	*Sula dactylatra*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Nazca Booby	*Sula granti*	Not Listed	N/A	Vagrant	Pyle & Pyle 2009
Brown Booby	*Sula leucogaster*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Red-Footed Booby	*Sula sula*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Great Frigatebird	*Fregata minor*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Lesser Frigatebird	*Fregata ariel*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Laughing Gull	*Leucophaeus atricilla*	Not Listed	N/A	Winter resident in the MHI	Pyle & Pyle 2009

Common name	Scientific name	ESA listing status	MMPA status	Occurrence	References
Franklin Gull	*Leucophaeus pipixcan*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Ring-Billed Gull	*Larus delawarensis*	Not Listed	N/A	Winter resident in the MHI	Pyle & Pyle 2009
Herring Gull	*Larus argentatus*	Not Listed	N/A	Winter resident in the NWHI	Pyle & Pyle 2009
Slaty-Backed Gull	*Larus schistisagus*	Not Listed	N/A	Winter resident in the NWHI	Pyle & Pyle 2009
Glaucous-Winged Gull	*Larus glaucescens*	Not Listed	N/A	Winter resident	Pyle & Pyle 2009
Brown Noddy	*Anous stolidus*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Black Noddy	*Anous minutus*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Blue-Gray Noddy	*Procelsterna cerulea*	Not Listed	N/A	Breeding visitor in the NWHI	Pyle & Pyle 2009
White Tern	*Gygis alba*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Sooty Tern	*Onychoprion fuscatus*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Gray-Backed Tern	*Onychoprion lunatus*	Not Listed	N/A	Breeding visitor	Pyle & Pyle 2009
Little Tern	*Sternula albifrons*	Not Listed	N/A	Breeding visitor in the NWHI	Pyle & Pyle 2009
Least Tern	*Sternula antillarum*	Not Listed	N/A	Breeding visitor in the NWHI	Pyle & Pyle 2009
Arctic Tern	*Sterna paradisaea*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
South Polar Skua	*Stercorarius maccormicki*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Pomarine Jaeger	*Stercorarius pomarinus*	Not Listed	N/A	Winter resident in the MHI	Pyle & Pyle 2009
Parasitic Jaeger	*Stercorarius parasiticus*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Long-Tailed Jaeger	*Stercorarius longicaudus*	Not Listed	N/A	Migrant	Pyle & Pyle 2009
Sea turtles					
Green Sea Turtle	*Chelonia mydas*	Threatened (Central North Pacific DPS)	N/A	Most common turtle in the Hawaiian Islands, much more common in nearshore state waters (foraging grounds) than offshore federal waters. Most nesting occurs on French Frigate Shoals in the NWHI. Foraging and haulout in the MHI.	43 FR 32800, 81 FR 20057, Balazs et al. 1992, Kolinski et al. 2001

Common name	Scientific name	ESA listing status	MMPA status	Occurrence	References
Green Sea Turtle	*Chelonia mydas*	Threatened (East Pacific DPS)	N/A	Nest primarily in Mexico and the Galapagos Islands. Little known about their pelagic range west of 90°W, but may range as far as the Marshall Islands. Genetic testing confirmed that they are incidentally taken in the HI DSLL fishery.	43 FR 32800, 81 FR 20057, WPRFMC 2009, Cliffton et al. 1982, Karl & Bowen 1999
Hawksbill Sea Turtle	*Eretmochelys imbricata*	Endangered[a]	N/A	Small population foraging around Hawai`i and low level nesting on Maui and Hawai`i Islands. Occur worldwide in tropical and subtropical waters.	35 FR 8491, NMFS & USFWS 2007, Balazs et al. 1992, Katahira et al. 1994
Leatherback Sea Turtle	*Dermochelys coriacea*	Endangered[a]	N/A	Regularly sighted in offshore waters, especially at the southeastern end of the archipelago.	35 FR 8491, NMFS & USFWS 1997
Loggerhead Sea Turtle	*Caretta caretta*	Endangered (North Pacific DPS)	N/A	Rare in Hawai`i. Found worldwide along continental shelves, bays, estuaries and lagoons of tropical, subtropical, and temperate waters.	43 FR 32800, 76 FR 58868, Dodd 1990, Balazs 1979
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 in Hawai`i. Occurs worldwide in tropical and warm temperate ocean waters.	43 FR 32800, Pitman 1990, Balacz 1982
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	Acoustically recorded off of Oahu and Midway Atoll, small number of sightings around Hawai`i. Considered extremely rare, generally occur in winter and summer.	35 FR 18319, Bradford et al. 2013, Northrop et al. 1971, Thompson & Friedl 1982, Stafford et al. 2001

