ANNUAL STOCK ASSESSMENT AND FISHERY EVALUATION (SAFE) REPORT: HAWAII ARCHIPELAGO FISHERY ECOSYSTEM PLAN 2015

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

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

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Executive Summary

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

The fishery performance section of this report presents general descriptions of the local commercial fisheries including the deep-7 bottomfish, non deep-7 bottomfish, and coral reef, crustacean, mollusk and limu management unit species (MUS). The data collection systems for each fishery are then explained. The fishery statistics are organized into a summary dashboard tables showcasing the values for the most recent fishing year and the percent change between short-term (10 years) and long-term (20 years) averages. Time series for historical fishing parameters, top species catch by gear, and total catch parameters by gear are also provided. For 2015 catch in Hawaii, crustaceans and mollusks exceeded allowable biological catch (ABC), and annual catch limit (ACL) but remained below the overfishing limit (OFL). All other MUS catch for this year fell below these limits.

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

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

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

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

The 2015 Annual Report includes an inaugural section on indicators of current and changing climate and related oceanic conditions in the geographic areas for which the Western Pacific

Regional Fishery Management Council has responsibility. In developing this section, the Council relied on a number of recent reports conducted in the context of the U.S. National Climate Assessment including, most notably, the 2012 Pacific Islands Regional Climate Assessment and the Ocean and Coasts chapter of the 2014 report on a Pilot Indicator System prepared by the National Climate Assessment and Development Advisory Committee. The primary goal for selecting the indicators used in this report is to provide fisheries-related communities, resource managers and businesses with climate-related situational awareness. In this context, indicators were selected to be fisheries relevant and informative, build intuition about current conditions in light of changing climate, provide historical context and recognize patterns and trends. The atmospheric concentration of carbon dioxide (CO_2) trend is increasing exponentially with the 2015 time series maximum at 400.83 ppm. The oceanic pH is decreasing at a rate of 0.039 pH units per year, equivalent to 0.4% increase in acidity per year. A strong El Niño was present with sea surface temperature in waters surrounding most of the Hawaiian Islands ranging between 26º and 37º C on leeward shores with waters on the windward shores ranging between 25-26ºC, reflecting a positive anomaly in all waters ranging from 0.5-1.0º C. In 2015, sea level in Honolulu was slightly above the mean sea level trend which continues to increase annually. This 2015 increase in Hawaii is highly correlated with El Niño. The year also saw an abundance of tropical cyclones including 18 named storms and nine major hurricanes in the eastern Pacific. This is the first year since reliable record keeping began in 1971 that the eastern Pacific saw nine major hurricanes. Wave forcing can have major implications for coastal ecosystems and pelagic fishing operations. Significant wave heights varied from between 1.0 - 2.0 m on the Big Island highest off the southern and eastern shores with Maui and Oahu showing a range between 1.0 - 1.5 m and Kauai showing a range between 1.5 - 2.0 m.

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

The marine planning section of this report tracks activities with multi-year planning horizons and begins to track the cumulative impact of established facilities. Development of the report in later years will focus on identifying appropriate data streams. In the Hawaii Archipelago, alternative energy development and military activities take center stage as activities with potential fisheries impact. The Bureau of Ocean Energy Management released a Request for Information and Notice of Intent in the summer of 2016 regarding the suitability of proposed Wind Lease Areas for floating wind farm development. The Department of Defense is expected to release a draft environmental impact statement regarding training and testing activities in spring of 2017.

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Acronyms and Abbreviations

ABC	Acceptable Biological Catch
ACE	Accumulated Cyclone Energy
ACL	Annual Catch Limits
ACT	Annual Catch Target
AM	Accountability Measures
AVHRR	Advanced Very High Resolution Radiometer
BAC-MSY	Biomass Augmented Catch MSY
B_{FLAG}	warning reference point for biomass
BiOp	Biological Opinion
BMUS	Bottomfish Management Unit Species
BOEM	Bureau of Ocean Energy Management
BSIA	Best Scientific Information Available
CFR	Code of Federal Regulations
CMLS	Commercial Marine License System
CMS	coastal and marine spatial
CMUS	Crustacean Management Unit Species
CNMI	Commonwealth of the Northern Mariana Islands
CPUE	Catch Per Unit Effort
CRED	Coral Reef Ecosystem Division
CREMUS	Coral Reef Ecosystem Management Unit Species
DLNR-DAR	Department of Land and Natural Resources-Division of Aquatic Resources
DPS	Distinct Population Segment

EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EKE	Eddy kinetic energy
ENSO	El Niño Southern Oscillation
EO	Executive Order
ESA	Endangered Species Act
FEP	Fishery Ecosystem Plan
FMP	Fishery Management Plan
FRS	Fishing Report System
GAC	Global Area Coverage
GFS	global forecast system
HAPC	Habitat Area of Particular Concern
HDAR	Hawaii Division of Aquatic Resources
IBTrACS	International Best Track Archive for Climate Stewardship
LOF	List of Fisheries
LVPA	Large Vessel Prohibited Area
MFMT	Maximum Fishing Mortality Threshold
MHI	Main Hawaiian Island
MMA	marine managed area
MMPA	Marine Mammal Protection Act
MPA	marine protected area
MPCC	Marine Planning and Climate Change
MPCCC	Council's MPCC Committee
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
MSST	Minimum Stock Size Threshold
MSY	Maximum Sustainable Yield
MUS	management unit species
NCADAC	National Climate Assessment & Development Advisory Committee
NCDC	National Climatic Data Center
NEPA	National Environmental and Policy Act
NESDIS	National Environmental Satellite, Data, and Information Service
NMFS	National Marine Fisheries Service
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NWHI	Northwestern Hawaiian Islands
OFL	Overfishing Limits
OFR	Online Fishing Report
ONI	Ocean Niño Index
OR&R	Office of Response and Restoration
OY	Optimum Yield
PacIOOS	Pacific Integrated Ocean Observing System
PCMUS	Precious Coral Management Unit Species
Pelagic FEP	Fishery Ecosystem Plan for the Pacific Pelagic Fisheries

PI	Pacific Islands
PIBHMC	Pacific Island Benthic Habitat Mapping Center
PIFSC	Pacific Island Fisheries Science Center
PIRCA	Pacific Islands Regional Climate Assessment
PIRO	NOAA NMFS Pacific Islands Regional Office
PMUS	pelagic management unit species
POES	Polar Operational Environmental Satellite
PRIA	Pacific Remote Island Areas
RAMP	Reef Assessment and Monitoring Program
RPB	Regional Planning Body
SAFE	Stock Assessment and Fishery Evaluation
SBRM	Standardized Bycatch Reporting Methodologies
SDC	Status Determination Criteria
SEEM	Social, Economic, Ecological, Management uncertainties
SPC	Stationary Point Count
SST	Sea Surface Temperature
TAC	Total Allowable Catch
USACE	United States Army Corps of Engineers
WPacFIN	Western Pacific Fishery Information Network
WPRFMC	Western Pacific Regional Fishery Management Council
WPSAR	Western Pacific Stock Assessment Review
WW3	Wave Watch 3

1 FISHERY PERFORMANCE

1.1 Deep-7 BMUS

1.1.1 Fishery Descriptions

The State of Hawaii, Department of Land and Natural Resources, Division of Aquatic Resources manages the deep-sea bottomfish fishery in the Main Hawaiian Islands (MHI) under a joint management arrangement with the National Marine Fisheries Service (NMFS), Pacific Islands Regional Office (PIRO) and the Western Pacific Regional Fishery Management Council (WPRFMC).

The State collects the fishery information, the NMFS analyzes this information, the Council, working with the State, proposes the management scheme. Lastly, the NMFS implements the scheme into federal regulations and the State adopts the state regulations. These three agencies coordinate their management to simplify the regulations for the fishing public, to prevent overfishing, and manage the fishery for long-term sustainability. This shared management responsibility is necessary because the bottomfish complex of species occurs in both State and Federal waters. The information in this report is largely based on the State collected data.

1.1.2 Data Collection Systems

The collection of commercial main Hawaiian Islands Deep-7 bottomfish fishing reports comes from two sources: paper report received by mail or fax or pdf copy of it via e-mail; and report filed online through the Online Fishing Report system (OFR) at dlnr.ehawaii.gov/cmls-fr. Since the federal management of the Deep-7 bottomfish fishery began in 2007, the bottomfish landings have been collected on three types of fishing reports. Bottomfishers were required to use the Monthly Fishing Report and Deep-sea Handline Fishing Trip Report to report their Deep-7 landings within 10 days after the end of the month. These reports were replaced by the MHI Deep-7 Bottomfish Fishing Trip Report on September 2011, and bottomfish fishers were required to submit the trip report within five days after the trip end date. DLNR-DAR implemented the OFR online website on February 2010.

Paper fishing reports received through mail by DLNR-DAR are initially processed by an office assistant that date stamps the report, scans the report image and enters the report header as index information into an archival database application to store the report image and header index into database files. The report header index information is downloaded in a batch text file via FTP at 12:00 AM for transmission to the web portal vendor that maintains the Commercial Marine Licensing System (CMLS). This information updates the fisher's license report log in the CMLS to credit submission of the fishing report. The web portal vendor also exports a batch text file extract of the updated license profile and report log data file via FTP on a daily basis at 2:00 AM for transmission to DLNR-DAR. The office assistant checks reports for missing information, and then sorts by fishery form type (e.g. Deep-7 or monthly fishing report) and distributes it to the appropriate database assistant by the next business day. Database assistants and the data monitoring associate will enter the Deep-sea Handline Fishing Trip Report into the DLNR-DAR Fishing Report System (FRS) database, and the other report types through the Online Fishing Reporting System (OFR) within two business days.

The data records from fishing reports submitted online by fishers are automatically extracted and exported as daily batch text files from the OFR and uploaded by DLNR-DAR and imported into the FRS database on the following business day.

The FRS processes the data, and a general error report is run daily by the data supervisor. A database assistant will contact the fisher when clarification of the data is needed. Duplicate data checks are run weekly, and then researched by a database assistant. Discrepancies between dealer and catch data are checked monthly by a fisheries database assistant. The assistant will call the fisher or dealer to clarify any discrepancies. The data supervisor then transfers both fisheries and dealer data to WPACFIN daily; data trends are reported weekly to Deep-7 fishery managers and stake holders; and a Bottomfish newsletter is published for bottomfishers and fish dealers on a quarterly basis.

1.1.2.1 Historical Summary

Table 1. Annual fishing parameters for the Deep-7 bottomfish fishery comparing current values with short-term (10 years) and long-term (20 years) averages. Values are for the fishing year.

			2015 Comparative Trends	
Fishery	**Parameters**	**2015 Values**	Short Average (10 years)	Long Average (20 years)
BMUS Deep-7	No. License	403	↓ 3.6%	↓ 7.5%
	Trips	2,652	↓ 7.6%	↓ 17.0%
	No. Caught	84,593	↑ 33.9%	↑ 20.1%
	Lbs. Caught	287,952	↑22.5%	↑ 14.7%

1.1.2.2 Species Summary

Table 2. . Annual species indicators for the Deep-7 bottomfish fishery comparing current estimates with the short-term (10 years) and the long-term (20 years) average. Values are for the fishing year.

Fishery	Species	2015 Parameters	2015 Comparative Trends	
		Catch (lbs) Effort (trips) CPUE (lbs/trip)	Short Average (10 years)	Long Average (20 years)
BMUS Deep-7	Opakapaka	142,608 1,815 78.6	↑ 27.5% ↓ 0.6% ↑ 28.2%	↑ 15.5% ↓ 11.4% ↑ 30.4%
	Onaga	75,459 1,118 67.5	↑ 10.5% ↓ 4.9% ↑ 16.1%	↑ 11.7% ↓ 9.9% ↑ 23.9%
	Ehu	29,810 1,240 24.0	↑ 24.6% ↓ 2.1% ↑ 27.3%	↑ 24.8% ↓ 6.1% ↑ 32.9%
	Kalekale	16,787 952 17.6	↑ 76.1% ↑ 31.2% ↑ 34.2%	↑ 30.7% ↑ 14.2% ↑ 14.5%
	Lehi	11,917 465 25.6	↑ 23.6% ↑ 20.2% ↑ 2.8%	↑ 21.7% ↑ 10.7% ↑ 9.9%
	Hapu'upu'u	8,726 283 30.8	↓ 1.0% ↓ 24.0% ↑ 30.2%	↓ 17.4% ↓ 43.1% ↑ 45.0%
	Gindai	2,645 367	↓ 9.5% ↓ 6.8%	↓ 10.7% ↓ 13.2%

		7.2	↓ 2.9%	↑ 2.8%

1.1.3 Time Series Statistics

1.1.3.1 Commercial Fishing Parameters

The time series format for the Deep-7 bottomfish fishery begins with an arrangement by the state fiscal year period (July – June) until June 1993. Prior to July 1993, the state issued and renewed the Commercial Marine License (CML) on a fiscal year basis and all licenses expired on June 30, regardless of when it was issued. During that period, the fisher received a different CML number. This will allow the reporting of un-duplicated count of licensees until June 1993. The state issued and renewed permanent CML numbers effective July 1993. The federal Deep-7 bottomfish fishing year - which is defined from September through August of the following year - was established in 2007. In order to evaluate Deep-7 bottomfish fishing trends, the time series format was re-arranged with the September through August period beginning with September 1993 until August 2015. This arrangement provides a 22-year time series trend for the Deep-7 bottomfish fishery. There is a two-month segment including July 1993 through August 1993 that is defined as a separate period.

Early in the time series, this artisan fishery is dominated by highliners with large landings. Beginning in Fiscal 1966, less than 100 fishers made just over 1,000 trips, but attained the highest CPUE at 178 pounds per trip. With the expansion of the small vessel fleet during the 70’s and 80’s, effort and landings increased until it peaked in the late-80’s at 6,253 trips and 559,293 lbs. In June 1993, the state established bottomfish fish regulation including bottomfish restricted fishing areas, vessel registration identification, and non-commercial bag limit. Fishing effort and landings further declined from that time. Since the implementation of the federal Deep-7 bottomfish management, the landings has been under the control of the former total annual catch (TAC) and now annual catch limit (ACL) fishing quotas.

Table 3. Time series of commercial fishermen reports for Deep-7 BMUS fishery (1966-2015). Historical record reported in fiscal year from 1966-1993 and switches to fishing year from 1994-2015. July andAugust 1993 omitted to allow for this change.

Year	No. License	Trips	No. Reports	No. Caught	Lbs. Caught
1966	92	1,055	284	71,844	181,629
1967	110	1,469	353	63,974	231,315
1968	121	1,193	382	49,613	194,851
1969	132	1,216	392	47,252	177,381
1970	139	1,150	387	40,080	158,195
1971	167	1,254	463	36,440	135,156
1972	218	1,929	654	55,860	228,375

Year	No. License	Trips	No. Reports	No. Caught	Lbs. Caught
1973	210	1,574	637	38,798	169,273
1974	264	2,163	723	58,149	225,767
1975	247	2,094	751	55,410	221,385
1976	303	2,265	902	60,930	250,295
1977	338	2,722	996	72,782	274,299
1978	434	2,658	1,359	84,261	307,672
1979	447	2,255	1,318	69,828	273,846
1980	461	2,853	1,338	59,919	244,219
1981	486	3,769	1,419	77,978	308,296
1982	451	3,917	1,429	79,158	329,470
1983	539	4,875	1,766	93,632	409,241
1984	554	4,467	1,739	81,266	341,067
1985	551	5,753	1,935	115,311	484,042
1986	605	5,748	2,132	140,826	509,123
1987	581	5,572	1,896	163,238	579,170
1988	550	6,033	1,764	157,889	566,724
1989	564	6,253	1,850	136,371	559,293
1990	531	5,249	1,853	110,547	455,802
1991	499	4,213	1,741	84,390	328,870
1992	488	4,509	1,703	102,089	371,260
1993	450	3,551	1,519	73,372	265,299
1994	518	3,882	1,658	95,453	317,192
1995	525	3,921	1,791	93,332	320,940
1996	519	3,999	1,747	94,786	295,927
1997	500	4,189	1,619	91,750	307,750

Year	No. License	Trips	No. Reports	No. Caught	Lbs. Caught
1998	520	4,119	1,735	91,066	290,100
1999	430	3,008	1,368	62,344	214,122
2000	497	3,929	1,677	91,923	311,610
2001	457	3,572	1,571	74,650	265,764
2002	388	2,856	1,266	56,642	209,351
2003	364	2,951	1,202	63,347	246,814
2004	331	2,650	1,098	57,429	208,888
2005	351	2,704	1,160	61,566	241,911
2006	352	2,270	1,132	45,427	189,598
2007	356	2,551	1,195	50,218	204,813
2008	353	2,358	1,213	49,445	196,903
2009	477	3,272	1,653	67,083	259,207
2010	461	2,798	1,591	56,757	208,174
2011	472	3,475	1,656	74,783	273,239
2012	479	3,106	1,619	67,989	226,701
2013	458	2,988	1,600	68,451	239,118
2014	423	3,172	1,529	90,098	310,287
2015	403	2,652	1,425	84,593	287,952
10 yr ave	418	2,869	1,435	63,182	234,995
20 yr ave	436	3,194	1,471	70,454	251,061

1.1.4 Top 4 Species Per Gear Type

1.1.4.1 Deep-sea Handline

The heavy tackle, deep-sea handline gear is the dominant method for this fishery. The opakapaka and onaga are the primary target species, with the latter requiring much more fishing skill. In recent years, bottomfishers have remarked that opakapaka is the preferred target due to less fishing grounds and because it is easier to land for what is now a one-day fishery.

Table 4. HDAR MHI Fiscal Annual Deep-7 Catch (Lbs. caught) Summary (1966-2015) by Species and top Gear: Deep-sea handline. Historical record reported in fiscal year from 1966-93 and switches to fishing year from 1994-2015. July and August 1993 omitted to allow for this change.

	Opakapaka		**Onaga**		**Ehu**		**Hapuupuu**	
Year	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1966	76	70,651	34	63,965	47	17,587	49	11,644
1967	96	120,888	43	68,442	62	18,350	60	10,624
1968	97	83,983	62	69,504	68	19,864	58	11,304
1969	115	85,663	48	53,839	68	16,088	60	10,881
1970	114	69,538	44	43,540	62	15,870	64	19,842
1971	130	59,002	53	39,213	78	15,255	81	14,471
1972	184	117,426	71	58,673	105	21,282	112	16,659
1973	175	93,197	68	35,584	94	14,524	117	14,828
1974	220	134,838	86	43,607	113	21,113	117	14,444
1975	199	114,571	94	45,016	113	21,136	108	23,078
1976	224	101,618	118	78,684	105	21,621	140	21,236
1977	255	98,398	100	82,049	144	32,530	130	26,769
1978	345	149,538	135	66,124	191	34,385	197	27,366
1979	306	140,303	133	51,601	190	20,859	184	28,053
1980	344	147,342	161	29,889	183	15,836	182	16,984
1981	386	193,944	153	42,659	207	20,754	188	16,056
1982	370	173,798	177	65,235	233	24,088	189	20,854
1983	422	226,589	240	71,687	277	27,450	209	31,733
1984	395	153,157	239	84,601	281	35,216	208	26,289
1985	437	196,016	296	162,305	308	40,325	250	30,960
1986	475	171,581	343	194,172	368	59,768	241	23,593
1987	454	254,234	287	173,638	320	45,258	175	27,703

Year	Opakapaka		Onaga		Ehu		Hapuupuu	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1988	445	299,861	272	156,077	296	41,010	194	10,039
1989	436	306,607	302	142,829	318	37,110	184	13,288
1990	419	209,597	307	141,419	312	37,326	176	13,488
1991	385	137,378	276	103,176	301	31,260	169	15,554
1992	375	174,143	253	95,363	308	33,331	165	17,915
1993	346	138,439	194	52,706	256	25,588	167	15,721
1994	393	175,859	241	71,970	287	22,515	190	10,925
1995	427	179,674	236	65,906	289	26,001	230	15,564
1996	417	148,425	245	68,198	279	31,370	223	12,017
1997	380	160,062	218	61,208	266	28,676	216	15,796
1998	386	146,576	250	68,984	299	25,402	215	12,458
1999	325	101,754	198	60,604	233	19,746	179	9,908
2000	386	166,796	251	72,599	283	27,599	209	13,569
2001	340	127,076	253	64,661	273	25,855	203	15,845
2002	288	100,795	194	59,867	218	17,149	165	8,676
2003	256	127,191	190	69,473	214	15,768	142	9,442
2004	233	87,142	185	76,754	193	20,557	131	8,384
2005	249	102,641	202	87,588	208	21,949	131	10,548
2006	245	73,282	202	74,749	206	18,328	122	7,635
2007	271	82,512	202	80,629	225	17,566	117	6,145
2008	271	94,145	197	55,683	210	17,910	133	6,729
2009	361	132,724	245	59,827	296	24,649	168	7,808
2010	325	102,003	251	56,167	297	23,719	165	8,022

Year	Opakapaka		Onaga		Ehu		Hapuupuu	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
2011	368	146,937	258	67,375	306	24,124	175	8,002
2012	344	109,264	261	55,524	323	27,276	157	9,737
2013	327	98,600	246	68,382	308	31,331	156	10,342
2014	324	162,145	234	75,144	276	29,985	161	10,500
2015	302	139,962	221	75,365	261	29,674	126	8,691
10 yr ave	309	110,425	230	68,107	266	23,684	149	8,547
20 yr ave	326	122,487	226	67,466	260	23,748	170	10,356

1.1.4.2 Inshore Handline

The inshore handline gear is supposed to be a lighter tackle than the deep-sea handline. The ehu and onaga landings were probably made with the heavier tackle gear, but were reported by fishers as inshore handline. For these cases, in recent years fishers were contacted to verify the gear reported. The fishing report was not amended if the fisher did not respond. The opakapaka and lehi landings were probably fished in shallow water habitat.