Common name	Scientific name	ESA listing status	MMPA status	Occurrence	References
Bottlenose Dolphin	*Tursiops truncatus*	Not Listed	Non-strategic	Distributed worldwide in tropical and warm-temperate waters. Pelagic stock distinct from island-associated stocks.	Perrin et al. 2009, Martien et al. 2012
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 year round in Hawaiian waters.	McSweeney et al. 2007
Dall's Porpoise	*Phocoenoides dalli*	Not Listed	Non-strategic	Range across the entire north Pacific Ocean.	Hall 1979
Dwarf Sperm Whale	*Kogia sima*	Not Listed	Non-strategic	Most common in waters between 500 m and 1,000 m in depth. Found worldwide in tropical and warm-temperate waters.	Nagorsen 1985, Baird et al. 2013
False Killer Whale	*Pseudorca crassidens*	Not Listed	Non-strategic	Found worldwide in tropical and warm-temperate waters. Pelagic stock tracked to within 11 km of Hawaiian islands.	Stacey et al. 1994, Baird et al. 2012, Bradford et al. 2015
Fin Whale	*Balaenoptera physalus*	Endangered	Strategic	Infrequent sightings in Hawai`i waters. Considered rare in Hawai`i, though may migrate into Hawaiian waters during fall/winter based on acoustic recordings.	35 FR 18319, Hamilton et al. 2009, Thompson & Friedl 1982
Fraser's Dolphin	*Lagenodelphis hosei*	Not Listed	Non-strategic	Found worldwide in tropical waters.	Perrin et al. 2009
Guadalupe Fur Seal	*Arctocephalus townsendi*	Threatened	Strategic	Rare sightings. Little known about their pelagic distribution. Breed mainly on Isla Guadalupe, Mexico.	50 FR 51252, Gallo-Reynoso et al. 2008, Fleischer 1987
Hawaiian Monk Seal	*Neomonachus schauinslandi*	Endangered[a]	Strategic	Endemic tropical seal. Occurs throughout the archipelago. MHI population spends some time foraging in federal waters during the day.	41 FR 51611, Baker at al. 2011

Common name	Scientific name	ESA listing status	MMPA status	Occurrence	References
Humpback Whale	*Megaptera novaeangliae*	Delisted Due to Recovery (Hawai`i DPS)	Strategic	Migrate through the archipelago and breed during the winter. Common during winter months, when they are generally found within the 100 m isobath.	35 FR 18319, 81 FR 62259, Childerhouse et al. 2008, Wolman & Jurasz 1976, Herman & Antinoja 1977, Rice & Wolman 1978
Killer Whale	*Orcinus orca*	Not Listed	Non-strategic	Rare in Hawai`i. Prefer colder waters within 800 km of continents.	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. Rare in Hawai`i.	Dalebout 2003, Baird et al. 2013
Melon-Headed Whale	*Peponocephala electra*	Not Listed	Non-strategic	Found in tropical and warm-temperate waters worldwide, found primarily in equatorial waters. Uncommon in Hawai`i.	Perryman et al. 1994, Barlow 2006, Bradford et al. 2013
Minke Whale	*Balaenoptera acutorostrata*	Not Listed	Non-strategic	Occur seasonally around Hawai`i	Barlow 2003, Rankin & Barlow 2005
North Pacific Right Whale	*Eubalaena japonica*	Endangered[a]	Strategic	Extremely rare in Hawai`i waters	35 FR 18319, 73 FR 12024, Rowntree et al. 1980, Herman et al. 1980
Northern Elephant Seal	*Mirounga angustirostris*	Not Listed	Non-strategic	Females migrate to central North Pacific to feed on pelagic prey	Le Beouf et al. 2000
Northern Fur Seal	*Callorhinus ursinus*	Not Listed	Non-strategic	Range across the north Pacific Ocean.	Gelatt et al. 2015
Pacific White-Sided Dolphin	*Lagenorhynchus obliquidens*	Not Listed	Non-strategic	Endemic to temperate waters of North Pacific Ocean. Occur both on the high seas and along continental margins.	Brownell et al. 1999
Pantropical Spotted Dolphin	*Stenella attenuata attenuata*	Not Listed	Non-strategic	Common and abundant throughout the Hawaiian archipelago. Pelagic stock occurs outside of insular stock areas (20 km for Oahu and 4-island stocks, 65 km for Hawai`i Island stock)	Baird et al. 2013, Oleson et al. 2013

Common name	Scientific name	ESA listing status	MMPA status	Occurrence	References
Pygmy Killer Whale	*Feresa attenuata*	Not Listed	Non-strategic	Small resident population in Hawaiian waters. Found worldwide in tropical and subtropical waters.	McSweeney et al. 2009, Ross & Leatherwood 1994
Pygmy Sperm Whale	*Kogia breviceps*	Not Listed	Non-strategic	Found worldwide in tropical and warm-temperate waters.	Caldwell & Caldwell 1989
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	Non-strategic	Found in tropical to warm-temperate waters worldwide. Occasionally found offshore of Hawai`i.	Perrin et al. 2009, Bradford et al. 2013, Barlow 2006, Baird et al. 2013
Sei Whale	*Balaenoptera borealis*	Endangered	Strategic	Rare in Hawai`i. 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. Commonly observed around MHI and present around NWHI.	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. Sighted off the NWHI and the MHI.	35 FR 18319, Rice 1960, Lee 1993, Barlow 2006, Mobley et al. 2000, Shallenberger 1981
Spinner Dolphin	*Stenella longirostris*	Not Listed	Non-strategic	Found worldwide in tropical and warm-temperate waters. Pelagic stock found outside of island-associated boundaries (10 nm)	Perrin et al. 2009
Striped Dolphin	*Stenella coeruleoalba*	Not Listed	Non-strategic	Found in tropical to warm-temperate waters throughout the world	Perrin et al. 2009
Elasmobranchs					

Common name	Scientific name	ESA listing status	MMPA status	Occurrence	References
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 shark	*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
Scalloped hammerhead shark	*Sphyrna lewini*	Endangered (Eastern Pacific DPS)	N/A	Found in coastal areas from southern California to Peru.	Compagno 1984, Baum et al. 2007, Bester 2011
Scalloped hammerhead shark	*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 ranging 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 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, and depth range is 1 to 5 m.	Veron 2014

Common name	Scientific name	ESA listing status	MMPA status	Occurrence	References
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 it has 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 m deep, and have been reported from mesophotic depths (less than 50 m depth).	Veron 2014
N/A	*Seriatopora aculeata*	Threatened	N/A	Found in broad range of habitats including, but not limited to, upper reef slopes, mid-slope terraces, lower reef slopes, reef flats, and lagoons, and depth ranges from 3 to 40 m.	Veron 2014
Invertebrates					
Chambered nautilus	*Nautilus pompilius*	Threatened	N/A	Found in small, isolated populations throughout the Indo-Pacific on steep-sloped forereefs with sandy, silty, or muddy bottom substrates from depths of 100 m to 500 m.	83 FR 48948, CITES 2016

[a] These species have critical habitat designated under the ESA. See Table B-4 .

Table B-3. Protected species found or reasonably believed to be found near or in American Samoa longline 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

Common name	Scientific name	ESA listing status	MMPA status	Occurrence	References
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
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

Common name	Scientific name	ESA listing status	MMPA status	Occurrence	References
Laysan Albatross	*Phoebastria immutabilis*	Not Listed	N/A	Breed mainly in Hawai`i, and range across the North Pacific Ocean.	Causey 2008
Hawaiian Petrel	*Pterodroma sandwichensis (Pterodroma phaeopygia sandwichensis)*	Endangered	N/A	Breed in MHI, and range across the central Pacific Ocean.	32 FR 4001, Simons & Hodges 1998
Laysan Albatross	*Phoebastria immutabilis*	Not Listed	N/A	Breed mainly in Hawai`i, and range across the North Pacific Ocean.	Causey 2009
Northern Fulmar	*Fulmarus glacialis*	Not Listed	N/A	Breed and range across North Pacific Ocean.	Hatch & Nettleship 2012
Short-Tailed Albatross	*Phoebastria albatrus*	Endangered	N/A	Breed in Japan and NWHI, and range across the North Pacific Ocean.	35 FR 8495, 65 FR 46643, BirdLife International 2017
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 endangered breeding population on the Pacific coast of Mexico)	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

Common name	Scientific name	ESA listing status	MMPA status	Occurrence	References
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. Pelagic stock distinct from island-associated stocks.	Perrin et al. 2009, Martien et al. 2012
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 U.S. EEZ of A. Samoa	Bradford et al. 2015
Fin Whale	*Balaenoptera physalus*	Endangered	Strategic	No known sightings but reasonably expected to occur in A. Samoa. 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
Guadalupe Fur Seal	*Arctocephalus townsendi*	Threatened	Strategic	No known sightings. Little known about their pelagic distribution. Breed mainly on Isla Guadalupe, Mexico.	50 FR 51252, Gallo-Reynoso et al. 2008, Fleischer 1987
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

Common name	Scientific name	ESA listing status	MMPA status	Occurrence	References
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
North Pacific Right Whale	*Eubalaena japonica*	Endangered[a]	Strategic	Extremely rare.	35 FR 18319, 73 FR 12024, Childerhouse et al. 2008, Wolman & Jurasz 1976, Herman & Antinoja 1977, Rice & Wolman 1978
Northern Elephant Seal	*Mirounga angustirostris*	Not Listed	Non-strategic	Females migrate to central North Pacific to feed on pelagic prey	Le Beouf et al. 2000
Pantropical Spotted Dolphin	*Stenella attenuata 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
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

Common name	Scientific name	ESA listing status	MMPA status	Occurrence	References
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 shark	*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
Scalloped hammerhead shark	*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

Common name	Scientific name	ESA listing status	MMPA status	Occurrence	References
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 depths (less than 50 m depth).	Veron 2014
Invertebrates					
Chambered nautilus	*Nautilus pompilius*	Threatened	N/A	Found in small, isolated populations throughout the Indo-Pacific on steep-sloped forereefs with sandy, silty, or muddy bottom substrates from depths of 100 m to 500 m.	83 FR 48948, CITES 2016

[a] These species have critical habitat designated under the ESA. See Table B-4.

Table B-4. 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	77 FR 4170

			from Cape Flattery, Washington to Cape Blanco, Oregon east of the 2,000 meter depth contour.	
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.

REFERENCES

Andrews, K.R., Karczmarski, L., Au, W.W.L., Rickards, S.H., Vanderlip, C.A., Bowen, B.W., Grau, E.G., and Toonen, R.J., 2010. Rolling stones and stable homes: social structure, habitat diversity and population genetics of the Hawaiian spinner dolphin (*Stenella longirostris*). *Molecular Ecology*, *19*, pp. 732-748.