Table 5. HDAR MHI Fiscal Annual Deep-7 Catch (Lbs. caught) Summary (1966-2015) by Species and second Gear: Inshore handline. Historical record reported in fiscal year from 1966-93 and switches to fishing year from 1994-2015. July and August 1993 omitted to allow for this change.

Year	Opakapaka		Ehu		Lehi		Onaga	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1966	4	500	4	55	n.d.	n.d.	n.d.	n.d.
1967	n.d.	n.d.			n.d.	n.d.		
1968			n.d.	n.d.				
1969	n.d.	n.d.	4	80			n.d.	n.d.
1970	n.d.	n.d.			4	129		
1971	4	56	5	26	n.d.	n.d.	6	57

1972	n.d.	n.d.	3	26	n.d.	n.d.	n.d.	n.d.
1973	n.d.	n.d.	3	37	3	32	n.d.	n.d.
1974	n.d.	n.d.			n.d.	n.d.		
1975	12	1,318	3	54	6	327	n.d.	n.d.
1976	21	975	9	398	10	387	11	857
1977	40	2,552	27	1,024	12	473	13	1,572
1978	43	1,735	28	415	36	943	5	84
1979	100	4,644	60	1,451	53	1,934	19	1,406
1980	13	113	9	40	21	712	3	14
1981	18	531	9	39	14	336	5	26
1982	15	111	16	129	19	296	6	84
1983	30	228	24	235	22	360	11	283
1984	16	668	16	154	29	274	14	883
1985			n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1986	8	267	4	36	5	29	n.d.	n.d.
1987	13	647	n.d.	n.d.	3	16		
1988	4	53	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1989	6	291	5	33			n.d.	n.d.
1990	n.d.	n.d.						
1991								
1992								
1993								
1994								
1995								
1996								
1997	3	22	n.d.	n.d.	4	29	n.d.	n.d.

1998	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.		
1999					n.d.	n.d.		
2000	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.		
2001	6	80	3	74				
2002	5	51	n.d.	n.d.			n.d.	n.d.
2003	8	211	6	191	n.d.	n.d.	n.d.	n.d.
2004	15	824	6	51	3	7	5	90
2005	9	772	5	246	7	68	3	200
2006	6	539	3	21			n.d.	n.d.
2007	9	1,074	3	430	4	88	n.d.	n.d.
2008	5	268	n.d.	n.d.	3	24	n.d.	n.d.
2009	15	733	5	78	3	111	3	40
2010	15	250	8	172	3	33	4	63
2011	8	242	3	13	n.d.	n.d.		
2012	n.d.	n.d.						
2013	3	12			n.d.	n.d.		
2014			n.d.	n.d.	n.d.	n.d.		
2015	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
10 yr ave	9	486	5	160	4	65	3	101
20 yr ave	8	391	5	142	4	51	4	9

n.d. = non-disclosure due to data confidentiality

1.1.4.3 Palu ahi

The primary use of palu ahi gear as it is defined for the state database is a form of tuna handline. This is normally a handline gear used during the day with drop stone or weight and chum. The target species is usually pelagic such as yellowfin and bigeye tunas. The Deep-7 bottomfish landings taken by palu ahi are common bycatches for Big Island fishers. Some of the landings may have been taken by bottomfishers who used deep-sea handline tackle but reported it as palu ahi because of the gear definition, which involves weights and chum on a handline. For these cases, in recent years fishers were contacted to verify the gear reported. The fishing report was not amended if the fisher did not respond.

Table 6. HDAR MHI Fiscal Annual Deep-7 Catch (Lbs. caught) Summary (1983-2015) by Species and third Gear: Palu ahi. Historical record reported in fiscal year from 1983-93 and switches to fishing year from 1994-2015. July and August 1993 omitted to allow for this change.

	Opakapaka		Ehu		Lehi		Hapuupuu	
Year	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1983	n.d.	n.d.			3	50		
1984	3	629	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1985					n.d.	n.d.		
1986	10	275	n.d.	n.d.	9	1,087		
1987	6	112	n.d.	n.d.	9	331		
1988	2	43	n.d.	n.d.	9	165	n.d.	n.d.
1989	3	110			4	91		
1990								
1991								
1992								
1993								
1994								
1995	n.d.	n.d.			6	92		
1996	4	15			12	228		
1997	3	64	n.d.	n.d.	14	226		
1998	n.d.	n.d.			11	291		
1999	5	86			13	410		
2000	8	133			11	302		
2001	4	30			4	34		
2002			n.d.	n.d.	4	135	n.d.	n.d.

Year	Opakapaka		Ehu		Lehi		Hapuupuu	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
2003	10	298	n.d.	n.d.	12	450	n.d.	n.d.
2004	13	436	n.d.	n.d.	15	717	3	68
2005	11	134	n.d.	n.d.	16	551	n.d.	n.d.
2006	8	680			18	782		
2007	9	340	n.d.	n.d.	12	539		
2008	12	1,754	3	8	16	1,238	3	39
2009	8	1,731	5	97	26	1,613	n.d.	n.d.
2010	15	272	4	73	20	683	n.d.	n.d.
2011	4	168	n.d.	n.d.	9	218	n.d.	n.d.
2012	18	400	n.d.	n.d.	18	1,029	n.d.	n.d.
2013	21	1,173	n.d.	n.d.	21	1,505	n.d.	n.d.
2014	24	1,217	4	24	25	1,322		
2015	16	1,444	n.d.	n.d.	18	920	n.d.	n.d.
10 yr ave	13	787	4	51	18	948	3	39
20 yr ave	11	576	4	51	14	633	3	54

n.d. = non-disclosure due to data confidentiality

1.1.5 Catch Parameters by Gear

The CPUE (lbs. per trip) for the dominant method, deep-sea handline, peaked at the beginning of the time series, and leveled off since the early 1990's and through 2012. Most of the flat CPUE ranging between 71 - 92 lbs. per trip is attributed to state and federal regulations that removed fishing areas, interim closed season, and quotas on the landings. Recently, CPUE is trending up since 2014; last year it was 112 lbs. per trip. Fishers are making fewer trips, but landings are larger because the size weight of the Deep-7 bottomfish is increasing.

Table 7. HDAR MHI Fiscal Annual Deep-7 CPUE by dominant fishing methods (1966-2015). Historical record reported in fiscal year from 1966-93 and switches to fishing year from 1994-2015. July and August 1993 omitted to allow for this change.

Year	Deep-sea handline				Inshore handline				Palu ahi			
	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE
1966	86	1,012	180,165	178.03	10	16	711	44.44				
1967	107	1,449	231,014	159.43	4	5	45	9.00				
1968	118	1,164	194,494	167.09	n.d.	n.d.	n.d.	n.d.				
1969	128	1,175	176,874	150.53	8	14	234	16.71				
1970	135	1,118	157,853	141.19	5	6	161	26.83				
1971	163	1,219	134,916	110.68	14	24	185	7.71				
1972	214	1,896	227,744	120.12	15	22	182	8.27				
1973	201	1,537	168,976	109.94	13	16	117	7.31				
1974	258	2,126	225,181	105.92	4	6	61	10.17				
1975	238	2,038	219,094	107.50	21	39	1,864	47.79				
1976	270	2,028	241,664	119.16	50	103	3,134	30.43				
1977	290	2,263	255,124	112.74	61	195	7,428	38.09				
1978	392	2,365	297,167	125.65	103	209	3,866	18.50				
1979	379	1,901	259,999	136.77	171	327	11,685	35.73				
1980	412	2,591	235,253	90.80	49	92	1,038	11.28				
1981	456	3,458	301,716	87.25	48	79	1,114	14.10				
1982	429	3,688	322,683	87.50	58	103	742	7.20	n.d.	n.d.	n.d.	n.d.
1983	501	4,571	401,606	87.86	90	166	1,482	8.93	3	8	64	8.00
1984	504	4,161	330,320	79.38	82	148	2,535	17.13	5	22	930	42.27
1985	533	5,624	481,308	85.58	10	13	1,024	78.77	n.d.	n.d.	n.d.	n.d.
1986	582	5,563	503,729	90.55	27	42	790	18.81	12	63	1,403	22.27
1987	562	5,412	569,395	105.21	21	39	887	22.74	13	35	484	13.83
1988	534	5,955	564,910	94.86	11	15	141	9.40	9	17	262	15.41
1989	536	6,155	556,924	90.48	20	27	629	23.30	5	12	201	16.75

Year	Deep-sea handline				Inshore handline				Palu ahi			
	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE
1990	526	5,230	454,948	86.99	n.d.	n.d.	n.d.	n.d.				
1991	492	4,195	328,743	78.37	4	4	55	13.75				
1992	483	4,486	371,093	82.72	n.d.	n.d.	n.d.	n.d.				
1993	445	3,538	265,198	74.96	n.d.	n.d.	n.d.	n.d.				
1994	511	3,860	316,888	82.10	6	7	64	9.14				
1995	516	3,897	320,634	82.28	n.d.	n.d.	n.d.	n.d.	6	6	105	17.50
1996	507	3,952	295,246	74.71	5	6	28	4.67	13	21	243	11.57
1997	484	4,129	306,174	74.15	13	16	128	8.00	16	23	301	13.09
1998	506	4,056	288,888	71.22	7	7	69	9.86	11	30	301	10.03
1999	415	2,920	213,036	72.96	4	4	38	9.50	14	48	496	10.33
2000	492	3,885	311,030	80.06	6	8	59	7.38	13	30	435	14.50
2001	447	3,536	265,436	75.07	9	19	178	9.37	6	9	79	8.78
2002	381	2,826	208,839	73.90	9	14	93	6.64	5	14	199	14.21
2003	345	2,850	244,718	85.87	15	35	543	15.51	16	50	850	17.00
2004	301	2,531	206,305	81.51	19	40	1,117	27.93	21	72	1,271	17.65
2005	319	2,598	239,410	92.15	21	50	1,389	27.78	22	49	803	16.39
2006	323	2,159	186,280	86.28	11	27	673	24.93	19	61	1,464	24.00
2007	334	2,436	201,372	82.67	14	46	2,291	49.80	16	56	902	16.11
2008	331	2,254	192,032	85.20	8	15	1,494	99.60	20	78	3,119	39.99
2009	449	3,122	252,861	80.99	19	30	1,078	35.93	31	105	3,943	37.55
2010	422	2,669	205,720	77.08	26	42	616	14.67	28	68	1,352	19.88
2011	449	3,378	270,290	80.01	10	21	284	13.52	11	33	542	16.42
2012	464	3,005	224,951	74.86	4	4	19	4.75	23	90	1,512	16.80
2013	439	2,858	235,663	82.46	5	5	21	4.20	32	119	2,785	23.40
2014	404	3,061	307,579	100.48	3	3	26	8.67	31	106	2,638	24.89
2015	385	2,536	284,026	112.00	n.d.	n.d.	n.d.	n.d.	24	85	2,514	29.58

Year	Deep-sea handline				Inshore handline				Palu ahi			
	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE
10 yr ave	393	2,754	231,616	84	12	24	789	28	23	77	1,906	24
20 yr ave	416	3,106	248,823	81	11	21	534	20	18	53	1,167	19

n.d. = non-disclosure due to data confidentiality

1.2 Non Deep-7 BMUS

1.2.1 Fishery Descriptions

This species group category is characterized by three jacks: the White or Giant ulua (*Caranx ignobilis*), Gunkan or Black ulua (*Caranx lugubris*), and Butaguchi or Pig-lip ulua (*Pseudocaranx dentex*); and two snappers, the Uku (*Aprion virescens*) and Yellowtail kalekale (*Pristipomoides auricilla*). All three jack species have been identified as specific species in the catch records since 1981. Before then, landings for these jacks were reported under the jack miscellaneous category, which is summarized in the CREMUS group category. The Yellowtail kalekale was identified as a specific species in the catch records in 1996. Previously, this species may have been reported with the Kalekale (*Pristipomoides sieboldii*), which is summarized in the Deep-7 BMUS group category.

The jacks are predators and found throughout the MHI, although the Black ulua and Butaguchi are more abundant in the NWHI. In terms of habitat, White ulua prefer nearshore with rocky shores, embayments, reefs, shallow and deep waters. Butaguchi forage in deeper waters near the bottom, and Gunkan also prefer deeper waters off reef slopes. The peak spawning period for White ulua is during new and full moon between May and August.

Citation: Hawaii's Comprehensive Wildlife Conservation Strategy. 9/6/2005

1.2.2 Dashboard Statistics

The collection of commercial non-Deep-7 BMUS fishing reports comes from two sources: paper report received by mail or fax or pdf copy of it via e-mail; and report filed online through the Online Fishing Report system (OFR). The non-Deep7 BMUS are reported by commercial fishers on the Monthly Fishing Report or the Net, Trap, Dive Activity Report or the MHI Deep-7 Bottomfish Fishing Trip Report.

Refer to data processing procedures documented in the Deep-7 BMUS section for paper fishing reports and fishing reports filed online. Database assistants and data monitoring associate will enter the paper Monthly Fishing Report information within 4 weeks, and the Net, Trap, Dive Activity Report and the MHI Deep-7 Bottomfish Fishing Trip Report within 2 business days.

1.2.2.1 Historical Summary

Table 8. Annual fishing parameters for the non Deep-7 Bottomfish fishery comparing current values with short-term (10 years) and long-term (20 years) averages. Values are for the fiscal year.

Fishery	Parameters	2015 Values	2015 Comparative Trends	
			Short Average (10 years)	Long Average (20 years)
BMUS Non Deep-7	No. License	463	↑ 7.2%	↑ 14.5%
	Trips	2,108	↑ 10.5%	↑ 23.0%
	No. Caught	14,711	↑ 14.7%	↑ 33.1%

	Lbs. Caught	123,852	↑ 9.0%	↑ 27.5%

1.2.2.2 Species Summary

Table 9. Annual species indicators for the non-Deep-7 bottomfish fishery comparing current estimates with the short-term (10 years) and the long-term (20 years) average. Values are for the fiscal year.

Fishery	Species	2015 Parameters	2015 Comparative Trends	
		Catch (lbs) Effort (trips) CPUE (lbs/trip)	Short Average (10 years)	Long Average (20 years)
BMUS Non Deep-7	Uku	112,518	↑ 18.8%	↑ 36.5%
		1,843	↑ 20.7%	↑ 28.2%
		61.05	↓ 1.6%	↑ 6.5%
	White Ulua	10,753	↓ 35.3%	↓ 0.9%
		362	↓ 27.0%	↑ 12.5%
		29.7	↓ 11.3%	↓ 11.9%
	Butaguchi	273	↓ 69.6%	↓ 91.6%
		12	↓ 33.3%	↓ 81.0%
		22.8	↓ 54.8%	↓ 55.6%
	Gunkan Ulua	261	↓ 80.5%	↓ 62.2%
		13	↓ 63.5%	↓ 23.0%
		20.1	↓ 46.6%	↓ 50.8%
	Yellowtail kalekale*	47	↑ 27.0%	N/A
		8	↑ 1.6%	N/A
		5.9	↑ 25.0%	N/A

*data available for seven of the previous 10 years

1.2.3 Time Series Statistics

1.2.3.1 Commercial Fishing Parameters

The most important species in this group category is the uku. Because of the wide habitat range where this species is found it is commonly taken by heavy (deep-sea handline) and light (inshore handline) tackles and troll gear. The white ulua, gunkan ulua, and butaguchi ulua, and yellowtail kalekale were not established as specific species during the entire time series. Refer to discussion in the previous section. Early in the time series up until 1982, the effort and catch trends reflect only uku landings. The White ulua was not widely accepted by markets during the 1990's because of the ciguatera toxin. Since the implementation of the federal bottomfish fishing year, uku landings have trended upwards. During the first four federal fishing years, the Deep-7 bottomfish fishery was closed because the TAC or ACL was attained. Bottomfish fishers shifted target to uku during the closures, and in recent years this effort is rewarding because of decent market prices.

Table 10. HDAR MHI Fiscal Annual non Deep-7 Bottomfish commercial fishermen reports (1966-2015).

Fiscal year	No. License	Trips	No. Reports	No. Caught	Lbs. Caught
1966	84	571	278	7,148	46,816
1967	108	733	366	7,749	64,215
1968	110	570	317	7,188	52,352
1969	116	716	377	5,920	54,139
1970	125	731	394	5,865	49,794
1971	137	608	356	4,575	48,418
1972	161	761	441	6,853	54,139
1973	169	767	472	6,133	46,578
1974	235	1,039	632	9,406	72,953
1975	213	1,041	580	9,627	75,490
1976	213	934	518	8,625	69,009
1977	245	1,093	612	6,232	47,094
1978	376	1,569	1,038	12,401	94,798
1979	381	1,346	1,037	11,262	82,747
1980	361	1,483	902	8,448	63,980
1981	392	2,117	1,107	11,699	95,027

Fiscal year	No. License	Trips	No. Reports	No. Caught	Lbs. Caught
1982	389	2,021	1,120	12,330	96,144
1983	431	2,769	1,366	13,791	123,244
1984	469	2,632	1,313	17,361	164,493
1985	467	2,112	1,157	11,198	101,889
1986	363	1,566	859	10,224	83,164
1987	366	1,586	887	12,756	117,959
1988	461	2,713	1,260	21,638	201,383
1989	509	3,317	1,621	39,015	347,700
1990	488	2,522	1,391	17,284	150,809
1991	453	2,176	1,252	14,465	138,047
1992	409	1,812	1,072	10,624	101,683
1993	365	1,498	897	8,847	76,343
1994	386	1,510	917	9,083	86,833
1995	395	1,710	954	9,377	85,106
1996	341	1,249	831	7,709	73,067
1997	448	1,901	1,144	10,907	93,504
1998	418	1,696	1,011	7,369	63,242
1999	366	1,458	916	10,114	84,116
2000	418	1,791	1,048	13,071	103,701
2001	374	1,521	924	9,904	78,127
2002	313	1,190	779	9,174	82,572
2003	334	1,235	788	7,133	66,225
2004	359	1,451	905	7,919	76,933
2005	383	1,575	956	10,732	95,028
2006	384	1,498	921	8,930	80,867

Fiscal year	No. License	Trips	No. Reports	No. Caught	Lbs. Caught
2007	362	1,722	967	9,740	94,679
2008	392	1,839	997	12,439	107,484
2009	416	1,749	1,031	11,406	97,131
2010	461	2,047	1,182	15,045	125,435
2011	501	2,441	1,350	16,554	149,341
2012	464	2,054	1,207	13,807	124,216
2013	496	2,134	1,290	17,509	157,812
2014	462	2,016	1,207	12,141	104,361
2015	463	2,108	1,248	14,711	123,852
10 yr ave	432	1,908	1,111	12,830	113,635
20 yr ave	404	1,714	1,020	11,049	97,147

1.2.4 Top Two Species Per Gear Type

1.2.4.1 Deep-sea Handline

Table 11. HDAR MHI Fiscal Annual non Deep-7 Bottomfish Catch (Lbs. caught) Summary (1966-2015) by Species and top Gear: Deep-sea handline.