Awkerman, J.A., Anderson, D.J., and Whittow, G.C., 2009. Laysan Albatross (*Phoebastria immutabilis*). *In*: Rodewald, P.G. [ed.]. The Birds of North America. Ithaca: Cornell Lab of Ornithology. Retrieved from the Birds of North America at https://birdsna.org/Species-Account/bna/species/layalb.

Backus, R.H., Springer, S., and Arnold, E.L., 1956. A contribution to the natural history of the white tip shark, *Pferdumiops kmgimunus* (Poey). *Deep-Sea Research*, *3*, pp. 178-188.

Baird, R.W., McSweeney, D.J., Bane, C., Barlow, J., Salden, D.R., Antoine, L.R.K., LeDuc, R.G. and Webster, D.L., 2006. Killer Whales in Hawaiian Waters: Information on Population Identity and Feeding Habits. *Pacific Science*, *60*(4), pp. 523-530.

Baird, R.W., Gorgone, A.M., McSweeney, D.J., Ligon, A.D., Deakos, M.H., Webster, D.L., Schorr, G.S., Martien, K.K., Salden, D.R., and Mahaffy, S.D., 2009. Population structure of island-associated dolphins: Evidence from photo-identification of common bottlenose dolphins (*Tursiops truncatus*) in the main Hawaiian Islands. *Marine Mammal Science*, *25*, pp. 251-274.

Baird, R.W., Webster, D.L., Aschettino, J.M., Schorr, G.S. and McSweeney, D.J., 2013. Odontocete cetaceans around the main Hawaiian Islands: Habitat use and relative abundance from small-boat sighting surveys. *Aquatic Mammals*, *39*(3), 253 pp.

Baker J.D., Harting, A.L., Wurth, T.A., and Johanos, T.C., 2011. Dramatic shifts in Hawaiian monk seal distribution predicted from divergent regional trends. *Marine Mammal Science*, *27*(1), pp. 78–93.

Balazs, G.H. 1979. Loggerhead turtle recovered from a tiger shark at Kure Atoll. *'Elepaio*, *39*(12), pp. 45-47.

Balazs, G.H 1982. Status of sea turtles in the central Pacific Ocean. *In:* Bjorndal, K.A. [ed.]. Biology and Conservation of Sea Turtles. *Smithsonian Institution Scholarly Press*, Washington, D.C., 583 pp.

Balazs, G.H., Craig, P., Winton, B.R. and Miya, R.K., 1994. Satellite telemetry of green turtles nesting at French Frigate Shoals, Hawaii, and Rose Atoll, American Samoa. *In:* Bjorndal, K.A., Bolten, A.B., Johnson, D.A., and Eliazar, P.J. [eds.]. Proceedings of the fourteenth annual symposium on sea turtle biology and conservation.

Balazs, G.H., Hirth, H., Kawamoto, P., Nitta, E., Ogren, L., Wass, R., and Wetherall, J., 1992. Interim Recovery Plan for Hawaiian Sea Turtles. Honolulu Lab, Southwest Fisheries Science Center, National Marine Fisheries Service, NOAA, Honolulu, HI 96822-2396. Southwest Fisheries Science Center Administrative Report H-92-01. 76 pp.

Barlow, J., 2003. Preliminary Estimates of the Abundance of Cetaceans along the U.S. West Coast, 1991-2001. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center.

Barlow, J., 2006. Cetacean abundance in Hawaiian waters estimated from a summer/fall survey in 2002. *Marine Mammal Science*, *22*(2), pp. 446-464.

Baum, J., Clarke, S., Domingo, A., Ducrocq, M., Lamónaca, A.F., Gaibor, N., Graham, R., Jorgensen, S., Kotas, J.E., Medina, E., Martinez-Ortiz, J., Monzini Taccone di Sitizano, J., Morales, M.R., Navarro, S.S., Pérez-Jiménez, J.C., Ruiz, C., Smith, W., Valenti, S.V. and Vooren, C.M., 2007. *Sphyrna lewini*. The IUCN Red List of Threatened Species 2007: e.T39385A10190088. Downloaded on 21 Feb 2017.

Baum, J.K., Medina, E., Musick, J.A., and Smale, M., 2006. *Carcharhinus longimanus*. *In*: IUCN 2007. 2007 IUCN Red List of Threatened Species.

Bester, C., 2011. Species Profile: Scalloped Hammerhead. Florida Museum of Natural History. http://www.flmnh.ufl.edu/fish/Gallery/Descript/Schammer/ScallopedHammerhead.html.

BirdLife International, 2017. Species factsheet: *Phoebastria albatrus*. Downloaded from http://www.birdlife.org on 02/04/2017.

Bonfil, R., Clarke, S., Nakano, H., Camhi, M.D., Pikitch, E.K. and Babcock, E.A., 2008. The biology and ecology of the oceanic whitetip shark, *Carcharhinus longimanus*. *In*: Camhi, M.D., Pikitch, E.K., and Babcock, E.A. [eds.]. Sharks of the Open Ocean: Biology, Fisheries, and Conservation, pp.128-139.