	Uku		White ulua	
Fiscal year	No. License	Lbs. Caught	No. License	Lbs. Caught
1966	78	46,358		
1967	101	63,303		
1968	104	51,705		
1969	107	52,824		
1970	115	48,645		
1971	133	48,038		
1972	154	53,336		
1973	161	45,817		
1974	216	72,130		

Fiscal year	Uku		White ulua	
	No. License	Lbs. Caught	No. License	Lbs. Caught
1975	191	74,325		
1976	166	63,048		
1977	187	36,177		
1978	303	75,501		
1979	248	67,218		
1980	290	57,725		
1981	338	90,177		
1982	355	88,334	15	426
1983	368	109,638	31	5,284
1984	381	134,414	49	8,369
1985	360	84,510	37	3,789
1986	267	62,839	20	1,253
1987	246	61,087	15	4,466
1988	347	166,300	29	3,193
1989	422	297,514	67	15,715
1990	374	121,439	63	10,686
1991	321	99,252	58	7,316
1992	281	68,668	13	1,368
1993	221	54,888	9	712
1994	270	68,352	12	1,333
1995	275	61,449	13	501
1996	224	51,616	19	2,037
1997	250	56,909	12	923
1998	228	37,599	5	416

Fiscal year	Uku		White ulua	
	No. License	Lbs. Caught	No. License	Lbs. Caught
1999	215	64,511	8	466
2000	252	78,851	8	403
2001	205	50,998	10	608
2002	176	58,177	7	1,313
2003	154	41,730	28	2,120
2004	133	47,695	30	1,966
2005	160	55,706	34	1,519
2006	167	46,767	30	1,415
2007	162	50,059	35	4,052
2008	170	53,056	37	4,405
2009	183	65,897	41	3,462
2010	200	75,732	56	4,113
2011	234	89,110	60	7,033
2012	207	65,393	42	4,319
2013	203	89,061	43	5,475
2014	174	57,152	37	3,104
2015	173	68,992	30	2,591
10 yr ave	186	64,793	42	3,890
20 yr ave	199	59,873	28	2,483

1.2.4.2 Inshore Handline

Table 12. HDAR MHI Fiscal Annual non Deep-7 Bottomfish (Lbs. caught) Summary (1966-2015) by Species and second Gear: Inshore handline.

Fiscal year	**Uku**		**White ulua**	
	No. License	Lbs. Caught	No. License	Lbs. Caught
1966	4	50		
1967	4	554		
1968	8	345		
1969	3	24		
1970	3	20		
1971	3	25		
1972	3	12		
1973	8	47		
1974	7	158		
1975	16	331		
1976	42	2,453		
1977	60	7,792		
1978	134	14,348		
1979	211	12,673		
1980	71	1,825		
1981	67	1,198		
1982	43	582	n.d.	n.d.
1983	45	560	6	182
1984	53	1,169	8	1,062
1985	4	207	3	91
1986	22	2,323	4	147
1987	91	11,687	14	537

Fiscal year	Uku		White ulua	
	No. License	Lbs. Caught	No. License	Lbs. Caught
1988	91	10,401	14	661
1989	75	4,532	10	415
1990	78	2,653	10	297
1991	106	4,675	23	973
1992	127	17,553	12	864
1993	114	8,222	13	552
1994	83	8,333	7	169
1995	98	8,413	11	436
1996	85	4,668	10	926
1997	175	14,612	14	1,206
1998	173	17,614	14	1,427
1999	134	10,050	12	930
2000	152	14,423	11	609
2001	142	14,844	17	827
2002	94	12,229	18	1,291
2003	71	6,748	25	1,458
2004	69	5,063	32	1,431
2005	80	6,980	26	1,856
2006	65	9,098	21	1,275
2007	64	10,452	22	1,642
2008	67	13,079	33	2,619
2009	91	9,148	36	2,446
2010	87	15,368	40	3,039
2011	102	17,679	47	5,070

Fiscal year	Uku		White ulua	
	No. License	Lbs. Caught	No. License	Lbs. Caught
2012	91	20,859	32	4,594
2013	89	21,188	38	2,174
2014	78	12,968	29	1,549
2015	62	11,915	23	1,352
10 yr ave	81	13,682	32	2,626
20 yr ave	100	12,274	24	1,840

n.d. = non-disclosure due to data confidentiality

1.2.4.3 Troll with Bait

The gear code for troll with bait was established in October 2002 when the revised commercial fishing reports were implemented. Previously all troll activities were reported as troll miscellaneous gear.

Table 13. HDAR MHI Fiscal Annual non Deep-7 Bottomfish Catch (Lbs. caught) Summary (2003 - 2015) by Species and third Gear: Troll with Bait.

Fiscal year	White Ulua		Uku	
	No. License	Lbs. Caught	No. License	Lbs. Caught
2003	11	1,034	19	2,270
2004	8	1,401	17	5,664
2005	6	1,036	21	9,041
2006	8	994	17	6,361
2007	16	1,837	12	4,842
2008	14	2,090	13	13,599
2009	15	1,292	15	2,470
2010	13	1,493	26	5,813
2011	19	2,075	31	3,679
2012	15	1,885	26	5,315
2013	18	2,370	40	6,615

Fiscal year	White Ulua		Uku	
	No. License	Lbs. Caught	No. License	Lbs. Caught
2014	19	2,177	45	6,334
2015	15	1,294	45	9,004
10 yr ave	14	1,725	25	6,407

1.2.4.4 Troll (Misc.)

The troll gear was standardized and reported under specific methods including troll with lure or bait or green stick in October 2002 when the revised commercial fishing reports were implemented. Since then fishers were contacted to verify miscellaneous troll activities on their fishing reports. The fishing report was not amended if the fisher did not respond.

Table 14. HDAR MHI Fiscal Annual non Deep-7 Bottomfish Catch (Lbs. caught) Summary (1972 - 2004) by Species and fourth Gear: Troll (misc.). Recent data restricted by confidentiality protocol.

Fiscal year	Uku		White Ulua	
	No. License	Lbs. Caught	No. License	Lbs. Caught
1972	5	142		
1973	5	204		
1974	12	326		
1975	16	283		
1976	20	2,206		
1977	26	955		
1978	20	1,374		
1979	n.d.	n.d.		
1980	51	1,748		
1981	29	1,125		
1982	27	1,329	6	470
1983	29	1,429	7	185
1984	42	2,573	34	1,689

Fiscal year	Uku		White Ulua	
	No. License	Lbs. Caught	No. License	Lbs. Caught
1985	9	380	83	4,568
1986	23	634	48	2,616
1987	24	1,777	15	3,731
1988	29	2,877	15	852
1989	49	6,196	18	1,389
1990	52	3,063	17	1,978
1991	41	5,991	27	2,007
1992	38	3,867	13	339
1993	24	932	10	872
1994	34	1,155	7	553
1995	37	1,028	4	261
1996	33	1,562	7	327
1997	47	2,410	6	556
1998	33	675	5	257
1999	23	1,724	4	369
2000	31	1,359	8	184
2001	40	2,340	9	1,129
2002	37	2,040	6	476
2003	10	373	3	115
2004	3	43		

n.d. = non-disclosure due to data confidentiality

1.2.5 Catch Parameters by Gear

With uku being the driver species in this group category, it is commonly caught by the following top dominant gears: deep-sea handline, inshore handline, troll with bait and troll miscellaneous. Landings of uku along with the Deep-7 bottomfish species peaked in 1989 with deep-sea handline gear. A second peak for this dominant gear occurred in 2013 because of bottomfishers shifting their fishing target to uku during the summer months.

Table 15. Time series of CPUE by dominant fishing methods from non Deep-7 BMUS (1966-2015).

	Deep-sea handline				Inshore handline				Troll with Bait				Troll (misc.)			
Fiscal year	No. Licen se	No. trips	Lbs. Caught	CPUE	No. Licen se	No. trips	Lbs. Caught	CPUE	No. Licen se	No. trips	Lbs. Caught	CPU E	No. Licen se	No. trips	Lbs. Caught	CPU E
1966	78	514	46,358	90.19	4	4	50	12.50								
1967	101	683	63,303	92.68	4	5	554	110.80					n.d.	n.d.	n.d.	n.d.
1968	104	509	51,705	101.58	8	13	345	26.54					n.d.	n.d.	n.d.	n.d.
1969	107	615	52,824	85.89	3	3	24	8.00					n.d.	n.d.	n.d.	n.d.
1970	115	633	48,645	76.85	3	4	20	5.00								
1971	133	548	48,038	87.66	3	4	25	6.25								
1972	154	663	53,336	80.45	3	3	12	4.00					5	10	142	14.20
1973	161	675	45,817	67.88	8	9	47	5.22					5	7	204	29.14
1974	216	968	72,130	74.51	7	10	158	15.80					12	13	326	25.08
1975	191	947	74,325	78.48	16	23	331	14.39					16	19	283	14.89
1976	166	732	63,048	86.13	42	97	2,453	25.29					20	52	2,206	42.42
1977	187	716	36,177	50.53	60	211	7,792	36.93					26	41	955	23.29
1978	303	1,097	75,501	68.82	134	298	14,348	48.15					20	41	1,374	33.51
1979	248	857	67,218	78.43	211	431	12,673	29.40					n.d.	n.d.	n.d.	n.d.
1980	290	1,196	57,725	48.27	71	110	1,825	16.59					51	82	1,748	21.32
1981	338	1,763	90,177	51.15	67	110	1,198	10.89					29	44	1,125	25.57
1982	355	1,760	90,223	51.26	45	66	603	9.14					30	40	1,799	44.98

Fiscal year	Deep-sea handline				Inshore handline				Troll with Bait				Troll (misc.)			
	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE
1983	374	2,506	115,980	46.28	51	74	748	10.11					36	46	1,614	35.09
1984	397	2,246	144,521	64.35	58	95	2,239	23.57					73	108	4,262	39.46
1985	378	1,853	92,057	49.68	8	8	306	38.25					91	133	4,948	37.20
1986	282	1,271	70,271	55.29	28	60	2,540	42.33					63	92	3,250	35.33
1987	262	1,084	82,513	76.12	100	264	12,376	46.88					35	75	5,555	74.07
1988	365	2,270	174,945	77.07	101	218	11,132	51.06					43	78	3,837	49.19
1989	441	2,867	320,763	111.88	83	174	4,955	28.48					62	116	7,585	65.39
1990	395	2,053	139,989	68.19	83	232	3,136	13.52					67	113	5,041	44.61
1991	345	1,667	118,413	71.03	120	259	5,679	21.93					64	126	7,998	63.48
1992	289	1,169	72,393	61.93	130	445	18,434	41.42					48	79	4,206	53.24
1993	237	911	62,746	68.88	122	372	8,790	23.63					31	68	1,804	26.53
1994	282	1,081	73,561	68.05	85	218	8,502	39.00					39	63	1,708	27.11
1995	291	1,230	72,242	58.73	105	298	8,886	29.82					40	63	1,289	20.46
1996	234	811	61,442	75.76	92	250	5,668	22.67					40	68	1,889	27.78
1997	268	1,033	71,884	69.59	179	655	15,868	24.23					51	91	2,966	32.59
1998	238	905	40,551	44.81	183	619	19,302	31.18					39	59	978	16.58
1999	222	782	67,217	85.96	140	473	11,029	23.32					27	44	2,093	47.57
2000	258	996	83,039	83.37	158	567	15,049	26.54					36	47	1,543	32.83

Fiscal year	**Deep-sea handline**				**Inshore handline**				**Troll with Bait**				**Troll (misc.)**			
	No. Licen se	No. trips	Lbs. Caught	CPUE	No. Licen se	No. trips	Lbs. Caught	CPUE	No. Licen se	No. trips	Lbs. Caught	CPU E	No. Licen se	No. trips	Lbs. Caught	CPU E
2001	212	850	55,632	65.45	152	464	15,707	33.85					50	84	3,481	41.44
2002	187	697	62,685	89.94	106	335	13,562	40.48					43	71	2,536	35.72
2003	174	677	46,791	69.12	81	242	8,390	34.67	23	66	3,333	50.50	13	18	488	27.11
2004	150	645	51,079	79.19	87	279	6,614	23.71	21	118	7,112	60.27	3	3	43	14.33
2005	175	766	60,697	79.24	90	317	8,904	28.09	22	127	10,077	79.35	n.d.	n.d.	n.d.	n.d.
2006	173	694	50,233	72.38	72	247	10,481	42.43	24	113	7,385	65.35				
2007	169	812	54,756	67.43	74	314	12,115	38.58	25	139	6,719	48.34				
2008	192	851	60,670	71.29	83	334	15,869	47.51	21	201	15,689	78.05				
2009	202	901	70,005	77.70	109	329	11,678	35.50	22	106	3,792	35.77				
2010	218	915	81,072	88.60	100	389	18,439	47.40	33	143	7,306	51.09				
2011	257	1,204	97,713	81.16	121	445	22,881	51.42	39	140	5,827	41.62				
2012	224	810	70,811	87.42	103	471	25,724	54.62	31	161	7,199	44.71				
2013	217	864	96,085	111.21	106	407	23,407	57.51	48	177	8,985	50.76	n.d.	n.d.	n.d.	n.d.
2014	184	809	60,670	74.99	88	341	14,787	43.36	52	225	8,511	37.83				
2015	180	824	71,996	87.37	71	334	13,326	39.90	49	228	10,300	45.18				
10 yr ave	201	863	70,271	81	95	359	16,429	45	32	153	8,149	53	N/A	N/A	N/A	N/A
20 yr ave	212	863	65,764	77	111	389	14,218	37	30	143	7,661	54	N/A	N/A	N/A	N/A

n.d. = non-disclosure due to data confidentiality

1.3 CREMUS Finfish

1.3.1 Fishery Descriptions

There are 66 different specific finfish species in this group category. These species represent a total of 12 species families including surgeonfish (*Acanthuridae*), jacks (*Carangidae*), squirrelfish (*Holocentridae*), rudderfish (*Kyphosidae*), wrasses (*Labridae*), emperor (*Lethrinidae*), snappers (*Lutjanidae*), mullet (*Mugilidae*), goatfish (*Mullidae*), parrotfish (*Scaridae*), grouper (*Serranidae*), and shark (*Carcharhinidae)*.

Overall, the key driver species in this group category is the akule, halalu (juvenile akule) and opelu from the Carangidae family; taape from the Lutjanidae family, amama from the Mugilidae family, and weke miscellaneous from the Mullidae family. The dominant gear types are inshore handline, purse seine net (pelagic), lay gill net, and seine net.

1.3.2 Dashboard Statistics

The collection of commercial CREMUS finfish fishing reports comes from two sources: paper report received by mail or fax or pdf copy of it via e-mail; and report filed online through the Online Fishing Report system (OFR). The CREMUS finfish are reported by commercial fishers on the Monthly Fishing Report or the Net, Trap, Dive Activity Report or the MHI Deep-7 Bottomfish Fishing Trip Report.

Refer to data processing procedures documented in the Deep-7 BMUS section for paper fishing reports and fishing reports filed online. Database assistants and data monitoring associate will enter the paper Monthly Fishing Report information within four weeks, and the Net, Trap, Dive Activity Report and the MHI Deep-7 Bottomfish Fishing Trip Report within two business days.

1.3.2.1 Historical Summary

Table 16. Annual fishing parameters for the CREMUS finfish fishery comparing current values with short-term (10 years) and long-term (20 years) averages.

Table 16. Annual fishing parameters for the CREMUS finfish fishery comparing current values with short-term (10 years) and long-term (20 years) averages.

Fishery	Parameters	2015 Values	2015 Comparative Trends	
			Short Average (last 10 years)	Long Average (last 20 years)
CREMUS Finfish	No. License	769	↑ 0.7%	↓ 9.8%
	Trips	7,861	↓ 8.6%	↓ 17.2%
	No. Caught	1,614,313	↓ 14.2%	↓ 24.8%
	Lbs. Caught	909,904	↓ 14.3%	↓ 28.2%

1.3.2.2 Species Summary

Table 17. Annual species indicators for the CREMUS finfish fishery comparing current estimates with the short-term (10 years) and the long-term (20 years) average.

Fishery	Species	2015 Parameters	2015 Comparative Trends	
		Catch (lbs)	Short Average (last 10 years)	Long Average (last 20 years)
CREMUS Finfish	Akule	285,514	↑ 40.9%	↓ 33.8%
	Opelu	80,284	↓ 41.6%	↓ 51.2%
	Hahalalu	18,609	↑ 316.0%	↑ 46.1%
	Amaama	5,141	↓ 36.0%	↓ 22.8%
	Taape	3,792	↓ 42.1%	↓ 65.7%

1.3.3 Time Series Statistics

1.3.3.1 Commercial Fishing Parameters

Table 18. Time series of commercial fishermen reports for CREMUS finfish fishery (1966-2015).

Fiscal year	No. License	Trips	No. Reports	No. Caught	Lbs. Caught
1966	261	6,387	756	2,798,353	1,114,853
1967	302	7,324	919	2,947,470	1,328,133
1968	294	6,463	809	3,013,297	1,512,844
1969	362	7,038	1,029	5,505,694	1,628,970
1970	417	7,870	1,120	3,245,252	1,469,487
1971	478	7,671	1,312	4,101,610	1,332,051
1972	488	8,288	1,388	4,006,934	1,287,455
1973	538	7,488	1,459	2,476,377	1,269,877
1974	646	8,294	1,690	1,956,763	1,115,872
1975	648	8,872	1,613	2,031,053	1,159,570
1976	684	9,047	1,787	1,791,039	1,378,934
1977	772	10,321	2,089	2,867,072	1,577,768

Fiscal year	No. License	Trips	No. Reports	No. Caught	Lbs. Caught
1978	942	8,739	2,597	2,233,851	1,315,632
1979	955	6,460	2,677	2,201,432	1,171,970
1980	954	9,315	2,638	2,358,063	1,410,824
1981	989	11,968	2,607	2,611,155	1,350,879
1982	868	10,477	2,499	1,704,234	1,075,781
1983	956	12,482	2,754	3,081,844	1,493,322
1984	1,037	12,531	2,968	2,111,049	1,476,615
1985	925	11,058	2,889	1,441,115	921,829
1986	996	11,149	2,921	1,184,415	848,554
1987	1,010	11,758	2,932	1,530,801	994,022
1988	1,029	11,671	3,031	1,275,748	960,842
1989	1,090	12,130	3,106	1,772,217	1,222,961
1990	1,051	12,046	3,005	2,534,415	1,477,667
1991	1,059	12,079	3,120	2,087,148	1,341,206
1992	1,055	12,513	2,791	2,685,228	1,547,378
1993	987	10,502	2,654	2,414,061	1,396,990
1994	1,036	10,523	2,721	1,909,365	1,152,160
1995	1,038	10,543	2,632	2,118,075	1,397,121
1996	1,060	11,532	2,825	2,342,267	1,382,271
1997	1,111	12,113	3,048	2,059,939	1,243,628
1998	1,098	12,349	2,999	3,455,336	1,953,488
1999	1,015	10,915	2,659	2,606,685	1,861,427
2000	953	11,088	2,512	3,098,486	1,795,065
2001	889	9,852	2,266	2,392,546	1,516,630
2002	808	8,381	2,019	1,612,635	1,064,380

Fiscal year	No. License	Trips	No. Reports	No. Caught	Lbs. Caught
2003	757	8,600	1,938	2,299,822	1,269,070
2004	699	8,425	1,828	2,134,541	1,232,572
2005	670	7,310	1,692	2,044,520	1,211,100
2006	659	6,766	1,605	2,073,034	1,095,374
2007	664	7,910	1,703	2,644,294	1,301,676
2008	676	7,950	1,726	1,999,466	1,071,970
2009	837	9,117	2,240	1,863,757	909,135
2010	852	10,353	2,275	1,864,297	1,075,199
2011	872	10,132	2,250	1,819,930	1,188,160
2012	805	9,324	2,139	1,524,218	947,892
2013	817	8,779	2,158	1,471,641	932,145
2014	781	8,354	2,034	1,507,137	883,330
2015	769	7,861	1,979	1,614,313	909,904
10 yr ave	763	8,600	1,982	1,881,229	1,061,598
20 yr ave	853	9,490	2,227	2,146,631	1,266,582

1.3.4 Top 4 Species Per Gear Type

1.3.4.1 Inshore Handline

Table 19. HDAR MHI Fiscal Annual CREMUS finfish Catch (Lbs. caught) Summary (1966 - 2015) by Species and top Gear: Inshore handline.