Bradford, A.L., Oleson, E.M., Baird, R.W., Boggs, C.H., Forney, K.A., and Young, N.C., 2015. Revised stock boundaries for false killer whales (*Pseudorca crassidens*) in Hawaiian waters. NOAA Tech. Memo. NMFS-PIFSC-47.

Bradford. A.L., K.A. Forney, E.M. Oleson, and J. Barlow. 2013. Line-transect abundance estimates of cetaceans in the Hawaiian EEZ. PIFSC Working Paper WP-13-004.

Brownell, J. R. L., W. A. Walker, and K. A. Forney. 1999. Pacific white-sided dolphin, *Lagenorhynchus obliquidens* Gill, 1865. *In*: Ridgeway, S.H., and Harrison, R. [eds.]. Handbook of marine mammals: the second book of dolphins and the porpoises. *Academic Press*, San Diego, CA.

Brueggeman, J.J., Green, G.A., Balcomb, K.C., Bowlby, C.E., Grotefendt, R.A., Briggs, K.T., Bonnell, M.L., Ford, R.G., Varoujean, D.H., Heinemann, D.and Chapman D.G., 1990. Oregon-Washington Marine Mammal and Seabird Survey: Information synthesis and hypothesis formulation. U.S. Department of the Interior, OCS Study MMS 89-0030.

Caldwell, D.K. and Caldwell, M.C., 1989. Pygmy sperm whale *Kogia breviceps* (de Blainville, 1838)/dwarf sperm whale *Kogia simus* (Owen, 1866). Handbook of marine mammals, *4*, pp. 235-260.

Childerhouse, S., J. Jackson, C. S. Baker, N. Gales, P. J. Clapham, and R. L. Brownell, Jr., 2008. *Megaptera novaeangliae*, Oceania subpopulation. IUCN Red List of Threatened Species http://www.iucnredlist.org/details/132832.

CITES (2016) Consideration of proposals for amendment of Appendices I and II: Nautilidae Convention on International Trade in Endangered Species of Wild Fauna and Flora; Seventeenth meeting of the Conference of the Parties; 24 September – 5 October 2016, Johannesburg, South Africa

Cliffton, K., Cornejo, D.O., and Felger, R.S., 1982. Sea turtles of the Pacific coast of Mexico. *In:* Bjorndal, K.A. [ed.]. Biology and Conservation of Sea Turtles. Smithsonian Inst. Press, Washington, D.C., 583 pp.

Compagno, L.J.V., 1984. FAO Species Catalogue. Vol. 4. Sharks of the World. An Annotated and Illustrated Catalogue of Shark Species Known to Date. Carcharhiniformes. FAO Fish Synop 124, Vol. 4, Part 2.

Craig, P., 2005. Natural history guide to American Samoa. National Park of American Samoa, Department of Marine and Wildlife Resources, American Samoa Community College.

Dalebout, M.L., Baker, C.S., Anderson, R.C., Best, P.B., Cockcroft, V.G., Hinsz, H.L., Peddemors, V. and Pitman, R.L., 2003. Appearance, distribution, and genetic distinctiveness of Longman's beaked whale, *Indopacetus pacificus*. *Marine Mammal Science*, *19*(3), pp. 421-461.

Dewar, H., Mous, P., Domeier, M., Muljadi, A., Pet, J., and Whitty, J., 2008. Movements and site fidelity of the giant manta ray, *Manta birostris*, in the Komodo Marine Park, Indonesia. *Marine Biology*, *155*, pp. 121-133.

Dodd, C.K., 1990. *Caretta caretta* (Linnaeus) Loggerhead Sea Turtle. Catalogue of American *Amphibians and Reptiles*, pp. 483.1-483.7.

Eckert, K.L., B.P. Wallace, J.G. Frazier, S.A. Eckert, and P.C.H. Pritchard. 2012. Synopsis of the biological data on the leatherback sea turtle (*Dermochelys coriacea*). U.S. Department of Interior, Fish and Wildlife Service, Biological Technical Publication BTP-R4015-2012, Washington, D.C.

Fleischer, L.A., 1987. Guadalupe fur seal, *Arctocephalus townsendi*. *In*: Croxall, J.P. and Gentry R.L. [eds.]. Status, biology, and ecology of fur seals. National Oceanic and Atmospheric Association, Technical Report, National Marine Fisheries Service 51, pp. 1-212.

Gallo-Reynoso, J.P., Figueroa-Carranza, A.L. and Le Boeuf, B.J., 2008. Foraging behavior of lactating Guadalupe fur seal females. *In*: Lorenzo, C., Espinoza, E., and Ortega, J. [eds.].

Avances en el Estudio de los Mamíferos de México. *Publicaciones Especiales*, *2*, pp. 595-614.

Garrigue, C., Franklin, T., Russell, K., Burns, D., Poole, M., Paton, D., Hauser, N., Oremus, M., Constantine, R., Childerhouse, S., Mattila, D., Gibbs, N., Franklin, W., Robbins, J., Clapham, P., and Baker, C.S., 2007. First assessment of interchange of humpback whales between Oceania and the east coast of Australia. International Whaling Commission, Anchorage, Alaska. SC/59/SH15.