Fiscal year	Opelu		Akule		Hahalalu		Taape	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1966	88	89,408	102	79,384	60	80,917		
1967	109	136,450	113	102,289	55	53,431		
1968	87	104,308	107	88,189	64	86,093		
1969	89	128,720	122	81,271	68	107,270		
1970	100	114,741	131	92,230	71	72,760	5	534
1971	111	97,302	149	78,525	70	71,967	25	1,546
1972	140	120,995	173	93,654	98	80,606	40	1,602
1973	137	92,282	174	96,129	66	50,943	48	1,822
1974	139	89,675	197	97,990	69	44,505	54	2,065
1975	143	164,833	190	105,663	82	54,152	66	3,262
1976	123	152,760	161	106,604	40	20,250	58	2,844
1977	119	122,355	128	35,045	52	17,376	77	2,298
1978	156	186,552	183	69,383	57	27,803	232	18,596
1979	138	172,771	220	79,799	94	29,272	244	20,643
1980	180	246,393	206	68,794	94	26,175	209	11,943
1981	195	217,082	226	79,026	96	30,423	200	13,603
1982	173	133,747	229	84,349	64	12,908	242	14,386
1983	164	114,400	286	111,956	144	50,563	246	16,390
1984	207	235,467	280	132,408	98	18,327	274	17,402
1985	182	151,699	210	94,223	52	7,447	191	14,188

Fiscal year	Opelu		Akule		Hahalalu		Taape	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1986	250	193,535	221	68,653	45	4,876	257	19,532
1987	289	252,473	214	66,158	58	12,615	197	16,682
1988	227	148,241	209	76,598	35	6,230	226	20,170
1989	228	142,750	196	73,857	80	17,005	173	7,112
1990	227	156,300	298	124,240	98	17,467	183	8,412
1991	212	184,668	298	166,377	116	37,043	250	13,989
1992	323	227,866	360	165,917	119	42,063	219	14,286
1993	243	205,254	314	138,619	77	15,962	194	12,284
1994	299	211,838	259	115,720	71	17,844	204	14,430
1995	222	176,137	236	90,955	63	12,169	201	19,664
1996	344	276,576	274	107,865	113	41,060	207	14,429
1997	327	230,136	353	158,540	94	20,766	255	16,995
1998	241	159,954	323	156,541	123	46,518	277	21,573
1999	208	170,547	291	183,979	54	11,994	212	17,345
2000	225	185,713	270	165,881	88	19,988	193	21,144
2001	214	185,394	235	130,388	50	10,094	176	20,370
2002	194	152,356	194	98,023	51	10,423	145	11,760
2003	209	214,377	144	92,063	38	15,321	115	6,835
2004	176	163,963	139	89,829	39	10,194	100	5,770
2005	141	100,975	101	77,402	25	5,857	89	5,212
2006	140	117,589	91	63,929	30	5,983	85	4,747
2007	187	172,682	110	82,817	31	5,095	88	4,846
2008	140	143,692	105	64,018	6	1,007	100	6,282

Fiscal year	Opelu		Akule		Hahalalu		Taape	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
2009	213	178,821	147	73,416	40	6,741	126	8,158
2010	198	159,413	164	117,061	41	4,525	124	8,980
2011	188	168,377	150	89,880	11	909	114	8,368
2012	166	117,301	155	84,688	46	6,918	117	9,017
2013	172	119,256	154	90,964	17	1,162	110	6,245
2014	161	96,798	127	77,555	26	2,088	88	3,612
2015	102	80,284	125	94,970	32	3,021	72	3,792
10 yr ave	171	137,490	130	82,173	27	4,029	104	6,547
20 yr ave	203	164,503	188	104,790	49	11,941	146	11,068

1.3.4.2 Purse Seine Net (Pelagic)

The purse seine net (pelagic) gear was standardized in October 2002 when the revised fishing reports were implemented. This gear was formerly called the akule or bag net by surrounding a school of fish with a net and drawing the bottom of the net closed to form a bag. In recent years this method was used by a few highliners to land large volumes of akule. The largest operation ended a few years ago and the vessel was converted to the longline fleet. Recent annual landings may not be available due to data confidentiality. Fishers who use this type of operation where the fish end up being entangled in the mesh will opt to report the method as gill net.

Table 20. HDAR MHI Fiscal Annual CREMUS Finfish Catch (Lbs. caught) Summary (1966 - 2000) by Species and 2nd Gear: Purse seine net (pelagic).

Fiscal year	Akule		Hahalalu		Ulua (misc.)		Kala	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1966	8	287,826	6	142,243	n.d.	n.d.		
1967	8	377,081	4	164,735	3	10,163	n.d.	n.d.
1968	18	570,987	8	231,823	4	6,860	3	5,214
1969	22	306,289	7	269,455	5	14,359	5	3,822

Fiscal year	Akule		Hahalalu		Ulua (misc.)		Kala	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1970	30	567,990	10	196,651	n.d.	n.d.	5	3,168
1971	14	442,203	6	161,910	3	1,332	3	4,500
1972	17	255,195	8	272,611	n.d.	n.d.	4	335
1973	26	399,065	6	164,254	4	1,919	n.d.	n.d.
1974	24	283,561	9	48,094	n.d.	n.d.	n.d.	n.d.
1975	21	179,035	6	54,314	4	341	n.d.	n.d.
1976	37	135,485	n.d.	n.d.	3	4,607	n.d.	n.d.
1977	20	349,789	9	20,024			n.d.	n.d.
1978	15	215,797	3	20,065	n.d.	n.d.	n.d.	n.d.
1979	26	184,363	4	14,294			n.d.	n.d.
1980	25	266,363	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1981	24	98,955	n.d.	n.d.				
1982	18	159,033	n.d.	n.d.				
1983	26	142,621	n.d.	n.d.				
1984	31	316,694	n.d.	n.d.	n.d.	n.d.	3	1,028
1985	13	46,523			n.d.	n.d.		
1986	6	53,683			n.d.	n.d.		
1987	13	19,779			n.d.	n.d.		
1988	12	10,660						
1989	24	251,299	n.d.	n.d.				
1990	21	105,824			n.d.	n.d.		
1991	26	96,578	n.d.	n.d.				
1992	16	39,060	3	8,660				

Fiscal year	Akule		Hahalalu		Ulua (misc.)		Kala	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1993	8	21,050	n.d.	n.d.				
1994	12	29,766						
1995	18	294,130						
1996	13	276,229	n.d.	n.d.				
1997	9	50,949						
1998	7	27,044	n.d.	n.d.	n.d.	n.d.		
1999	5	55,633			n.d.	n.d.	n.d.	n.d.
2000	6	81,399	n.d.	n.d.				

n.d. = non-disclosure due to data confidentiality

1.3.4.3 Lay Gill Net

The lay gill net gear was standardized in October 2002 when the revised fishing reports were implemented. This gear is defined more like a method in that it is net that captures fish by entangling the fish head in the mesh. Subsequently, most fishers who use mesh net and entangle the fish will report this method.

Table 21. HDAR MHI Fiscal Annual CREMUS Finfish Catch (Lbs. caught) Summary (1966 - 2015) by Species and 3rd Gear: Lay gill net.

Fiscal year	Akule		Weke (misc.)		Amaama		Hahalalu	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1966	7	22,260	23	6,421	25	14,090	3	451
1967	6	14,380	26	10,865	25	19,491		
1968	13	48,802	29	12,389	19	16,964	n.d.	n.d.
1969	17	33,761	43	11,405	30	22,603	n.d.	n.d.
1970	17	35,368	56	24,342	35	14,449		
1971	22	86,063	54	16,467	36	17,357	n.d.	n.d.
1972	26	103,523	49	15,346	34	15,600	4	838

Fiscal year	Akule		Weke (misc.)		Amaama		Hahalalu	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1973	34	94,120	68	21,882	42	13,898	3	315
1974	50	146,634	71	23,164	41	15,358	7	2,138
1975	50	184,367	61	27,097	44	12,100	8	3,726
1976	35	139,045	66	27,985	28	11,021	n.d.	n.d.
1977	46	196,546	79	24,005	35	13,304	9	12,093
1978	49	144,199	87	31,425	46	13,230	4	388
1979	31	92,072	84	15,208	38	15,676	n.d.	n.d.
1980	27	106,572	70	37,174	39	8,369	11	63,694
1981	31	136,832	73	55,584	36	8,031	5	36,597
1982	21	70,425	62	36,216	40	6,900	3	10,138
1983	29	77,965	58	32,332	33	5,723	4	88,487
1984	36	137,237	62	28,351	35	4,027	n.d.	n.d.
1985	21	104,324	31	8,541	16	2,581	n.d.	n.d.
1986	19	61,882	22	6,857	17	1,773		
1987	13	26,469	22	9,146	22	3,721		
1988	19	21,536	30	8,386	17	1,296		
1989	22	29,699	43	11,727	13	1,427	n.d.	n.d.
1990	25	183,362	23	7,052	15	2,046	3	39,982
1991	26	113,657	30	6,467	12	276	4	890
1992	33	144,378	36	8,836	14	7,820	4	11,382
1993	35	154,262	34	11,727	14	8,500	3	4,135
1994	29	126,707	35	5,767	14	5,636	5	4,948
1995	28	95,775	36	10,008	16	4,658	n.d.	n.d.

Fiscal year	Akule		Weke (misc.)		Amaama		Hahalalu	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1996	24	102,623	36	19,069	14	6,026	3	7,324
1997	27	182,017	29	11,848	16	4,904		
1998	23	204,654	24	6,283	10	5,469	n.d.	n.d.
1999	24	198,843	22	6,960	13	3,537	n.d.	n.d.
2000	19	212,870	18	2,851	14	2,862	7	4,169
2001	27	135,139	20	2,448	11	5,759	n.d.	n.d.
2002	20	42,147	14	3,875	9	5,423	n.d.	n.d.
2003	20	97,978	12	4,592	12	7,054		
2004	19	114,171	8	2,021	11	7,089	n.d.	n.d.
2005	25	135,340	7	450	11	8,214	n.d.	n.d.
2006	16	74,065	n.d.	n.d.	11	6,116	n.d.	n.d.
2007	15	128,642			6	8,515		
2008	16	112,086			10	11,905		
2009	16	54,885	3	206	10	8,102	n.d.	n.d.
2010	19	112,551	4	1,152	12	6,038	n.d.	n.d.
2011	21	169,486	n.d.	n.d.	8	6,177	n.d.	n.d.
2012	19	148,480	n.d.	n.d.	4	14,111	n.d.	n.d.
2013	20	126,436			12	5,400	5	2,165
2014	14	142,033			11	5,802	3	2,277
2015	23	190,544			8	5,141	3	15,588
10 yr ave	18	120,400	5	603	10	8,038	4	2,221
20 yr ave	21	129,511	18	5,520	11	6,658	5	3,984

n.d. = non-disclosure due to data confidentiality

1.3.4.4 Seine Net

The seine net gear was standardized in October 2002 when the revised fishing reports were implemented. This gear is defined as using a net by moving it through the water to surround a school of fish and corralling and trapping them within the walls of the net. Fishers who use this type of operation where the fish end up being entangled in the mesh will opt to report the method as gill net.

Table 22. HDAR MHI Fiscal Annual CREMUS Finfish Catch (Lbs. caught) Summary (1977 - 2015) by Species and fourth Gear: Seine net.

Fiscal year	Akule		Weke (misc.)		Taape		Opelu	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1977	3	73,648	4	1,800	n.d.	n.d.		
1978	n.d.	n.d.	10	21,158	4	12,207		
1979	n.d.	n.d.	19	30,891	15	17,900		
1980	n.d.	n.d.	12	17,748	6	7,372	n.d.	n.d.
1981			8	7,508	n.d.	n.d.		
1982	3	21,445	8	14,802	6	14,106	n.d.	n.d.
1983	5	43,102	10	14,654	5	14,829	n.d.	n.d.
1984	5	41,034	4	7,516	3	1,355		
1985	3	7,423	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1986	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1987	4	68,407	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1988	3	78,420	6	8,426	3	1,165	n.d.	n.d.
1989	n.d.	n.d.	5	2,033	n.d.	n.d.		
1990	10	274,127	4	2,123	3	451	n.d.	n.d.
1991	12	222,235	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1992	13	244,562	9	6,998	8	14,558		
1993	8	394,896	10	12,045	5	22,492	n.d.	n.d.
1994	7	198,718	9	5,130	8	12,948		

Fiscal year	Akule		Weke (misc.)		Taape		Opelu	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1995	8	252,684	6	6,072	6	15,149	n.d.	n.d.
1996	5	42,163	8	9,763	6	9,248	n.d.	n.d.
1997	9	97,418	6	12,556	6	6,169	n.d.	n.d.
1998	10	678,128	6	11,763	5	18,361	n.d.	n.d.
1999	7	589,076	12	13,361	8	18,275	n.d.	n.d.
2000	7	631,296	5	6,236	5	13,654		
2001	10	578,861	7	8,844	6	12,386	n.d.	n.d.
2002	4	280,697	6	4,579	3	4,978	n.d.	n.d.

n.d. = non-disclosure due to data confidentiality

1.3.5 Catch Parameters by Gear

The top gear in this group category is inshore handline where the driver species landed are opelu and akule. The CPUE is basically flat throughout the time series at about 68 lbs. per trip. In the most recent years, the number of fishers and trips are about half the levels observed in the first 25 years of the time series. The driver species are landed by the more efficient net methods with higher CPUEs.

Table 23. . Time series of CPUE by dominant fishing methods from CREMUS Finfish (1966-2015).

	Inshore handline				Purse Seine Net (Pelagic)				Lay Gill Net				Seine Net			
Fiscal year	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE
1966	150	3,774	266,302	70.56	9	147	430,497	2,928.55	45	419	49,542	118.24	n.d.	n.d.	n.d.	n.d.
1967	182	4,008	309,477	77.21	8	146	553,059	3,788.08	50	458	57,619	125.81				
1968	158	3,793	297,015	78.31	20	262	821,723	3,136.35	44	538	91,095	169.32				
1969	188	3,978	339,863	85.44	22	265	598,758	2,259.46	73	570	84,914	148.97	n.d.	n.d.	n.d.	n.d.
1970	215	4,191	300,057	71.60	32	312	778,068	2,493.81	88	701	94,010	134.11	n.d.	n.d.	n.d.	n.d.
1971	266	4,082	269,197	65.95	14	251	619,914	2,469.78	100	708	137,975	194.88				
1972	292	4,898	318,019	64.93	19	220	531,166	2,414.39	97	723	158,686	219.48				
1973	300	4,009	262,107	65.38	27	249	578,496	2,323.28	122	850	167,162	196.66	n.d.	n.d.	n.d.	n.d.
1974	347	4,125	255,203	61.87	25	202	336,492	1,665.80	151	1,140	239,854	210.40	n.d.	n.d.	n.d.	n.d.
1975	344	4,498	352,409	78.35	22	215	238,058	1,107.25	144	1,230	288,651	234.68	n.d.	n.d.	n.d.	n.d.
1976	312	3,993	305,383	76.48	38	182	144,679	794.94	137	1,182	277,153	234.48	n.d.	n.d.	n.d.	n.d.
1977	299	3,340	201,757	60.41	25	138	370,673	2,686.04	170	1,481	351,439	237.30	9	52	85,379	1,641.9
1978	522	4,331	360,820	83.31	16	97	237,134	2,444.68	190	1,205	258,359	214.41	11	94	63,100	671.2
1979	557	3,074	363,052	118.10	27	104	198,671	1,910.30	162	705	161,428	228.98	29	158	89,697	567.7
1980	495	4,126	385,421	93.41	27	228	271,488	1,190.74	147	1,110	280,779	252.95	13	52	37,893	728.7
1981	539	5,442	371,769	68.31	25	208	104,009	500.04	140	1,345	352,970	262.43	9	53	15,596	294.2

Fiscal year	Inshore handline				Purse Seine Net (Pelagic)				Lay Gill Net				Seine Net			
	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE
1982	512	4,526	273,897	60.52	18	230	159,754	694.58	115	1,248	199,378	159.76	16	111	81,279	732.2
1983	550	5,628	316,216	56.19	27	241	153,022	634.95	121	1,271	279,881	220.21	17	106	287,499	2,712.2
1984	640	6,645	438,365	65.97	32	251	334,178	1,331.39	125	1,025	225,320	219.82	11	62	61,697	995.1
1985	593	5,656	306,086	54.12	13	56	46,551	831.27	57	638	142,018	222.60	7	20	15,264	763.2
1986	594	5,997	315,886	52.67	6	48	54,278	1,130.79	50	454	84,349	185.79	4	61	37,354	612.3
1987	567	6,230	385,860	61.94	13	36	20,258	562.72	47	486	60,314	124.10	6	110	112,255	1,020.5
1988	557	5,373	286,062	53.24	14	32	11,308	353.38	51	454	57,236	126.07	11	101	100,070	990.7
1989	546	4,890	279,454	57.15	26	113	263,017	2,327.58	73	600	79,365	132.28	9	63	35,218	559.0
1990	617	5,718	340,318	59.52	21	91	105,841	1,163.09	58	577	245,178	424.92	15	118	283,108	2,399.2
1991	612	6,414	440,419	68.67	26	121	102,669	848.50	55	532	145,638	273.76	13	94	240,900	2,562.7
1992	663	7,115	493,187	69.32	16	73	47,720	653.70	67	700	192,317	274.74	20	186	298,547	1,605.0
1993	587	6,044	403,978	66.84	8	27	23,160	857.78	71	922	198,350	215.13	20	277	464,809	1,678.0
1994	605	6,023	389,646	64.69	12	35	29,766	850.46	67	748	174,593	233.41	15	109	238,403	2,187.1
1995	589	5,626	335,008	59.55	18	54	294,130	5,446.85	72	717	147,546	205.78	14	129	300,961	2,333.0

	Inshore handline				Purse Seine Net (Pelagic)				Lay Gill Net				Seine Net			
Fiscal year	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE
1996	641	6,813	466,273	68.44	14	88	276,929	3,146.92	66	747	201,023	269.11	15	162	99,743	615.70
1997	705	7,550	472,493	62.58	9	27	50,949	1,887.00	64	747	237,614	318.09	17	146	139,146	953.05
1998	706	7,630	444,827	58.30	8	35	28,328	809.37	52	712	245,845	345.29	16	190	751,628	3,955.9
1999	583	6,419	430,366	67.05	6	73	62,049	849.99	52	674	247,793	367.65	20	188	643,390	3,422.2
2000	571	6,891	424,637	61.62	7	48	105,931	2,206.90	42	680	254,315	373.99	13	130	667,234	5,132.5
2001	546	6,259	387,024	61.83	3	22	4,397	199.86	37	616	179,294	291.06	18	116	613,925	5,292.4
2002	477	5,270	302,263	57.36					37	467	92,792	198.70	10	65	361,127	5,555.8
2003	389	4,603	348,882	75.79					47	553	182,512	330.04	3	14	53,886	3,849.0
2004	326	4,006	285,912	71.37					43	489	168,519	344.62				
2005	268	3,300	207,353	62.83					49	447	174,188	389.68				
2006	267	2,735	203,121	74.27					38	385	110,986	288.28				
2007	315	3,625	277,237	76.48					28	327	156,379	478.22				
2008	284	3,309	226,576	68.47					31	287	150,939	525.92				
2009	390	4,252	285,604	67.17					36	203	86,770	427.44				
2010	383	4,492	308,265	68.63					39	328	145,384	443.24				

Fiscal year	Inshore handline				Purse Seine Net (Pelagic)				Lay Gill Net				Seine Net			
	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE
2011	365	4,108	287,232	69.92					39	407	217,742	534.99				
2012	339	3,801	237,514	62.49					33	398	201,600	506.53				
2013	346	3,418	236,703	69.25					41	441	178,374	404.48				
2014	283	2,923	197,917	67.71					34	462	186,917	404.58				
2015	236	2,691	198,835	73.89					39	507	243,522	480.32				
10 yr ave	324	3,596	246,752	68.72	N/A	N/A	N/A	N/A	37	369	160,928	440.34	N/A	N/A	N/A	N/A
20 yr ave	439	4,852	318,260	66.56	9	50	117,530	2,078.13	44	504	178,327	372.38	14	127	403,449	3,456.6

n.d. = non-disclosure due to data confidentiality

1.4 Crustacean

1.4.1 Fishery Descriptions

This species group category is comprised of the *Heterocarpus* deep water shrimps (*H. laevigatus* and *H. ensifer*), spiny (*Panulirus marginatus* and *P. Penicillatus*) and slipper lobsters (*S. haanii* and *S. squammosus*), kona crab (*R. ranina*), kuahonu crab (*P. Sanguinolentus*), Hawaiian crab (*P. vigil*), Opaelolo (*Penaeus marginatus*), and aama crab (*G. tenuicrustatus*). The main gear types are shrimp trap, loop net, trap miscellaneous, and crab trap.

1.4.2 Dashboard Statistics

The collection of commercial Crustacean fishing reports comes from two sources: paper report received by mail or fax or pdf copy of it via e-mail; and report filed online through the Online Fishing Report system (OFR). The Crustacean landings are reported by commercial fishers on the Monthly Fishing Report or the Net, Trap, Dive Activity Report or the MHI Deep-7 Bottomfish Fishing Trip Report.

Refer to data processing procedures documented in the Deep-7 BMUS section for paper fishing reports and fishing reports filed online. Database assistants and data monitoring associates will enter the paper Monthly Fishing Report information within 4 weeks, and the Net, Trap, Dive Activity Report and the MHI Deep-7 Bottomfish Fishing Trip Report within 2 business days.

1.4.2.1 Historical Summary

Table 24. Annual fishing parameters for the Crustacean fishery comparing current values with short-term (10 years) and long-term (20 years) averages.

Fishery	Parameters	2015 Values	2015 Comparative Trends	
			Short Average (last 10 years)	Long Average (last 20 years)
Crustacean	No. License	58	↓ 22.1%	↓ 44.8%
	Trips	676	↓ 10.5%	↓ 9.5%
	No. Caught	369,612	↑ 15.6%	↓ 11.3%
	Lbs. Caught	65,521	↓ 13.3%	↓ 17.5%

1.4.2.2 Species Summary

Table 25. Annual species indicators for the Crustacean fishery comparing current estimates with the short-term (10 years) and the long-term (20 years) average.

Fishery	Species	2015 Catch (lbs)	2015 Comparative Trends	
			Short Average	Long Average

			(last 10 years)	(last 20 years)
Crustacean	Levigatus	27,163	↓ 38.0%	↓ 42.8%
	Kona Crab	2,332	↓ 74.2%	↓ 83.9%
	Kauhonu Crab*	38,280	↑ 39.9%	↑ 115.4%

*Kauhonu crab comparison is for 2014 fiscal year catch

1.4.3 Time Series Statistics

1.4.3.1 Commercial Fishing Parameters

Table 26. Time series of commercial fishermen reports for Crustacean fishery (1966-2015).

Fiscal year	No. License	Trips	No. Reports	No. Caught	Lbs. Caught
1966	64	805	71	60,500	33,264
1967	74	759	82	62,578	38,359
1968	56	592	62	77,659	40,873
1969	84	817	100	125,521	56,873
1970	75	886	96	200,089	82,730
1971	94	1,248	114	353,871	104,014
1972	92	1,070	109	161,097	119,988
1973	77	942	88	226,240	107,373
1974	113	911	135	284,481	80,283
1975	109	1,123	138	255,115	89,689
1976	125	1,041	151	281,110	74,056
1977	125	1,199	153	248,854	64,335
1978	138	781	165	233,183	68,289
1979	115	472	140	122,243	42,366
1980	111	487	138	86,590	24,689
1981	117	631	133	55,824	27,680
1982	111	740	140	159,947	30,683

Fiscal year	No. License	Trips	No. Reports	No. Caught	Lbs. Caught
1983	121	865	146	273,372	38,359
1984	171	1,254	197	2,235,322	238,826
1985	160	1,358	191	747,084	110,526
1986	160	1,000	200	77,348	53,374
1987	173	1,048	206	103,821	51,870
1988	124	806	146	170,777	48,713
1989	106	596	130	502,756	74,013
1990	122	747	148	3,654,923	377,734
1991	132	845	157	845,264	123,992
1992	148	935	169	186,846	77,038
1993	129	831	148	482,384	86,093
1994	130	821	145	607,153	101,006
1995	140	856	154	873,802	117,203
1996	172	1,016	196	807,752	119,882
1997	159	785	185	617,161	79,349
1998	157	945	179	312,568	80,900
1999	157	802	177	2,030,152	242,736
2000	149	782	175	173,927	53,546
2001	128	615	143	58,519	34,803
2002	113	576	130	82,605	32,919
2003	98	500	130	114,897	35,703
2004	85	500	98	62,658	36,340
2005	83	740	95	643,766	98,315
2006	74	790	96	548,154	146,245
2007	59	588	76	94,426	41,582

Fiscal year	No. License	Trips	No. Reports	No. Caught	Lbs. Caught
2008	68	727	87	160,455	67,125
2009	83	764	103	160,732	59,564
2010	79	880	100	180,014	70,786
2011	94	768	117	168,921	60,295
2012	75	671	100	146,140	40,936
2013	64	758	82	280,244	69,670
2014	66	870	84	815,091	100,880
2015	58	676	74	369,612	65,521
10 yr ave	75	756	94	319,794	75,540
20 yr ave	105	747	125	416,599	79,439

1.4.4 Top 4 Species Per Gear Type

1.4.4.1 Shrimp Trap

This gear code was established in 1985. Prior to 1985 all trap activities were reported under trap miscellaneous gear. The principal species taken by shrimp trap or shrimp pot are the deep water heterocarpus shrimp. There are only a hand-full of resident fishers in the state who actively fish for heterocarpus. This fishery pulses every 5 to 7 years when large vessels from the mainland return to the islands to harvest the heterocarpus, then land it in the state for export to external markets.

Table 27. . HDAR MHI Fiscal Annual Crustacean Catch (Lbs. caught) Summary (1987 - 2015) by species and Top Gear: Shrimp trap.

	Laevigatus		Ensifer		Opaelolo		A'ama	
Fiscal year	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1987	3	1,796	n.d.	n.d.	n.d.	n.d.		
1988	n.d.	n.d.	3	1,568				
1989	n.d.	n.d.	n.d.	n.d.				
1990	5	341,780	n.d.	n.d.				
1991	n.d.	n.d.						

Fiscal year	Laevigatus		Ensifer		Opaelolo		A'ama	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1992	n.d.	n.d.			n.d.	n.d.		
1993	n.d.	n.d.						
1994	4	47,737	n.d.	n.d.				
1995	6	69,962	n.d.	n.d.	n.d.	n.d.		
1996	4	67,077	n.d.	n.d.	n.d.	n.d.		
1997	8	32,564	n.d.	n.d.	n.d.	n.d.		
1998	7	21,157	n.d.	n.d.	n.d.	n.d.		
1999	5	185,139	n.d.	n.d.				
2000	3	11,770	n.d.	n.d.				
2001	4	6,307	n.d.	n.d.	n.d.	n.d.		
2002	n.d.	n.d.						
2003	3	4,284	n.d.	n.d.				
2004	n.d.	n.d.						
2005	4	51,996	n.d.	n.d.				
2006	5	99,718	n.d.	n.d.				
2007	n.d.	n.d.	n.d.	n.d.				
2008	n.d.	n.d.	n.d.	n.d.				
2009	n.d.	n.d.	n.d.	n.d.				
2010	n.d.	n.d.	n.d.	n.d.			n.d.	n.d.
2011	n.d.	n.d.	n.d.	n.d.				
2012	4	6,854	n.d.	n.d.				
2013	5	12,759	n.d.	n.d.				
2014	10	47,764	5	927				
2015	7	27,163	3	21				

Fiscal year	Laevigatus		Ensifer		Opaelolo		A'ama	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
10 yr ave	6	43,818	N/A	N/A	N/A	N/A	N/A	N/A
20 yr ave	5	47,489	N/A	N/A	N/A	N/A	N/A	N/A

n.d. = non-disclosure due to data confidentiality

1.4.4.2 Loop Net

The driver species for this gear is the kona crab with the kuahonu or white crab making up the bycatch. The level of fishing effort and landings has gradually declined since 2000. The state established or amended several regulations on the taking and sale of kona crab. Besides longstanding restrictions for minimum size, berried females and closed season, the added prohibition of taking females hampered the fishing effort of fishers and may have discouraged them from further participation in the fishery. Another factor that impacted the decline in kona crab landings was the retirement of a longtime highline fisher from this fishery a few years ago.

Table 28. HDAR MHI Fiscal Annual Crustacean Catch (Lbs. caught) Summary (1966 - 2015) by species and 2nd Gear: Loop net.

Fiscal year	Kona crab		Kuahonu crab		Spiny lobster		Samoan crab	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1966	21	10,029						
1967	30	17,444						
1968	25	26,419						
1969	28	35,939						
1970	29	35,033						
1971	38	42,977						
1972	40	69,328						
1973	32	62,455						
1974	49	39,121						
1975	58	23,996						

Fiscal year	Kona crab		Kuahonu crab		Spiny lobster		Samoan crab	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1976	50	23,195	n.d.	n.d.			n.d.	n.d.
1977	33	15,966						
1978	60	28,582						
1979	51	24,674						
1980	39	8,162						
1981	47	12,141						
1982	48	8,291						
1983	48	9,009			n.d.	n.d.		
1984	58	12,910						
1985	71	20,916						
1986	80	27,200						
1987	62	16,310						
1988	47	12,475						
1989	32	11,790	4	668				
1990	32	16,118						
1991	44	22,789						
1992	71	34,291						
1993	66	25,305	n.d.	n.d.				
1994	70	23,783						
1995	77	22,763						
1996	88	30,581						
1997	86	28,893	n.d.	n.d.				
1998	82	28,611	n.d.	n.d.				
1999	90	25,417	n.d.	n.d.				

Fiscal year	Kona crab		Kuahonu crab		Spiny lobster		Samoan crab	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
2000	84	16,908	n.d.	n.d.				
2001	61	10,035	n.d.	n.d.				
2002	64	11,372	n.d.	n.d.				
2003	51	11,755	3	17				
2004	49	12,716	n.d.	n.d.				
2005	51	11,750	n.d.	n.d.				
2006	38	9,143	3	58				
2007	33	5,653	n.d.	n.d.				
2008	35	13,197	3	14				
2009	43	7,519	3	15				
2010	39	11,449	3	12				
2011	49	10,616	n.d.	n.d.				
2012	41	8,149	n.d.	n.d.				
2013	28	9,551	n.d.	n.d.				
2014	29	2,999	3	19				
2015	24	2,293	n.d.	n.d.				
10 yr ave	39	9,003	N/A	N/A	N/A	N/A	N/A	N/A
20 yr ave	56	14,454	N/A	N/A	N/A	N/A	N/A	N/A

n.d. = non-disclosure due to data confidentiality

1.4.4.3 Trap (Misc.)

When the revised fishing reports were implemented in October 2002, DAR launched an outreach campaign to inform fishers to report specific trap gears. Fishers were contacted to verify reports with miscellaneous trap in an effort to categorize method as a specific trap gear.

Table 29. HDAR MHI Fiscal Annual Crustacean Catch (Lbs. caught) Summary (1966 - 2015) by species and 3rd Gear: Trap (misc.).

Fiscal year	Kuahonu crab		Laevigatus		Spiny lobster		Opaelolo	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1966	3	5,399			12	2,683		
1967	5	4,070			9	2,180		
1968	4	2,757			9	1,714		
1969	8	2,488			14	4,142		
1970	7	19,012			8	1,983	n.d.	n.d.
1971	11	42,507			11	1,878	n.d.	n.d.
1972	8	39,091			12	2,886		
1973	8	34,095			10	3,945		
1974	11	28,858			14	3,969	n.d.	n.d.
1975	11	52,730			13	2,599	3	245
1976	11	29,457			10	1,619	n.d.	n.d.
1977	10	10,024			14	4,382	n.d.	n.d.
1978	7	17,015			14	5,383	4	1,681
1979	3	3,409			12	2,139	n.d.	n.d.
1980	5	1,590			15	4,303	4	2,889
1981	5	2,054			11	2,372	4	2,086
1982	5	2,693	n.d.	n.d.	12	4,937	8	7,497
1983	3	2,832	n.d.	n.d.	16	4,639	7	11,289
1984	5	3,167	7	197,277	19	11,279	n.d.	n.d.
1985	6	7,437	5	60,781	22	9,347		
1986	n.d.	n.d.			3	465	n.d.	n.d.
1987	n.d.	n.d.			3	179		
1988	n.d.	n.d.			n.d.	n.d.		
1989					n.d.	n.d.		

Fiscal year	Kuahonu crab		Laevigatus		Spiny lobster		Opaelolo	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1990					n.d.	n.d.		
1991	n.d.	n.d.			n.d.	n.d.		
1992	n.d.	n.d.						
1993	n.d.	n.d.						
1994	n.d.	n.d.						
1995	n.d.	n.d.						
1996	n.d.	n.d.						
1997	n.d.	n.d.						
1998	n.d.	n.d.			3	95		
1999	n.d.	n.d.			3	20		

n.d. = non-disclosure due to data confidentiality

1.4.4.4 Crab Trap

The gear code for crab trap was established in 1985. Prior to 1985 all trap activities were reported under trap miscellaneous gear. The driver species for this gear is the kuahonu or white crab. Throughout the time series, there is a small group of fishers participating in this fishery numbering no more than eight (8) in a year. There is a market demand for kuahonu crab and the landings are trending upwards for the past eight (8) years, except for 2015 (undisclosed because of data confidentiality.)

Table 30. HDAR MHI Fiscal Annual Crustacean Catch (Lbs. caught) Summary (1986 - 2015) by species and 4th Gear: Crab trap.

Fiscal year	Kuahonu crab		Kona crab		Samoan crab		Spiny lobster	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1986	8	8,965	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1987	8	10,864	5	3,513			n.d.	n.d.
1988	3	3,571						
1989	4	6,247	n.d.	n.d.				

Fiscal year	**Kuahonu crab**		**Kona crab**		**Samoan crab**		**Spiny lobster**	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1990	7	6,417	3	2,117				
1991	5	19,372	n.d.	n.d.				
1992	5	17,176	4	2,360				
1993	7	18,297	n.d.	n.d.	n.d.	n.d.		
1994	5	22,408	n.d.	n.d.	n.d.	n.d.		
1995	3	13,805			n.d.	n.d.		
1996	n.d.	n.d.			n.d.	n.d.		
1997	3	4,426	n.d.	n.d.	n.d.	n.d.		
1998	3	3,279	n.d.	n.d.				
1999	6	13,106	3	83			n.d.	n.d.
2000	4	12,983	n.d.	n.d.				
2001	6	8,816	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
2002	4	4,366	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
2003	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
2004	n.d.	n.d.	n.d.	n.d.				
2005	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.		
2006	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.		
2007	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.		
2008	4	32,474	n.d.	n.d.	n.d.	n.d.		
2009	4	32,525	n.d.	n.d.	5	505		
2010	3	38,487	n.d.	n.d.	n.d.	n.d.		
2011	5	28,633	3	270	n.d.	n.d.		
2012	4	13,961	n.d.	n.d.	n.d.	n.d.		
2013	3	34,398	n.d.	n.d.	3	178		

Fiscal year	**Kuahonu crab**		**Kona crab**		**Samoan crab**		**Spiny lobster**	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
2014	4	38,261	n.d.	n.d.	n.d.	n.d.		
2015	n.d.	n.d.	3	39	n.d.	n.d.		

n.d. = non-disclosure due to data confidentiality

1.4.5 Catch Parameters by Gear

Table 31. Time series of CPUE by dominant fishing methods from Crustaceans (1966-2015).

	Shrimp trap				Kona crab net (loop)				Trap (misc.)				Crab trap			
Fiscal year	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE
1966					21	178	10,029	56.34	14	430	15,088	35.09				
1967					30	185	17,444	94.29	13	366	13,050	35.66				
1968					25	167	26,419	158.20	12	206	8,785	42.65				
1969					28	232	35,939	154.91	22	301	10,734	35.66				
1970					29	195	35,033	179.66	15	339	24,429	72.06				
1971					38	241	42,977	178.33	21	590	49,430	83.78				
1972					40	259	69,328	267.68	18	491	44,080	89.78				
1973					32	230	62,455	271.54	15	495	40,430	81.68				
1974					49	199	39,121	196.59	24	481	35,987	74.82				
1975					58	233	23,996	102.99	23	616	56,667	91.99				
1976					50	205	23,256	113.44	21	510	33,147	64.99				
1977					33	133	15,966	120.05	23	426	18,149	42.60				
1978					60	227	28,582	125.91	21	278	27,316	98.26				
1979					51	188	24,674	131.24	15	101	7,828	77.50				
1980					40	101	8,192	81.11	24	177	11,057	62.47				

Fiscal year	Shrimp trap				Kona crab net (loop)				Trap (misc.)				Crab trap			
	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE
1981					47	143	12,141	84.90	19	235	6,923	29.46				
1982					48	163	8,291	50.87	23	344	15,424	44.84				
1983					48	148	9,305	62.87	24	406	21,291	52.44				
1984					58	178	12,910	72.53	30	700	218,324	311.89				
1985					71	309	20,916	67.69	33	712	81,665	114.70				
1986					80	302	27,200	90.07	5	15	1,245	83.00	10	201	9,261	46.07
1987	5	26	3,481	134	62	158	16,310	103.23	5	33	1,379	41.79	12	231	14,613	63.26
1988	3	44	12,934	294	47	179	12,475	69.69	n.d.	n.d.	n.d.	n.d.	3	81	3,571	44.09
1989	n.d.	n.d.	n.d.	n.d.	33	140	12,458	88.99	3	3	20	6.67	4	124	7,534	60.76
1990	5	87	343,102	3,944	32	130	16,118	123.98	n.d.	n.d.	n.d.	n.d.	12	129	8,615	66.78
1991	n.d.	n.d.	n.d.	n.d.	44	161	22,789	141.55	4	9	110	12.22	8	223	19,483	87.37
1992	n.d.	n.d.	n.d.	n.d.	71	316	34,291	108.52	4	27	3,137	116.19	9	211	19,724	93.48
1993	n.d.	n.d.	n.d.	n.d.	66	309	25,306	81.90	n.d.	n.d.	n.d.	n.d.	9	181	18,945	104.67
1994	4	75	49,505	660	70	245	23,783	97.07	n.d.	n.d.	n.d.	n.d.	7	216	22,580	104.54
1995	7	103	74,697	725	77	296	22,763	76.90					5	147	13,947	94.88
1996	5	190	70,386	370	88	329	30,581	92.95	3	11	892	81.09	3	42	8,500	202.38
1997	9	99	34,009	343	86	278	28,895	103.94	n.d.	n.d.	n.d.	n.d.	6	42	4,651	110.74
1998	8	82	21,537	263	82	307	28,632	93.26	4	70	12,310	175.86	5	50	3,717	74.34

	Shrimp trap				Kona crab net (loop)				Trap (misc.)				Crab trap			
Fiscal year	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE
1999	5	111	186,400	1,679	90	258	25,425	98.55	3	29	7,306	251.93	7	119	13,459	113.10
2000	3	72	11,798	164	84	195	16,914	86.74					4	125	13,145	105.16
2001	6	64	6,436	101	61	151	10,067	66.67					7	135	9,107	67.46
2002	n.d.	n.d.	n.d.	n.d.	64	179	11,382	63.59	n.d.	n.d.	n.d.	n.d.	5	75	4,479	59.72
2003	3	50	4,748	95	51	165	11,772	71.35	n.d.	n.d.	n.d.	n.d.	3	66	11,055	167.50
2004	n.d.	n.d.	n.d.	n.d.	49	158	12,721	80.51					3	69	13,618	197.36
2005	4	67	54,379	812	51	170	11,815	69.50					3	197	21,525	109.26
2006	5	163	103,857	637	38	160	9,201	57.51					3	122	21,787	178.58
2007	n.d.	n.d.	n.d.	n.d.	33	134	5,657	42.22					3	127	25,510	200.87
2008	n.d.	n.d.	n.d.	n.d.	35	221	13,211	59.78					5	182	32,829	180.38
2009	n.d.	n.d.	n.d.	n.d.	43	168	7,534	44.85					8	186	33,508	180.15
2010	n.d.	n.d.	n.d.	n.d.	39	209	11,461	54.84					6	207	38,846	187.66
2011	n.d.	n.d.	n.d.	n.d.	49	190	10,630	55.95					8	182	29,071	159.73
2012	4	95	7,140	75	41	129	8,154	63.21					4	105	14,123	134.50
2013	5	150	12,972	86	28	107	9,554	89.29					6	181	34,672	191.56
2014	10	316	48,691	154	29	59	3,017	51.14					5	193	38,583	199.91
2015	7	228	27,184	119	24	64	2,319	36.23					4	149	26,160	175.57
10 yr ave	6	158	45,408	353	39	155	9,023	58.83	N/A	N/A	N/A	N/A	5	168	29,045	172.26

Fiscal year	Shrimp trap				Kona crab net (loop)				Trap (misc.)				Crab trap			
	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE
20 yr ave	6	120	49,004	423	56	193	14,469	71.14	N/A	N/A	N/A	N/A	5	128	19,307	145.76

n.d. = non-disclosure due to data confidentiality

1.5 Mollusk and Limu

1.5.1 Fishery Descriptions

This species group category is comprised of seaweed or algae including miscellaneous *Gracilaria spp*., limu kohu (*A. taxiformis*), limu manauea (*G. coronopifolia*), ogo (*G. parvispora*), and limu wawaeiole (*U. fasciata*), and mollusks including clam (*T. phililippinarum*), he'e (*O. cyanea*), he'e pu loa (*O. ornatus*), octopus (*Octopus spp*.), hihiwai (*Theodoxus spp*.), opihi ‘alina (yellowfoot, *C. sandwicensis*), opihi makaiauli (black foot, *C. exarata*), opihi (*Cellana spp*.), pupu (top shell).

The top gears for this species group category are handpicked, spear and inshore handline.