Gelatt, T., Ream, R., and Johnson, D., 2015. *Callorhinus ursinus*. The IUCN Red List of Threatened Species 2015:e.T3590A45224953. Available at http://www.iucnredlist.org/details/3590/0.

Grant, G.S. 1994. Juvenile leatherback turtle caught by longline fishing in American Samoa. *Marine Turtle Newsletter*, *66*, pp. 3-5.

Hall, J., 1979. A survey of cetaceans of Prince William Sound and adjacent waters - their numbers and seasonal movements. Unpubl. rep. to Alaska Outer Continental Shelf Environmental Assessment Programs. NOAA OCSEAP Juneau Project Office, Juneau, AK. 37 pp.

Hamilton, T.A., Redfern, J.V., Barlow, J., Balance, L.T., Gerrodette, T., Holt, R.S., Forney, K.A., and Taylor, B.L., 2009. Atlas of cetacean sightings for Southwest Fisheries Science Center Cetacean and Ecosystem Surveys: 1986-2005. U.S. Dep. of Commerce, NOAA Technical Memorandum, NOAA-TM-NMFSSWFSC-440. 70 pp.

Herman, L.M. and Antinoja, R.C., 1977. Humpback whales in the Hawaiian breeding waters: Population and pod characteristics. *Scientific Reports of the Whales Research Institute*, *29*, pp. 59-85.

Herman, L. M., C. S. Baker, P. H. Forestell, and R. C. Antinoja. 1980. Right whale, *Balaena glacialis*, sightings near Hawaii: a clue to the wintering grounds? *Marine Ecology Progress Series*, 2, pp. 271-275.

Heyning, J.E. 1989. Cuvier's beaked whale, *Ziphius cavirostris* (Cuvier, 1823). pp. 289-308. *In*: S.H. Ridgway and R. Harrison (eds.) Handbook of Marine Mammals. Vol. 4. River Dolphins and the Larger Toothed Whales. *Academic Press*, London and San Diego. 442 pp.

Hill, M.C., Oleson, E.M., and Andrews, K.R., 2010. New island-associated stocks for Hawaiian spinner dolphins (*Stenella longirostris longirostris*): Rationale and new stock boundaries. Pacific Islands Fisheries Science Center Admin Report H-10-04, 12 pp.

Johnston, D.W., Robbins, J., Chapla, M.E., Mattila, D.K. and Andrews, K.R., 2008. Diversity, Johnston, D.W., Robbins, J., Chapla, M.E., Mattila, D.K. and Andrews, K.R., 2008. Diversity, habitat associations and stock structure of odontocete cetaceans in the waters of American Samoa, 2003-2006. *Journal of Cetacean Research and Management*, *10*(1), pp. 59-66.

Karczmarski, L., Würsig, B., Gailey, G., Larson, K.W., and Vanderlip, C., 2005. Spinner dolphins in a remote Hawaiian atoll: social grouping and population structure. *Behavioral Ecology*, *16*, pp. 675-685.

Karl, S.A. and Bowen, B.W., 1999. Evolutionary significant units versus geopolitical taxonomy: molecular systematics of an endangered sea turtle (genus *Chelonia*). *Conservation Biology*, *13*, pp. 990–999.

Katahira, L.K., C.M. Forbes, A.H. Kikuta, G.H. Balazs, and M. Bingham. 1994. Recent findings and management of hawksbill turtle nesting beaches in Hawaii. *In:* Bjorndal, K.A, Bolton, A.B., Johnson, D.A., and Eliazar, P.J. [eds.], Proc. of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-351, 323 pp.

Klimley, A.P., 1993. Highly directional swimming by scalloped hammerhead sharks, *Sphyrna lewini*, and subsurface irradiance, temperature, bathymetry, and geomagnetic field. *Marine Biology*, *117*(1), pp. 1-22.

Kolinski, S.P., Parker, D.M., Ilo, L.I., and Ruak, J.K, 2001. An assessment of sea turtles and their marine and terrestrial habitats at Saipan, Commonwealth of the Northern Mariana Islands. *Micronesica*, 34, pp. 55-72.

Le Boeuf, B.J., Crocker, D.E., Costa, D.P., Blackwell, S.B., Webb, P.M. and Houser, D.S. 2000. Foraging ecology of northern elephant seals. *Ecological Monographs*, *70*(3), pp. 353-382.

Lee, T. 1993. Summary of cetacean survey data collected between the years of 1974 and 1985. NOAA Tech.Mem. NMFS 181, 184 pp.

Leatherwood, J.S. and Dahlheim, M.E., 1978. Worldwide distribution of pilot whales and killer whales. Naval Ocean System Center Technical Report 443, pp. 1-39.

Leatherwood, S., Reeves, R.R., Perrin, W.F., and Evans, W.E. 1982. Whales, dolphins, and porpoises of the North Pacific and adjacent arctic waters. NOAA Tech. Rep. NMFS Circ. No. 444.

Mallory M.L., Hatch, S.A., and Nettleship, D.N. 2012. Northern Fulmar (*Fulmarus glacialis*). *In*: Rodewald, P.G. [ed.]. The Birds of North America. Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America at https://birdsna.org/Species-Account/bna/species/norful.

Marshall, A., L.J.V. Compagno, and M.B. Bennett. 2009. Redescription of the genus Manta with resurrection of *Manta alfredi* (Krefft, 1868) (Chondrichthyes; Myliobatoidei; Mobulidae). *Zootaxa*, *2301*, pp. 1-28.

Marshall, A., Bennett, M.B., Kodja, G., Hinojosa-Alvarez, S., Galvan-Magana, F., Harding, M., Stevens, G., and Kashiwagi, T., 2011. *Manta birostris*. The IUCN Red List of Threatened Species 2011: e.T198921A9108067.

Martien, K.K., Baird, R.W., Hedrick, N.M., Gorgone, A.M., Thieleking, J.L., McSweeney, D.J., Robertson, K.M. and Webster, D.L. 2012. Population structure of island‐associated dolphins: Evidence from mitochondrial and microsatellite markers for common bottlenose dolphins (*Tursiops truncatus*) around the main Hawaiian Islands. *Marine Mammal Science*, 25(3), pp. 208-232.

McSweeney, D.J., Baird, R.W., and Mahaffy, S.D., 2007. Site fidelity, associations and movements of Cuvier's (*Ziphius cavirostris*) and Blainville's (*Mesoplodon densirostris*) beaked whales off the island of Hawaiʻi. *Marine Mammal Science*, 23, pp. 666-687.

McSweeney, D.J., Baird, R.W., Mahaffy, S.D., Webster, D.L., and Schorr, G.S. 2009. Site fidelity and association patterns of a rare species: Pygmy killer whales (*Feresa attenuata*) in the main Hawaiian Islands. *Marine Mammal Science*, 25, pp. 557-572.

Mead, J.G., 1989. Beaked whales of the genus *Mesoplodon*. *In*: Ridgeway, S.H. & Harrison, R. [eds.]. Handbook of marine mammals. Volume 4. River dolphins and the larger toothed whales. Academic Press Ltd: London, 452 pp.

Mitchell, E., 1975. Report on the meeting on smaller cetaceans, Montreal, April 1-11, 1974. *Journal of the Fisheries Research Board of Canada*, *32*(7), pp. 914-916

Mobley, J.R. Jr., Spitz, S.S., Forney, K.A., Grotenfendt, R., and Forestell, P.H., 2000. Distribution and abundance of odontocete species in Hawaiian waters: preliminary results of 1993-98 aerial surveys. Southwest Fisheries Science Center Administrative Report LJ-00–14C. La Jolla, CA 92037. 26 pp.

Nagorsen, D., 1985. *Kogia simus*. *Mammalian Species*, *239*, pp. 1-6.

NMFS and USFWS, 1998. Recovery Plan for U.S. Pacific Populations of the Leatherback Turtle (*Dermochelys coriacea*). National Marine Fisheries Service, Silver Spring, MD. 77 pp.

NMFS and USFWS, 2007. Hawksbill Sea Turtle (*Eretmochelys imbricata*) 5-Year Review: Summary and Evaluation. National Marine Fisheries Service, Silver Spring, Maryland, and U.S. Fish and Wildlife Service Jacksonville, Florida. 90 pp.

Norris, K.S. and Dohl, T.P., 1980. Behavior of the Hawaiian spinner dolphin, *Stenella longirostris*. *Fisheries Bulletin*, *77*, pp. 821-849.

Norris, K.S., B. Würsig, B., Wells, R.S., and Würsig, M., 1994. The Hawaiian Spinner Dolphin. *University of California Press*, 408 pp.

Northrop, J., Cummings, W.C., and Morrison, M.F. 1971. Underwater 20-Hz signals recorded near Midway Island. *Journal of the Acoustical Society of America*, 49, pp. 1909-1910.

Oleson, E.M., Boggs, C.H., Forney, K.A., Hanson, M.B., Kobayashi, D.R., Taylor, B.L., Wade, P.R., and Ylitalo, G.M., 2010. Status Review of Hawaiian Insular False Killer Whales (*Pseudorca crassidens*) under the Endangered Species Act. U.S. Dep. Commer. NOAA Tech Memo., NOAA-TM-NMFS-PIFSC-22. 140 pp.

Oleson, E.M., Baird, R.W., Martien, K.K., and Taylor, B.L., 2013. Island-associated stocks of odontocetes in the main Hawaiian Islands: A synthesis of available information to facilitate evaluation of stock structure. PIFSC Working Paper WP-13-003. 41 pp.

Olson, P.A., Ensor, P., Olavarria, C., Bott, N., Constantine, R., Weir, J., Childerhouse, S., van der Linde, M., Schmitt, N., Miller, B.S. and Double, M.C., 2015. New Zealand Blue Whales: Residency, Morphology, and Feeding Behavior of a Little-Known Population. *Pacific Science*, *69*(4), pp. 477-485.

Perrin, W.F., Wursig, B., and Thewissen J.G.M. [eds.], 2009. Encyclopedia of marine mammals. *Academic Press*.