1.5.2 Dashboard Statistics

The collection of commercial Mollusk and limu fishing reports comes from two sources: paper report received by mail or fax or pdf copy of it via e-mail; and report filed online through the Online Fishing Report system (OFR). The Mollusk and limu landings are reported by commercial fishers on the Monthly Fishing Report or the Net, Trap, Dive Activity Report.

Refer to data processing procedures documented in the Deep-7 BMUS section for paper fishing reports and fishing reports filed online. Database assistants and data monitoring associate will enter the paper Monthly Fishing Report information within fourweeks, and the Net, Trap, Dive Activity Report within two business days.

1.5.2.1 Historical Summary

Table 32. Annual fishing parameters for the Mollusk and Limu fishery comparing current values with short-term (10 years) and long-term (20 years) averages.

Fishery	Parameters	2015 Values	2015 Comparative Trends	
			Short Average (last 10 years)	Long Average (last 20 years)
Mollusk and Limu	No. License	58	↓ 9.6%	↓ 17.3%
	Trips	676	↓ 27.2%	↓ 8.2%
	No. Caught	369,612	↑ 38.0%	↑ 30.4%
	Lbs. Caught	65,521	↓ 1.1%	↑ 11.4%

1.5.2.2 Species Summary

Table 33. Annual species indicators for the Mollusk and Limu fishery comparing current values with the short-term (10 years) and the long-term (20 years) average.

Fishery	Species	2014	2014 Comparative Trends

		Parameters Catch (lbs)	Short Average (last 10 years)	Long Average (last 20 years)
Mollusk and Limu	He'e (day tako)	32,673	↑ 22.1%	N/A
	Opihi'alina	14,390	↑ 6.0%	↑ 13.8%
	Limu kohu	5,065	↑ 42.9%	↑ 66.15%
	Octopus (misc.)*	405	↓ 50.9%	↓ 96.5%
	Wawaeiole**	348	↓ 94.8%	↓ 93.1%

*data available for 7 of 10 and 17 of 20 years

**data available for 15 of 20 years

1.5.3 Time Series Statistics

1.5.3.1 Commercial Fishing Parameters

Table 34. Time series of commercial fishermen reports for Mollusk and Limu fishery (1966-2015).

Fiscal year	No. License	Trips	No. Reports	No. Caught	Lbs. Caught
1966	43	435	44	226,356	23,044
1967	75	996	76	574,669	44,221
1968	52	651	54	368,858	33,000
1969	71	831	73	414,202	72,176
1970	98	1,075	102	503,915	83,503
1971	103	1,133	108	274,772	85,479
1972	111	1,265	116	90,736	129,860
1973	119	1,363	125	368,863	125,317
1974	145	1,400	153	1,397,861	103,763
1975	136	1,294	143	110,120	91,586
1976	127	1,234	134	109,211	90,865
1977	169	1,632	180	373,829	133,804
1978	180	1,119	190	355,336	89,918

Fiscal year	No. License	Trips	No. Reports	No. Caught	Lbs. Caught
1979	186	738	196	248,918	58,359
1980	195	1,135	200	30,957	48,302
1981	153	1,376	159	255,429	36,955
1982	128	972	133	10,152	26,604
1983	138	867	141	115,073	24,502
1984	194	1,708	203	38,719	57,751
1985	160	1,837	171	30,168	50,431
1986	204	2,022	218	51,191	57,333
1987	247	2,526	264	222,303	71,628
1988	211	2,106	220	220,956	58,079
1989	208	2,135	222	29,118	47,015
1990	165	1,649	174	133,089	29,992
1991	175	1,551	190	129,239	30,730
1992	206	1,796	218	156,983	38,106
1993	195	1,891	207	101,551	41,109
1994	192	1,868	205	170,307	41,601
1995	186	2,033	199	236,813	55,517
1996	212	2,136	224	230,832	41,700
1997	207	1,832	218	16,407	38,267
1998	224	2,253	242	362,844	43,896
1999	214	1,972	228	198,377	35,968
2000	190	2,306	204	178,357	44,732
2001	185	2,384	195	105,805	52,219
2002	183	2,308	187	71,474	48,262
2003	150	2,267	159	231,025	46,540

Fiscal year	No. License	Trips	No. Reports	No. Caught	Lbs. Caught
2004	131	2,093	136	159,760	44,821
2005	104	2,187	108	33,767	46,550
2006	124	1,705	128	127,281	37,217
2007	112	1,491	120	179,844	33,332
2008	126	1,454	131	83,397	37,517
2009	135	1,740	138	663,168	57,779
2010	151	1,949	159	476,666	66,269
2011	149	2,151	153	519,540	67,042
2012	150	1,951	154	427,643	70,837
2013	144	1,951	152	343,559	78,324
2014	132	1,749	136	505,553	72,960
2015	120	1,334	125	463,594	56,136
10 yr ave	133	1,833	138	336,042	56,783
20 yr ave	160	1,996	169	257,606	50,987

1.5.4 Top Four Species Per Gear Type

1.5.4.1 Handpick

The top gear for this group category is handpick or gleaning. Fishers typically use their hands to gather seaweed or an instrument such as a knife to harvest opihi from the shoreline. Two specific species codes were established in 2002 for opihi. They are the yellow foot and black foot species. Prior to 2002, all opihi species were reported under opihi (misc.). The specific limu species were established in 1985. Prior to 1985, all seaweed species were reported under limu miscellaneous. When the revised fishing reports were implemented in October 2002, DAR launched an outreach campaign to inform fishers to report specific opihi and limu species.

Table 35. HDAR MHI Fiscal Annual Mollusk & Limu Catch (Lbs. caught) Summary (1966 – 2015) by Species and top Gear: Handpick.

Fiscal year	Opihi		Opihi 'alina		Wawaeiole		Limu kohu	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1966	13	13,989						

Fiscal year	Opihi		Opihi 'alina		Wawaeiole		Limu kohu	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1967	40	36,000						
1968	26	22,994						
1969	36	23,818						
1970	41	20,446						
1971	46	17,229						
1972	44	16,689						
1973	46	17,169						
1974	51	19,558						
1975	46	14,277						
1976	47	18,090						
1977	54	10,494						
1978	51	14,267						
1979	51	14,146						
1980	48	8,435						
1981	33	7,231						
1982	28	6,050						
1983	32	4,765						
1984	28	5,709						
1985	27	4,850			n.d.	n.d.	n.d.	n.d.
1986	61	10,607			6	4,238	9	2,119
1987	88	16,748			12	5,661	23	5,373
1988	70	11,989			6	6,254	14	2,313
1989	67	11,914			3	1,260	13	2,600
1990	56	7,848			4	1,441	12	3,319

Fiscal year	**Opihi**		**Opihi 'alina**		**Wawaeiole**		**Limu kohu**	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1991	55	7,618			4	1,954	24	3,180
1992	55	9,271			9	1,982	13	1,354
1993	38	5,587			6	2,529	14	1,709
1994	40	9,879			5	820	21	3,101
1995	50	13,462			7	1,086	19	2,868
1996	52	14,012			6	1,879	14	2,592
1997	45	10,291			6	2,346	17	3,547
1998	55	11,886			n.d.	n.d.	23	2,999
1999	43	12,028			n.d.	n.d.	9	1,832
2000	35	10,338			5	3,129	16	1,608
2001	31	12,385			5	7,328	15	1,941
2002	28	12,847			6	3,550	10	2,351
2003	19	4,392	15	7,300	4	2,694	10	2,606
2004	6	608	15	8,685	n.d.	n.d.	12	3,179
2005	n.d.	n.d.	10	8,240	n.d.	n.d.	7	1,728
2006	4	87	11	8,364	n.d.	n.d.	7	2,163
2007	4	165	14	6,487	5	2,158	12	1,480
2008	n.d.	n.d.	25	6,993	5	4,834	9	3,061
2009	n.d.	n.d.	19	14,866	9	4,013	12	3,120
2010	9	789	28	19,521	7	5,317	14	4,243
2011	n.d.	n.d.	18	16,183	5	5,458	10	4,643
2012	n.d.	n.d.	30	15,129	6	10,643	10	5,454
2013			18	16,475	8	18,864	9	4,895
2014	n.d.	n.d.	19	23,479	5	2,057	9	4,659

Fiscal year	Opihi		Opihi 'alina		Wawaeiole		Limu kohu	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
2015	n.d.	n.d.	19	14,390	3	348	12	5,065
10 yr ave	N/A	N/A	19	13,574	6	6,668	10	3,545
20 yr ave	N/A	N/A	19	12,644	6	5,024	12	3,048

n.d. = non-disclosure due to data confidentiality

1.5.4.2 Spear

For the secondary gear, spear, the driver species is octopus. Two specific species for octopus to distinguish the day species (*O. cyanea*) from night (*O. ornatus*) were established in 2002. Prior to 2002, all octopus species were reported under octopus (misc.). When the revised fishing reports were implemented in October 2002, DAR launched an outreach campaign to inform fishers to report specific octopus species. The use of spear may or may not include SCUBA apparatus. It is possible that the introduction of SCUBA may have increased fishing power and attributed to the overall increasing octopus landing trends. It should be noted that opihi and limu (misc.) species taken by this gear type are probably reporting discrepancies. Since 2002, fishers were contacted to verify the report discrepancy. The fish report remains unchanged if there is no response from fishers.

Table 36. HDAR MHI Fiscal Annual Mollusk & Limu Catch (Lbs. caught) Summary (1966 - 2015) by Species and 2nd Gear: Spear.

Fiscal year	Octopus (misc.)		He'e (day tako)		Opihi		Limu (misc.)	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1966	15	4,704						
1967	20	6,573						
1968	15	5,622			n.d.	n.d.		
1969	18	4,809						
1970	27	4,609						
1971	30	5,548						
1972	38	9,003						
1973	41	7,358						

Fiscal year	Octopus (misc.)		He'e (day tako)		Opihi		Limu (misc.)	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1974	54	9,234						
1975	59	9,637			n.d.	n.d.		
1976	51	7,267						
1977	58	12,594					n.d.	n.d.
1978	81	14,793			n.d.	n.d.		
1979	81	13,712						
1980	74	16,100			4	760		
1981	54	11,130						
1982	45	7,131			n.d.	n.d.		
1983	44	6,605			4	250	n.d.	n.d.
1984	66	13,411			n.d.	n.d.	n.d.	n.d.
1985	63	10,550			n.d.	n.d.		
1986	89	14,814			n.d.	n.d.		
1987	73	20,881			n.d.	n.d.		
1988	68	13,547						
1989	71	15,351			n.d.	n.d.		
1990	52	6,881						
1991	58	7,293						
1992	71	9,357						
1993	71	10,973						
1994	75	12,252						
1995	74	11,505						
1996	94	11,663						
1997	89	14,233			n.d.	n.d.		

Fiscal year	Octopus (misc.)		He'e (day tako)		Opihi		Limu (misc.)	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1998	100	17,594						
1999	94	11,668						
2000	84	18,924						
2001	80	18,857						
2002	73	15,002						
2003	48	11,536	33	5,340				
2004	17	1,012	51	12,592	n.d.	n.d.		
2005	20	2,144	45	13,028				
2006	4	630	56	11,489				
2007	n.d.	n.d.	47	12,472	n.d.	n.d.		
2008			62	14,432				
2009	5	133	68	21,865				
2010	7	115	63	22,351				
2011			75	27,910				
2012	4	72	67	29,521				
2013	11	652	69	28,044				
2014	4	468	61	29,873				
2015	6	173	53	29,332				
10 yr ave	8	602	61	21,099	N/A	N/A	N/A	N/A
20 yr ave	48	8,012	58	19,076	N/A	N/A	N/A	N/A

n.d. = non-disclosure due to data confidentiality

1.5.4.3 Inshore Handline

Another popular method to take octopus, especially for the day species, is using a cowrie shell dragged by handline along the bottom. This gear also reported under inshore handline. It should be noted that hihiwai and limu (misc.) species taken by this gear type are probably reporting discrepancies. Since 2002, fishers were contacted to verify the report discrepancy. The fish report remains unchanged if there is no response from fishers.

Table 37. HDAR MHI Fiscal Annual Mollusk & Limu Catch (Lbs. caught) Summary (1966 - 2015) by Species and 3rd Gear: Inshore handline.

Fiscal year	Octopus (misc.)		He'e (day tako)		Limu (misc.)		Hihiwai	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1966	6	139						
1967	7	117						
1968	4	83						
1969	5	43						
1970	6	423						
1971	6	69						
1972	8	249						
1973	12	482						
1974	15	400						
1975	12	254						
1976	9	459						
1977	13	340						
1978	29	1,920						
1979	43	3,927						
1980	47	5,377						
1981	49	5,003						
1982	35	2,914						
1983	39	6,090						
1984	56	14,503			3	763	n.d.	n.d.
1985	46	7,914						

Fiscal year	Octopus (misc.)		He'e (day tako)		Limu (misc.)		Hihiwai	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
1986	43	10,429						
1987	44	12,402						
1988	46	17,047						
1989	33	5,390						
1990	30	3,893						
1991	25	5,635						
1992	45	6,322						
1993	44	8,729						
1994	41	5,333						
1995	30	4,566						
1996	37	7,315						
1997	40	4,468						
1998	46	6,874						
1999	46	5,798						
2000	41	6,264						
2001	40	5,966						
2002	42	7,653						
2003	31	6,442	7	735				
2004	10	978	22	5,994				
2005	12	1,099	14	4,832				
2006	n.d.	n.d.	23	7,416				
2007			15	7,156				
2008			13	3,960				
2009			19	7,399				

Fiscal year	Octopus (misc.)		He'e (day tako)		Limu (misc.)		Hihiwai	
	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught	No. License	Lbs. Caught
2010	n.d.	n.d.	16	4,622				
2011			27	5,427				
2012	n.d.	n.d.	19	4,500				
2013	7	312	25	5,476				
2014	6	153	19	5,903				
2015	5	232	24	3,341				
10 yr ave	8	521	19	5,669	N/A	N/A	N/A	N/A
20 yr ave	30	4,453	18	5,285	N/A	N/A	N/A	N/A

n.d. = non-disclosure due to data confidentiality

1.5.5 Catch Parameters by Gear

Table 38. Time series of CPUE by dominant fishing methods from Mollusk and Limu (1966-2015).

Fiscal year	Handpicked				Spear				Inshore Handline			
	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE
1966	13	172	14,584	84.79	15	131	4,704	35.91	6	16	139	8.69
1967	41	783	36,210	46.25	20	128	6,573	51.35	7	15	117	7.80
1968	26	454	23,766	52.35	16	120	5,813	48.44	4	6	83	13.83
1969	37	415	23,968	57.75	18	101	4,809	47.61	5	8	43	5.38
1970	43	401	21,089	52.59	27	126	4,609	36.58	6	21	423	20.14
1971	48	372	17,980	48.33	30	196	5,548	28.31	6	9	69	7.67
1972	45	273	18,519	67.84	38	209	9,003	43.08	8	15	249	16.60
1973	47	275	19,462	70.77	41	235	7,358	31.31	12	37	482	13.03
1974	54	389	24,946	64.13	54	302	9,234	30.58	15	28	400	14.29
1975	49	363	17,553	48.36	60	322	9,709	30.15	12	18	254	14.11
1976	47	304	18,283	60.14	51	287	7,267	25.32	9	25	459	18.36

Fiscal year	Handpicked				Spear				Inshore Handline			
	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE
1977	54	247	10,518	42.58	58	450	12,854	28.56	13	20	340	17.00
1978	52	222	14,375	64.75	82	430	14,803	34.43	29	77	1,920	24.94
1979	51	183	14,174	77.45	81	335	13,712	40.93	43	83	3,927	47.31
1980	48	199	8,435	42.39	77	415	16,860	40.63	47	139	5,377	38.68
1981	33	199	7,231	36.34	54	394	11,130	28.25	49	187	5,003	26.75
1982	28	156	6,054	38.81	45	284	7,154	25.19	35	156	2,914	18.68
1983	33	154	4,871	31.63	47	298	6,891	23.12	39	210	6,090	29.00
1984	29	135	5,761	42.67	66	493	13,656	27.70	60	410	15,484	37.77
1985	27	170	5,600	32.94	63	494	10,613	21.48	46	296	7,914	26.74
1986	82	891	25,441	28.55	89	582	14,879	25.57	43	392	10,429	26.60
1987	126	1,373	32,771	23.87	74	694	21,164	30.50	44	387	12,402	32.05
1988	95	1,113	25,112	22.56	68	482	13,547	28.11	46	463	17,047	36.82
1989	100	1,415	24,568	17.36	72	530	15,565	29.37	33	175	5,390	30.80
1990	95	1,212	18,718	15.44	52	279	6,881	24.66	30	143	3,893	27.22
1991	102	1,108	17,336	15.65	58	307	7,293	23.76	25	123	5,635	45.81
1992	101	1,068	17,354	16.25	71	496	9,357	18.86	45	201	6,322	31.45
1993	86	1,057	14,088	13.33	71	454	10,973	24.17	44	323	8,729	27.02
1994	90	1,116	17,676	15.84	75	538	12,252	22.77	41	185	5,333	28.83
1995	91	1,293	20,693	16.00	74	526	11,505	21.87	30	170	4,566	26.86
1996	87	991	21,487	21.68	94	850	11,663	13.72	37	251	7,315	29.14
1997	85	921	18,884	20.50	89	660	14,268	21.62	40	215	4,468	20.78
1998	90	1,046	17,975	17.18	100	920	17,594	19.12	46	242	6,874	28.40
1999	82	952	17,610	18.50	94	738	11,668	15.81	46	245	5,798	23.67
2000	80	1,054	18,559	17.61	84	986	18,924	19.19	41	229	6,264	27.35
2001	74	1,276	27,040	21.19	80	863	18,857	21.85	40	211	5,966	28.27
2002	68	1,354	24,731	18.27	73	698	15,002	21.49	43	210	7,665	36.50

Fiscal year	Handpicked				Spear				Inshore Handline			
	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE	No. License	No. trips	Lbs. Caught	CPUE
2003	55	1,298	22,055	16.99	60	689	16,876	24.49	33	248	7,176	28.94
2004	45	1,299	23,713	18.25	54	496	13,633	27.49	23	265	7,015	26.47
2005	33	1,294	21,018	16.24	49	573	15,171	26.48	20	275	5,931	21.57
2006	39	742	16,279	21.94	57	607	12,119	19.97	23	300	7,434	24.78
2007	43	540	12,479	23.11	49	633	12,505	19.76	15	250	7,156	28.62
2008	50	640	17,369	27.14	62	564	14,465	25.65	13	169	3,960	23.43
2009	49	723	27,177	37.59	70	728	21,998	30.22	19	233	7,399	31.76
2010	64	923	36,790	39.86	65	702	22,641	32.25	17	216	4,655	21.55
2011	45	973	32,765	33.67	75	881	27,918	31.69	27	208	5,427	26.09
2012	57	795	36,136	45.45	71	911	29,616	32.51	20	193	4,533	23.49
2013	43	824	43,556	52.86	77	871	28,722	32.98	30	219	5,788	26.43
2014	39	683	35,642	52.18	63	801	30,341	37.88	25	183	6,056	33.09
2015	34	487	22,463	46.13	58	679	29,505	43.45	27	103	3,572	34.68
10 yr ave	46	814	27,921	35.01	64	727	21,550	28.94	21	225	5,834	26.08
20 yr ave	61	981	24,598	26.81	72	735	18,274	24.80	29	227	6,072	26.86

1.6 Precious Corals Fishery

Precious corals data will be made available in subsequent reports, as resources allow, and if fisheries data may be considered non-confidential.

1.7 Status Determination Criteria

1.7.1 Bottomfish and Crustacean Fishery

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

The maximum sustainable yield (MSY) control rule is used as the maximum fishing mortality threshold (MFMT). The MFMT and minimum stock size threshold (MSST) are specified based on recommendations in Restrepo et al. (1998) and both are dependent on the natural mortality rate (M). The value of M used to determine the reference point values are not specified in this document. The latest estimate, published annually in the SAFE report, is used and the value is occasionally re-estimated using the best available information. The range of M among species within a stock complex is taken into consideration when estimating and choosing the M to be used for the purpose of computing the reference point values.

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

Table 39. Overfishing threshold specifications for the bottomfish and crustacean management unit species in Hawaii (

Table 39).

Table 39. Overfishing threshold specifications for the bottomfish and crustacean management unit species in Hawaii

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

Standardized values of fishing effort (E) and catch-per-unit-effort (CPUE) are used as proxies for F and B, respectively, so E_{MSY}, $CPUE_{MSY}$, and $CPUE_{FLAG}$ are used as proxies for F_{MSY}, B_{MSY}, and B_{FLAG}, respectively.

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

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

Table 40. Again, E_{MSY} is used as a proxy for F_{MSY}.

Table 40. Rebuilding control rules for the bottomfish and crustacean management unit species in Hawaii

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

1.7.2 Coral Reef Fishery

Available biological and fishery data are poor for all coral reef ecosystem management unit species in the Hawaiian Islands. There is scant information on the life histories, ecosystem dynamics, fishery impact, community structure changes, yield potential, and management reference points for many coral reef ecosystem species. Additionally, total fishing effort cannot be adequately partitioned between the various management unit species (MUS) for any fishery or area. Biomass, maximum sustainable yield, and fishing mortality estimates are not available for any single MUS. Once these data are available, fishery managers can establish limits and reference points based on the multi-species coral reef ecosystem as a whole.

When possible, the MSY control rule should be applied to the individual species in a multi-species stock. When this is not possible, MSY may be specified for one or more species; these values can then be used as indicators for the multi-species stock's MSY.

Individual species that are part of a multi-species complex will respond differently to an OY-determined level of fishing effort (F_{OY}). Thus, for a species complex that is fished at F_{OY}, managers still must track individual species' mortality rates in order to prevent species-specific population declines that would lead to depletion.

For the coral reef fishery, the multi-species complex as a whole is used to establish limits and reference points for each area. When possible, available data for a particular species are used to evaluate the status of individual MUS stocks in order to prevent recruitment overfishing. When better data and the appropriate multi-species stock assessment methodologies become available, all stocks will be evaluated independently, without proxy.

Establishing Reference Point Values

Standardized values of catch per unit effort (CPUE) and effort (E) are used to establish limit and reference point values, which act as proxies for relative biomass and fishing mortality, respectively. Limits and reference points are calculated in terms of $CPUE_{MSY}$ and E_{MSY} included in **Error! Reference source not found.**.

Table 41. Status determination criteria for the coral reef management unit species using CPUE-based proxies

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

When reliable estimates of E_{MSY} and $CPUE_{MSY}$ are not available, they are generated from time series of catch and effort values, standardized for all identifiable biases using the best available analytical tools. $CPUE_{MSY}$ is calculated as one-half a multi-year moving average reference CPUE ($CPUE_{REF}$).

1.7.3 Current Stock Status

1.7.3.1 Deep-7 Bottomfish Management Unit Species Complex

Despite availability of catch and effort (from which CPUE is derived), some life history, and fishery independent information, the main Hawaiian island Deep-7 BMUS complex is still considered as data moderate. The stock assessment is conducted on a subset of the population that is being actively managed because of the closure of the Northwestern Hawaiian Islands to commercial fishing. The assessment is also conducted on the species complex because a typical bottom fishing trip is comprised primarily of these seven species.

Generally, data are only available on commercial landings by species and catch-per-unit-effort (CPUE) for the multi-species complexes as a whole. The assessment utilized a state-space surplus production model with explicit process and observation error terms (Meyer and Millar 1999). Determinations of overfishing and overfished status can then be made by comparing current biomass and harvest rates to MSY level reference points. To date, the main Hawaiian island Deep-7 bottomfish complex is not subject to overfishing and is not overfished (Table 42).

Table 42. Stock assessment parameters for the main Hawaiian island Deep-7 complex (Boggs memo 3/3/2015)

Parameter	**Value**	**Notes**	**Status**
MSY	0.404 ± 0.156	Expressed in million lbs (± std error)	

H_{2013}	3.8 ± 1.4	Expressed in percentage	
H_{MSY}	6 ± 2.1	Expressed in percentage (± std error)	
H/H_{MSY}	0.627		No overfishing occurring
B_{2013}	13.34 ± 5.397	Expressed in million pounds	
B_{MSY}	14.51 ± 4.267	Expressed in million lbs (± std error)	
B/ B_{MSY}	0.930		Not overfished

1.7.3.2 Coral reef

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

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

Table 43. The SSC utilized the MSYs for the coral reef MUS complexes as the OFLs.

Table 43. Best available MSY estimates for the coral reef MUS in Hawaii

Fishery	**Management Unit Species**	**MSY (lbs)**
Coral Reef Ecosystem	*Selar crumenopthalmus* – akule	1,150,800
	Decapterus macarellus – opelu	538,000
	Acanthuridae-surgeonfish	445,500
	Carangidae-jacks	185,100
	Carcharhinidae-reef sharks	12,400
	Crustaceans-crabs	43,100
	Holocentridae-squirrelfish	159,800
	Kyphosidae - rudderfish	122,800
	Labridae – wrasse	229,200
	Lethrinidae - emperors	39,600
	Lutjanidae-snappers	359,300

	Mollusk-turbo snails, octopus, giant clam	50,300
	Mugilidae-mullets	24,600
	Mullidae-goatfish	195,700
	Scaridae-parrotfish	271,500
	Serranidae - groupers	141,300
	All other CREMUS combined	540,800

1.7.3.3 Crustacean

The application of the SDCs for the crustacean MUS is limited. Previous studies conducted in the main Hawaiian islands estimated the MSY for spiny lobsters at approximately 15,000 – 30,000 lobsters per year of 8.26 cm carapace length or longer (WPFMC 1983). There are insufficient data to estimate MSY values for MHI slipper lobsters. MSY for deepwater shrimp is estimated for the Hawaii Islands at 40 kg/nm2 (Tagami and Ralston, 1988 in King, 1993).

A stock assessment model was developed in 2014 in an attempt to understand and determine the status of the Kona crab stock in the main Hawaii islands (Thomas 2011). This assessment utilized a non-equilibrium generalized production model (using the Stock-Production Model Incorporating Covariate –ASPIC statistical routine) to estimate parameters needed to determine stock status. Based on this, the Kona crab stock is overfished (possibly rebuilding) but not experiencing overfishing (Table 44)

Table 44. Stock assessment parameters for the Kona crab stock (Thomas, Lee and Piner 2015)

Parameter	Value	Notes	Status
MSY	40,400	Expressed in lbs	
H_{2007}		Expressed in percentage	
H_{MSY}	0.2534	Expressed in percentage (± std error)	
H/H_{MSY}	0.9218		No overfishing occurring
B_{2007}		Expressed in million pounds	
B_{MSY}	159,500	Expressed in lbs	
B/ B_{MSY}	0.1810		Overfished

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

Table 45.

Table 45. Best available MSY estimates for the crustacean MUS in Hawaii

Fishery	**Management Unit Species**	**MSY (lbs)**

Crustacean	Deepwater shrimp	598,328
	Spiny lobsters	20,400
	Slipper lobsters	None
	Kona crab	40,400

SOURCE: Deepwater shrimp MSY – Tagami and Ralston 1988; Spiny lobster MSY – WPRFMC 2014; Kona crab – Thomas. 2011

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

1.8.1 Brief description of the ACL process

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

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

1.8.2 Current OFL, ABC, ACL, and recent catch

The most recent multiyear specification of OFL, ABC, and ACL for the coral reef, non-Deep-7, crustaceans, and precious coral fisheries was completed in the 160th Council meeting from June 25 to 27, 2014. The specification covers fishing years 2015, 2016, 2017, and 2018 for the coral reef MUS complexes. A P* and SEEM analysis was performed for this multiyear specification (NMFS 2015a).

The most recent multiyear specification of OFL, ABC and ACL for the main Hawaiian island Deep-7 bottomfish complex, was completed at the 163rd meeting in June of 2015. The specification covers fishing year 2015-2016, 2016-2017, and 2017-2018. This multi-year specification utilized a phased-in approach (Slow-up Fast-down) to alleviate the impact of a sudden drop of the new catch limit. A P* and SEEM analysis was also performed for this multiyear specification (NMFS 2015b).

Table 46. Hawaii Archipelago – Hawaii ACL table with 2015 catch (values are in pounds). Red font indicates overages.

Fishery	**Management Unit Species**	**OFL**	**ABC**	**ACL**	**Catch**
Bottomfish	MHI Deep-7 stock complex	352,000	326,000	326,000	219,017*
	Non Deep-7 stock complex	265,000	187,100	178,000	128,675
Crustaceans	Deepwater shrimp	N.A.	250,773	250,773	25,631
	Spiny lobster	20,400	15,800	15,000	7,960
	Slipper lobster	N.A.	280	280	69
	Kona crab	N.A.	27,600	27,600	3,818
Precious coral	Auau channel black coral	8,250	7,500	5,512	N.A.F.
	Makapuu bed-pink coral	3,307	3,009	2,205	N.A.F.
	Makapuu bed-bamboo coral	628	571	551	N.A.F.
	180 fathom bank-pink coral	734	668	489	N.A.F.
	180 fathom bank-bamboo coral	139	126	123	N.A.F.
	Brooks bank-pink coral	1,470	1,338	979	N.A.F.
	Brooks bank-bamboo coral	280	256	245	N.A.F.
	Kaena point bed-pink coral	220	201	148	N.A.F.
	Kaena point bed-bamboo coral	42	37	37	N.A.F.
	Keahole bed-pink coral	220	201	148	N.A.F.
	Keahole bed-bamboo coral	42	37	37	N.A.F.
	Precious coral in HI exploratory area	N.A.	2,205	2,205	N.A.F.
Coral Reef Ecosystem	S. crumenopthalmus-akule	1,150,800	1,025,000	988,000	297,041
	D. macarellus-opelu	538,000	459,800	428,000	267,427
	Acanthuridae-surgeonfish	445,500	367,900	342,000	142,026
	Carangidae-jacks	185,100	168,100	161,200	42,297
	Carcharhinidae-reef sharks	12,400	9,800	9,310	2,273
	Crustaceans-crabs	43,100	35,400	**33,500**	**40,363**
	Holocentridae-squirrelfish	159,800	150,000	148,000	65,027
	Kyphosidae - rudderfish	122,800	108,600	105,000	28,849
	Labridae - wrasse	229,200	211,000	205,000	7,555
	Lethrinidae - emperors	39,600	36,600	35,500	5,918
	Lutjanidae-snappers	359,300	338,200	330,300	41,026
	Mollusk-turbo snails, octopus, giant clam	50,300	38,200	**35,700**	**40,237**
	Mugilidae-mullets	24,600	20,100	19,200	8,048
	Mullidae-goatfish	195,700	173,100	165,000	68,710
	Scaridae-parrotfish	271,500	251,700	239,000	85,024
	Serranidae - groupers	141,300	132,200	128,400	3,732
	All other CREMUS combined	540,800	496,500	485,000	110,811

NOTE:

* The MHI Deep-7 bottomfish is still ongoing; data as of 04/22/2016

***Cheilinus undulatus* and *Bolbometopon muricatum* are species not present in Hawaii

The catch shown in

Table 46 takes the average of the recent three years as recommended by the Council at its 160th meeting to avoid large fluctuations in catch due to data quality and outliers. NAF indicates no active fisheries as of date.

1.9 Best scientific information available

1.9.1 Main Hawaiian Island Deep-7 Bottomfish Fishery

1.9.1.1 Stock assessment benchmark

In 2011, NOAA's Pacific Islands Fisheries Science Center (PIFSC) completed a stock assessment for the MHI Deep-7 bottomfish fishery (2011 stock assessment) using data through 2010 (Brodziak et al. 2011). The 2011 stock assessment used similar commercial fishery data as in a 2008 assessment update (Brodziak et al. 2009), but includes a modified treatment of unreported catch and catch per unit effort (CPUE) standardization, as well as new research information on the likely life history characteristics of bottomfish (A. Andrews, PIFSC, unpublished 2010 research) in response to recommendations from the Western Pacific Stock Assessment Review (WPSAR) of the 2008 update (Stokes, 2009). Additionally, while the 2008 assessment considered the entire assemblage of Hawaii BMUS on an archipelagic basis (NWHI and MHI), the 2010 assessment focused solely on the Deep-7 bottomfish stock complex in the MHI.

To address the unreported catch issue, the 2011 assessment included four scenarios of unreported catch developed from available information. The four scenarios are labeled in order of magnitude from the highest (Scenario 1) to the lowest (Scenario 4) estimates of unreported catch.

- Catch Scenario 1: Unreported catch is two times commercial reported catch
- Catch Scenario 2: Unreported catch equals the commercial reported catch
- Catch Scenario 3: Unreported catch is one-fifth the commercial reported catch
- Catch Scenario 4: There is no unreported catch

According to the 2011 assessment the Catch Scenario 2 is the baseline (i.e., most plausible scenario) because it used the best available information on unreported to reported catch ratios estimated for individual MHI Deep-7 bottomfish species.

To determine the appropriate CPUE, the 2011 assessment included three scenarios to represent changes in fishing power of the fleet that targets Deep-7 bottomfish for commercial catch. CPUE is used in stock assessments as an index of relative stock abundance. Standardizing CPUE from different anglers over different areas and over many years helps to minimize the effects that could bias CPUE as an index of stock abundance.

- CPUE Scenario 1: Negligible change in bottomfish fishing power through time.
- CPUE Scenario 2: Moderate change in bottomfish fishing power through time. Specifically, this scenario assumed that: (i) there was no change in fishing power

during 1949-1970; (ii) fishing power increased at a rate of 0.25 percent per year during 1971-1980; fishing power increased at a rate of 0.5 percent per year during 1981-1990; (iii) fishing power increased at a rate of 0.25 percent per year during 1991-2000; and (iv) fishing power did not change during 2001-2010.

- CPUE Scenario 3: Substantial change in bottomfish fishing power through time. Specifically, this scenario assumed that a substantial change in fishing power scenario had occurred since the 1950s with an average increase in fishing power of roughly 1.2 percent per year.

According to the 2011 assessment, CPUE Scenario 1 is the baseline (i.e., most plausible scenario) because it represented the best scientific information about the efficiency of the Deep-7 bottomfish fishing fleet through time, and because it did not include ad hoc assumptions about changes in fishing power for the deep handline fishery that has traditionally harvested the Deep-7 bottomfish complex.

Based on the Catch 2/CPUE 1 scenario combination, the 2011 assessment estimates a maximum sustainable yield (MSY) of 417,000 lb for the MHI Deep-7 bottomfish stock complex. The 2011 stock assessment also included projection results of a range of commercial catches of Deep-7 bottomfish that would produce probabilities of overfishing ranging from 0 percent to 100 percent and at five percent intervals (Table 19.1 in Brodziak et al., 2011, and shown in Appendix A). Under the Catch 2/CPUE 1 scenario combination, the catch limit associated with a 50 percent probability of overfishing is 383,000 lb of MHI Deep-7 bottomfish. Therefore, while the long-term MSY for the fishery is 417,000 lb, the OFL for fishery is 383,000 lb.

Findings of an Independent Peer Review

In January 2011, PIFSC contracted the Center for Independent Experts (CIE) to provide three independent experts to review a draft of the 2011 stock assessment and prepare a report of their independent findings and recommendations, and whether the 2011 stock assessment is the best scientific information available for management purposes. In general, the CIE review panel found that the 2011 stock assessment was scientifically sound, and applied appropriate modeling approaches and methods given data limitations. In addition, each reviewer provided recommendations on how to improve the next assessment particularly with respect to providing credible CPUE standardization. The reports of the CIE reviewers are available on the PIFSC website at http://www.pifsc.noaa.gov/do/peer_reviews/.

1.9.1.2 Stock assessment updates

In 2014, the PIFSC completed a draft 2014 stock assessment update for the MHI Deep-7 bottomfish fishery (2014 stock assessment), using data through fishing year 2013 (Brodziak et al. 2014). The 2014 stock assessment update uses the previous 2011 stock assessment's methods for data analysis, modeling, and stock projections, with one improvement--it included the State of Hawaii's CML data as a variable to standardize CPUE over time. The State began issuing CMLs uniquely and consistently to individuals through time starting in 1994. Therefore, beginning in 1994 the CML number assigned to an individual has remained the same. The 2014 stock assessment included individual CMLs in the CPUE standardization for that year onward. This improvement is highly significant, resulting in a two-fold increase in the explanatory power (R-squared) of the CPUE standardization and a substantial decrease in the Akaike information criterion value of the CPUE standardization, which now explains over 50% of the variation in observed CPUE over time. Additionally, in the three additional years (2011-13) covered by the 2014 assessment, the biomass of the Deep-7 species and the exploitation rate were about the same as in the preceding three years. Therefore, the updated estimates of the values for management (i.e., MSY, OFL, probability of overfishing etc.) are not a result of any significant change in biomass or exploitation rate, but are due to better estimation of the values provided by the previous assessment.

Based on the revised CPUE standardization method and three years of additional catch data, the 2014 stock assessment update re-estimates MSY to be 415,000 lb, which is similar to the previous MSY estimate of 417,000 lb reported in the 2011 stock assessment. The 2014 stock assessment also included projection results of a range of commercial catches of Deep-7 bottomfish that would produce probabilities of overfishing ranging from 0 percent to 100 percent and at five percent intervals (Table 15 in Brodziak et al., 2014). Based on a maximum potential harvest of 325,000 lb of MHI Deep-7 bottomfish in the then-ongoing 2013-14 fishing year, the 2014 stock assessment estimated an OFL of 316,000 lb, which is 67,000 lb less than the OFL estimate in the 2011 stock assessment. These updated estimates of MSY and OFL are not the result of any significant change in biomass or exploitation rate, but are due to better estimations resulting from the revised CPUE standardization method.

Findings of an Independent Peer Review

In December 2014, PIFSC again contracted the CIE to provide three independent experts to review the 2014 stock assessment and prepare a report of their independent findings and recommendations, and to assist NMFS in determining whether the 2014 stock assessment is the best scientific information available for management purposes. In summary, the CIE panel found that including individual CML data as a variable to standardize CPUE over time was an improvement over the method used in the 2011 stock assessment. However, the CIE panel had strong reservations regarding the quality of input catch data and CPUE index of abundance used in both the 2011 and 2014 stock assessments. Specifically, the panel raised concern about the historical pre-1990 data for CPUE calculation and estimates of unreported catch. Given the concerns with the incomplete effort information, the CIE panel concluded that the 2014 stock assessment had serious flaws that compromised its utility for management. In particular, the CIE panel noted that because the 2014 stock assessment was an update only, and required improvements in the index and the population model, the science reviewed in the 2014 stock assessment is not considered the best available. The reports of the CIE reviewers are available on NMFS website at http://www.st.nmfs.noaa.gov/science-quality-assurance/cie-peer-reviews/cie-review-2015

1.9.1.3 Current best available scientific information

National Standard 2 requires that conservation and management measures be based on the best scientific information available, and be founded on comprehensive analyses. National Standard 2 guidelines (78 FR 43087, July 19, 2013) state that scientific information that is used to inform decision making should include an evaluation of its uncertainty and identify gaps in the information (50 CFR 600.315(a)(1). The guidelines also recommend scientific information used to support conservation and management be peer reviewed (50 CFR 600.315(a)(6)(vii)). However, the guidelines also state that mandatory management actions should not be delayed due to limitations in the scientific information or the promise of future data collection or analysis (50 CFR 600.315(a)(6)(v)).

On March 3, 2015, PIFSC outlined reasons why the fisheries data in the 2014 assessment produced results that the CIE panel advised were not ready for management application, and identified two ways in which the fisheries data can be improved for future application in the new CPUE standardization method.

1. Although catch per day fished is the best available CPUE that is available continuously over the whole time series, it may not be the best available over the most recent time series. If the time series is to be split with CPUE issues addressed differently before and after the split, one could also analyze and include detailed effort data that has been collected only for the last dozen years. This data could strongly influence recent trends. This was not seen by PIFSC as work that could be done as a simple update in 2014, because it is a complex undertaking.
   The use of CPUE defined as catch per day fished is subject to great criticism, and one way to address this is by using details on hours and numbers of lines and hooks used by fishermen over the last dozen years. Only inexplicit, undescribed differences among fishermen linked through time were applied to the recent stanza in the 2014 CPUE standardization. Using the recent effort detail would still allow differences between individual fishermen to be standardized, and also allow changes in effort details through time to be addressed. Both were factors of great concern to the reviewers. Differences among areas and seasons and other such factors that can be applied throughout the whole time series have remained part of the CPUE standardization in both 2011 and 2014.

2. Further efforts could be made to apply the CPUE standardization to account for differences among fishermen to more data using various exploratory methods and other data sets. The 2014 assessment overlooked a compilation of confidential non-electronic records held by the State of Hawaii that may help to link fisher's identities back through an earlier stanza of time.

Although the CIE panel noted the improvement in catch rate standardization in the 2014 stock assessment compared to 2011, it had strong reservations regarding the input catch data in both stock assessments, However, PIFSC cannot improve the assessment for MHI Deep-7 bottomfish in the ways described above in short order because it is a complex undertaking. Although catch per day fished may not be the best available CPUE data that can be used in the superior split-stanza CPUE standardization (i.e. after 1994), it is the best available CPUE data that is available over the entire time series, and thus appropriate for use in the 2011 assessment approach, which does not utilize a split-stanza CPUE standardization approach. Therefore, NMFS believes that a much more simple update of the 2011 assessment using data from the three most recent years available (i.e., 2011, 2012 and 2013) provides the best scientific information available for management. Applying this updated data, NMFS revised the MSY for MHI Deep-7 bottomfish from 417,000 lb to 404,000 lb and the OFL from 383,000 lb 352,000 lb. These values do not reflect a drastic change in stock status from the information considered by the Council, and the proposed ACL of 346,000 lb remains below the revised OFL of 352,000 lb.