Perryman, W.L., Au, D.W.K., Leatherwood, S., and Jefferson, T.A., 1994. Melon-headed whale *Peponocephala electra* Gray, 1846. *In*: Ridgway, S.H. and Harrison, R. [eds.]. Handbook of Marine Mammals, Volume 5. The first book of dolphins. *Academic Press*, London, U.K.

Pitman, R.L. 1990. Pelagic distribution and biology of sea turtles in the eastern tropical Pacific. *In*: Richardson, T.H., Richardson, J.I., and Donnelly, M. [eds.]. Proc. of the Tenth Annual Workshop on Sea Turtle Biology and Conservation. U.S. Dep. of Comm., NOAA Tech. Memo. NMFS-SEFC-278. 286 pp.

Pyle, R.L., and Pyle, P., 2009. The Birds of the Hawaiian Islands: Occurrence, History, Distribution, and Status. B.P. Bishop Museum, Honolulu, Hawaii. Version 1 (31 December 2009). Accessed from http://hbs.bishopmuseum.org/birds/rlp-monograph.

Rankin, S. and Barlow, J., 2005. Source of the North Pacific "boing" sound attributed to minke whales. *Journal of the Acoustical Society of America*, *118*(5), pp. 3346-3335

Reeves, R.R., Leatherwood, S., Stone, G.S., and Eldredge, L.G., 1999. Marine Mammals in the Area Served by the South Pacific Regional Environment Program. Report of the South Pacific Regional Environment Program (P.O. Box 240, Apia, Samoa). 48 pp.

Reeves, R.R., Leatherwood, S., and Baird, R.W., 2009. Evidence of a possible decline since 1989 in false killer whales (*Pseudorca crassidens*) around the main Hawaiian Islands. *Pacific Science*, *63*(2), pp. 253–261.

Rice, D.W., 1960. Distribution of the bottle-nosed dolphin in the leeward Hawaiian Islands. *Journal of Mammalogy*, *41*(3), pp. 407-408.

Rice, D. W., and A. A. Wolman. 1984. Humpback whale census in Hawaiian waters—February 1977. *In:* Norris, K.S., and Reeves, R.R. (eds.). Report on a workshop on problems related to humpback whales (*Megaptera novaeangliae*) in Hawaii. Final report to the Marine Mammal Commission, U.S. Department of Commerce, NTIS PB-280-794.

Ross, G.J.B. and Leatherwood, S., 1994. Pygmy killer whale *Feresa attenuata* (Gray, 1874). Handbook of Marine Mammals, Volume 5, pp. 387-404.

Rowntree, V., Darling, J., Silber, G., and M. Ferrari, M., 1980. Rare sighting of a right whale (*Eubalaena glacialis*) in Hawaii. *Canadian Journal of Zoology*, *58*, pp. 308-312.

Sanches, J.G., 1991. Catálogo dos principais peixes marinhos da República de Guiné-Bissau. Publicações avulsas do I.N.I.P. No. 16. 429 pp. as cited in Froese, R. and D. Pauly, Editors. 2000. FishBase 2000: concepts, design and data sources. ICLARM, Los Baños, Laguna, Philippines. 344 pp.

Schorr, G.S., Baird, R.W., Hanson, M.B., Webster, D.L., McSweeney, D.J., and Andrews, R.D., 2009. Movements of satellite-tagged Blainville's beaked whales off the island of Hawai'i. *Endangered Species Research*, *10*, pp. 203-213.

Schulze-Haugen, M. and Kohler, N.E. [eds.], 2003. Guide to Sharks, Tunas, & Billfishes of the U.S. Atlantic and Gulf of Mexico. RI Sea Grant/National Marine Fisheries Service.

Shallenberger, E.W., 1981. The status of Hawaiian cetaceans. Marine Mammal Commission Report No. MMC–77/23 (NTIS PB82–109398).

Stafford, K.M., Nieukirk, S.L., and Fox, C.G., 2001. Geographic and seasonal variation of blue whale calls in the North Pacific. *Journal of Cetacean Research and Management*, *3*, pp. 65-76.

Strasburg, D.W., 1958. Distribution, abundance, and habits of pelagic sharks in the central Pacific Ocean. *Fishery Bulletin*, *138*(58), pp. 335-361.

Thompson, P.O., and Friedl, W.A., 1982. A long-term study of low frequency sounds from several species of whales off Oahu, Hawaii. *Cetology*, *45*, pp. 1-19.

Tuato'o-Bartley, N., Morrell, T.E., and Craig, P., 1993. Status of sea turtles in American Samoa in 1991. *Pacific Science*, *47*(3), pp. 215-221.

Utzurrum, R., 2002. Sea turtle conservation in American Samoa. *In:* Kinan, I. [ed.]. Proceedings of the western Pacific sea turtle cooperative research and management workshop.

Veron, J.E.N., 2014. Results of an update of the Corals of the World Information Base for the Listing Determination of 66 Coral Species under the Endangered Species Act. Report to the Western Pacific Regional Fishery Management Council, Honolulu, Hawaii.

Wolman, A.A. and Jurasz, C.M., 1977. Humpback whales in Hawaii: Vessel Census, 1976. *Marine Fisheries Review*, *39*(7), pp. 1-5.