1.9.2 Non-Deep-7 Bottomfish Fishery

1.9.2.1 Stock assessment benchmark

There is no benchmark stock assessment for the non-Deep-7 bottomfish. An attempt to determine sustainability of the non-Deep-7 bottomfish stock was done in conjunction with the assessment of the MHI Deep-7 bottomfish stocks. In 2011, NMFS Pacific Islands Fisheries Science Center completed a stock assessment for the Deep-7 bottomfish stock complex using data from 1949-2010 and produced stock projection results of a range of commercial catches of Deep-7 bottomfish that would produce probabilities of overfishing ranging from zero percent to 100 percent, and at five-percent intervals in fishing year 2011-12, and in 2012-13 (Brodziak et al., 2011, Table 19.1 and shown in Appendix C). The 2011 stock assessment used similar commercial fishery data as in the previous 2008 stock assessment that assessed the entire Hawaii multi-species bottomfish stock complex as a whole (Brodziak et al., 2009); however, the 2011 assessment includes a modified treatment of unreported catch and CPUE standardization, as well as new research information on the likely life history characteristics of Deep-7 bottomfish (A. Andrews, PIFSC, unpublished 2010 research).

According to the 2011 bottomfish stock assessment, the Catch 2/CPUE 1 scenario combination represents the best approximation (with a 40 percent probability) of the true state of the bottomfish fishery and Deep-7 bottomfish population dynamics. Under the Catch 2/CPUE 1 scenario combination, the long-term MSY of the MHI Deep-7 bottomfish stock complex is estimated to be 417,000 lb. The assessment model also estimates that the commercial catch associated with a 50 percent probability of overfishing the MHI Deep-7 bottomfish complex in fishing year 2011-12 and again in fishing year 2012-13 is 383,000 lb. Therefore, while the long-term MSY for the Deep-7 bottomfish fishery is 417,000 lb, the overfishing limit (OFL) for the 2011-12 and 2012-13 fishing years is estimated to be 383,000 lb.

The 2011 MHI Deep-7 bottomfish stock assessment does not include an evaluation of stock status or the risk of overfishing for any of the remaining BMUS in the MHI. Therefore, biological reference points, including estimates of MSY and OFL for the MHI non-Deep-7 bottomfish are unknown. However, the stock assessment projection results for the MHI Deep-7 bottomfish stock complex can be used to develop an OFL proxy for the MHI non-Deep-7 bottomfish stock complex, and a range of commercial non-Deep-7 bottomfish catches that would produce probabilities of overfishing ranging from zero percent to 100 percent. This approach relies on the assumption that population dynamics, catchability and other parameters of the non-Deep-7 bottomfish are similar in relative scale to the Deep-7 bottomfish (Brodziak, pers. com. March 31, 2011). In general, MHI non-Deep-7 bottomfish are coral reef associated species and are more productive compared to MHI Deep-7 bottomfish. However, non-Deep-7 bottomfish are also harvested by a greater range of gear methods, which results in levels, and rates of exploitation that have not been assessed quantitatively or qualitatively in any previous stock assessment.

While a separate stock assessment for MHI non-Deep-7 bottomfish is the preferred approach, until one is produced, estimating a proxy for OFL and probabilities of overfishing for this stock complex based on projection results for MHI Deep-7 bottomfish is an appropriate approach given the fact that only catch data are available for the non-Deep-7 stock complex. Additionally, this catch data indicate that reported commercial catches of MHI Deep-7 bottomfish in proportion to the total reported commercial catches of all MHI bottomfish (Deep-7 + non-Deep-7) are relatively stable over time as reported in Tables 5 (estimates of total Deep-7 catches) and Table 6 (estimates of total bottomfish catches) contained in Brodziak et al. (2011). Therefore, reported commercial catches of MHI non-Deep-7 bottomfish in proportion to total reported commercial catches of all MHI bottomfish are also stable over time.

Table 47 summarizes the average proportion of the reported commercial catches (C) of MHI Deep-7 bottomfish relative to the total reported commercial catches of all MHI bottomfish for three time periods: (1) 1949-2010; (2) 2000-2009; and 2008-2010 as presented in Tables 5 and 6 in Brodziak et al. (2011). The proportion of MHI Deep-7 catch (PDEEP7) to the total MHI bottomfish catch is also provided and is calculated using the following equation:

PDEEP7(t) = CDEEP7(t) / C Total BMUS(t)

These three time periods were chosen because they reflect the nature of the Hawaii bottomfish fishery over (1) the entire available catch history; (2) the recent decade; and (3) three recent years when the fishery operated under a catch limit system. The results summarized in Table 47 clearly demonstrate that the proportion of Deep-7 to the total reported commercial catches of all MHI bottomfish (Deep-7 + non-Deep-7) has been relatively stable over time with ranges from 67 percent to 72 percent. Conversely, this demonstrates the proportion of non-Deep-7 bottomfish to the total MHI bottomfish catch ranged from 33 percent to 28 percent.

Table 47. Proportion of reported commercial catches of MHI Deep-7 and total reported commercial MHI bottomfish catch over time under Catch 2/CPUE 1 scenario

	t = 1949-2010	**t =2000-2009**	**t =2008-2010**
Catch of Deep-7 bottomfish[1]	281.3	234.3	221.5
Catch of Total BMUS[2]	422.1	325.3	330.7
Proportion of Deep-7 (P_{DEEP7})	0.666	0.720	0.700

[1] Source: Table 5 in Brodziak et al., (2011)

[2] Source: Table 6 in Brodziak et al., (2011)

Because two Hawaii BMUS, taape *(Lutjanus kasmira)* and kahala (*Seriola dumerili),* are specifically excluded from the NMFS Hawaii bottomfish stock assessment parameters, their catch information is not included in the total bottomfish estimates used in Table 6 of Brodziak et al. (2011).

To estimate an OFL proxy for the MHI non-Deep-7 bottomfish stock complex and a range of commercial non-Deep-7 bottomfish catches that would produce probabilities of overfishing ranging from zero percent to 100 percent, the commercial catch values for MHI Deep-7 bottomfish associated with Catch 2/ CPUE Scenario 1 as presented in Table 19.1 of Brodziak et al., (2011), and shown in Appendix C can be divided by the P_{DEEP7} values in Table 47 above. The results of this calculation will derive the total commercial catch equivalent of all MHI bottomfish (Deep-7 + non-Deep-7) and the corresponding probabilities of overfishing all MHI bottomfish.

To derive the level of catch that would produce the corresponding probability of overfishing for MHI non-Deep-7 bottomfish (excluding taape and kahala), the level of catch for MHI Deep-7 bottomfish is simply subtracted from the level of catch for all MHI bottomfish.

Table 48 summarizes the results of this calculation for the time period 1949-2010. This time period is identical to the time period used to produce stock projection results for the Deep-7 stock complex and is the baseline for impact analyses.

Table 48. Commercial catch (in1000 pounds) of MHI Deep-7 BMUS, MHI non-Deep-7 BMUS and all MHI BMUS combined that would produce probabilities of overfishing from 0 through 99% based on 1949-2010 catch data (P_{DEEP7} = 0.666)

Probability of Overfishing[1]	Catch of MHI Deep-7 BMUS[1]	Catch of All MHI BMUS *(Deep-7 + non-Deep-7)*[2]	Catch of MHI non-Deep-7 BMUS[2]
0	11	17	6
5	147	221	74
10	197	296	99
15	229	344	115
20	255	386	131
25	277	415	138
30	299	449	150
35	319	479	160
40	341	512	171
45	361	542	181
50	383	575	192
55	407	611	204
60	429	644	215
65	455	683	228
70	481	722	241
75	513	779	266
80	549	824	275
85	597	896	299
90	665	998	333
95	783	1176	393
99	1001	1503	502

[1] Source: Table 19.1 in Brodziak et al., (2011)

[2] Excludes Hawaii BMUS taape *(Lutjanus kasmira)* and kahala (*Seriola dumerili)*

Based on

Table 48 above, the catch limit associated with a 50 percent probability of overfishing the MHI Deep-7 bottomfish complex in fishing year 2011-12 and again in fishing year 2012-13 is 383,000 lb. The catch limit associated with a 50 percent probability of overfishing the MHI non-Deep-7 bottomfish complex in fishing year 2012 and again in 2013 is 192,000 lb and is the OFL proxy. These estimates will continue to apply in future fishing years until a new Deep-7 stock assessment update and associated stock projection analysis is conducted or a separate non-Deep-7 assessment is prepared.

1.9.2.2 Stock assessment updates

The initial method described above was abandoned in 2014. Estimates of MSY and OFL for non-Deep-7 bottomfish in the MHI are based on a modeling approach that uses catch data from local resource management agencies as described in section 1.2 ; together with a measure of population growth (r), carrying capacity (k), and biomass data from NMFS PIFSC underwater fish census surveys (Williams 2010). This model, termed the "Biomass Augmented Catch-MSY" model is described in detail in Sabater and Kleiber (2014). In summary, the model creates annual biomass projections from a set of r and k combinations that would not result in biomass that would exceed the carrying capacity or the stock being depleted. The assumption behind the biomass can be informed by augmenting the model with an independent source of biomass information.

The Biomass Augmented Catch-MSY model is based on the Catch-MSY model developed by Martell and Froese (2013), but differs in that it incorporates biomass data. Application of the model provides the very first model-based estimate of MSY for MHI non-Deep-7 bottomfish. In addition to estimates of MSY, the Biomass Augmented Catch-MSY model also generates a range of catches that if realized, would result in a probability of exceeding MSY ranging from five to 50 percent (See Appendix B for MSY estimates and probability of overfishing projection results from the Biomass Augmented Catch-MSY model).

Because of the large number of possible combinations of r and k values available to estimate MSY using the Biomass Augmented Catch-MSY model, the model explored two methods to define the most meaningful and most likely (most plausible) range of r and k combinations. Method A allows for only a very narrow range of starting r and k values, while method B allows for a broad range of starting r and k values, with each method providing different MSY estimates and associated probability of overfishing projections. In reviewing the two methods, the SSC at its 114th meeting held March 11-13, 2014, determined the resulting MSY estimates from method B be used for management decisions because this method provides a more complete range of most likely r and k combinations compared to method A. The 114th SSC also found that method B also yielded r and k density plots that generally correspond better to the estimates of MSY than the method A approach.

Based on the method B approach, the Biomass Augmented Catch-MSY model estimates MSY for MHI non-Deep-7 bottomfish to be 265,000 lb. However, catch projection results generated from the model estimates the level of catch associated with a 50 percent probability of exceeding MSY to be 259,200 lb. Consistent with National Standard 1 guidelines (74 FR 3178, January 9, 2011), the Council at its 160th meeting, set OFL for MHI non-Deep-7 bottomfish equal to the level of catch associated with a 50 percent probability of exceeding MSY

1.9.3 Coral reef fishery

1.9.3.1 Stock assessment benchmark

There was no formal stock benchmark stock assessment conducted on the coral reef ecosystem MUS to date. The first attempt to use a model-based approach in assessing the coral reef MUS complexes was done in 2014 using a biomass-based population dynamics model (Sabater and Kleiber 2014) for the purpose of improving the ACL specification for these stocks. This model was based on the original Martell and Froese (2012) model but was augmented with biomass information to relax the assumption behind carrying capacity. It estimates MSY based on a range of rate of population growth (*r*) and carrying capacity (K) values. The best available information for the coral reef stock assessment is as follows:

Input data: The catch data was derived commercial marine license reports.

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

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

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

1.9.3.2 Stock assessment updates

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

1.9.3.3 Other information available

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

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

1.9.4 Crustacean fishery

1.9.4.1 Stock assessment benchmark

Spiny Lobsters: There is no benchmark stock assessment for any of the crustacean MUS. The first attempt to use a model-based approach in assessing the crustacean MUS complexes, particularly spiny lobsters, was done in 2014 using a biomass-based population dynamics model (Sabater and Kleiber 2014) for the purpose of improving the ACL specification for these stocks. This model was based on the original Martell and Froese (2012) model but was augmented with biomass information to relax the assumption behind carrying capacity. It estimates MSY based on a range of rate of population growth (*r*) and carrying capacity (K) values. The best available information for the coral reef stock assessment is as follows:

Input data: The catch data was derived from the commercial marine license report.

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

Fishery independent source for biomass: There is no fishery independent data collection for crustaceans

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

Slipper Lobsters: There has been no attempt to conduct an assessment of the slipper lobster stock. The best attempt to come up with a yield estimate was to use the 75th percentile of the entire catch time series. This follows recommendations from the ORCS Working Group for data poor species (Berkson et al 2011).

Deep-water Shrimp: The deep water shrimp (*Heterocarpus laevigatus* and *H. ensifer*) initial resource assessment was conducted in the late 1980s by Ralston and Tagami (1988). This involved depletion experiments, stratified random sampling of different habitats, and calculation of exploitable biomass using the Ricker equation (Ricker 1975). Since then no new estimates were calculated for this stock.

Kona crab: A stock assessment model was developed in 2014 in an attempt to understand and determine the status of the Kona crab stock in the main Hawaii islands (Thomas, Lee, and Piner 2015). This assessment utilized a non-equilibrium generalized production model (using the Stock-Production Model Incorporating Covariate –ASPIC statistical routine) to estimate parameters needed to determine stock status. Based on this, the Kona crab stock is overfished (possibly rebuilding) but not experiencing overfishing.

This assessment had undergone a CIE desktop review in December 2015 (N.G. Hall 2015). The review concluded that the assessment had utilized the appropriate model and used the data and assumptions correctly making the assessment best available. However, the reviewer also cautioned that there are large uncertainties associated with the results which could change dramatically with the changes in the non-commercial catch assumptions and effects of the State of Hawaii's female release regulations. PIFSC agreed that further work is needed to provide advice on the current status of the population in more recent years. This was included in the list of stocks that PIFSC will conduct a benchmark assessment on in the future. To date, the best available information is based on the 75th percentile of the entire catch time series as a proxy for sustainable yield levels.

1.9.4.2 Stock assessment updates

There were no stock assessment updates available for the crustacean MUS.

1.9.4.3 Best available scientific information

To date the best available scientific information for the crustacean MUS are as follows:

- Spiny lobsters – Sabater and Kleiber (2014)
- Slipper lobsters – WPRFMC (2011) – cite non-fin-fish EA
- Deepwater shrimp – Ralston and Tagami 1988
- Kona crab – WPRFMC (2011) – cite non-fin-fish EA

1.10 Harvest capacity and extent

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

- will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems.
- is prescribed on the basis of the MSY from the fishery, as reduced by any relevant social, economic, or ecological factor.
  in the case of an overfished fishery, provides for rebuilding to a level consistent with producing the MSY in such fishery [50 CFR §600.310(f)(1)(i)].

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

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

The harvest extent, in this case, is defined as the level of catch harvested in a fishing year relative to the ACL or OY. The harvest capacity is the level of catch remaining in the annual catch limit that can potentially be used for the total allowable level of foreign fishing (TALFF). Table 49 summarizes the harvest extent and harvest capacity information for Hawaii in 2015

Table 49. Hawaii Archipelago – Main Hawaiian Island proportion of harvest extent (values are in percentage), defined as the proportion of fishing year landing relative to the ACL or OY, and the harvest capacity, defined as the remaining portion of the ACL or OY that can potentially be harvested in a given fishing year.

Fishery	**Management Unit Species**	**ACL**	**Catch**	**Harvest extent (%)**	**Harvest capacity (%)**
Bottomfish	MHI Deep-7 stock complex	326,000	219,017*		
	Non Deep 7 stock complex	178,000	128,675	72	28
Crustaceans	Deepwater shrimp	250,773	25,631	10	90
	Spiny lobster	15,000	7,960	53	47
	Slipper lobster	280	69	25	75
	Kona crab	27,600	3,818	14	86
Precious coral	Auau channel black coral	5,512	N.A.F.		
	Makapuu bed-pink coral	2,205	N.A.F.		
	Makapuu bed-bamboo coral	551	N.A.F.		
	180 fathom bank-pink coral	489	N.A.F.		
	180 fathom bank-bamboo coral	123	N.A.F.		
	Brooks bank-pink coral	979	N.A.F.		
	Brooks bank-bamboo coral	245	N.A.F.		
	Kaena point bed-pink coral	148	N.A.F.		
	Kaena point bed-bamboo coral	37	N.A.F.		
	Keahole bed-pink coral	148	N.A.F.		
	Keahole bed-bamboo coral	37	N.A.F.		
	Precious coral in HI exploratory area	2,205	N.A.F.		
Coral Reef Ecosystem	S. crumenopthalmus-akule	988,000	297,041	30	70
	D. macarellus-opelu	428,000	267,427	62	38
	Acanthuridae-surgeonfish	342,000	142,026	42	58
	Carangidae-jacks	161,200	42,297	26	74
	Carcharhinidae-reef sharks	9,310	2,273	24	76
	Crustaceans-crabs	**33,500**	**40,363**	**120**	**-20**
	Holocentridae-squirrelfish	148,000	65,027	44	56
	Kyphosidae - rudderfish	105,000	28,849	27	73
	Labridae - wrasse	205,000	7,555	4	96
	Lethrinidae - emperors	35,500	5,918	17	83
	Lutjanidae-snappers	330,300	41,026	12	88
	Mollusk-turbo snails, octopus, giant clam	**35,700**	**40,237**	**113**	**-13**
	Mugilidae-mullets	19,200	8,048	42	58
	Mullidae-goatfish	165,000	68,710	42	58
	Scaridae-parrotfish	239,000	85,024	36	64

	Serranidae - groupers	128,400	3,732	3	97
	All other CREMUS combined	485,000	110,811	23	77

1.11 Administrative and regulatory actions

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

On August 31, 2015, NMFS published a final rule to implement annual catch limits for 2015 Pacific Island bottomfish, crustacean, precious coral, and coral reef ecosystem fisheries, and accountability measures to correct or mitigate any overages of catch limits (80 FR 52415). The catch limits and accountability measures support the long-term sustainability of fishery resources of the U.S. Pacific Islands.

On January 19, 2016, NMFS establishes the annual harvest guideline for the commercial lobster fishery in the Northwestern Hawaiian Islands for calendar year 2016 at zero lobsters (81 FR 2761).

On January 25, 2016, NMFS announced the availability of a draft environmental assessment in support of a Special Coral Reef Ecosystem Fisheries Permit to Kampachi Farms, Inc. (81 FR 4021). Kampachi Farms applied for the permit to use a floating net pen anchored about six miles off the Big Island to raise 30,000 kampachi over a two-year period. The comment period ended on February 16, 2016. The permit is under agency review.

On February 12, 2016, NMFS published proposed Amendment 4 to the Fishery Ecosystem Plan for Fisheries of the Hawaiian Archipelago. If approved, Amendment 4 would revise the descriptions of essential fish habitat and habitat areas of particular concern for 14 species of bottomfish and three species of seamount groundfish in the Hawaiian Archipelago. The proposed action considers the best available scientific, commercial, and other information about the fisheries, and supports the long-term sustainability of fishery resources. The comment period ended April 12, 2016. The Secretarial Decision to approve, partially approve, or disapprove Amendment 4 must be made by May 12, 2016.

On February 23, 2016, NMFS published proposed 2015-16 Annual Catch Limits (ACLs) and Accountability Measures (AMs) for Main Hawaiian Islands Deep 7 Bottomfish. NMFS proposes to specify an ACL of 326,000 lb for Deep 7 bottomfish in the main Hawaiian Islands (MHI) for the 2015-16 fishing year, which began on September 1, 2015, and ends on August 31, 2016. If the ACL is projected to be reached, as an AM, NMFS would close the commercial and non-commercial fisheries for MHI Deep 7 bottomfish for the remainder of the fishing year. The proposed ACL and AM support the long-term sustainability of Hawaii bottomfish. The comment period closed March 9, 2016.

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Thomas, L., 2011. Characterizing the Kona crab (Ranina ranina) fishery in the Main Hawaii Islands. Report to the Western Pacific Regional Fishery Management Council. 52 pp.

Williams, I. 2010. U.S. Pacific Reef Fish Estimates Based on Visual Survey Data. NOAA Pacific Islands Fisheries Science Center Internal Report IR-10-024

WPFMC and NMFS. 2011. Omnibus amendment for the western Pacific region to establish a process for specifying annual catch limits and accountability measures, including an environmental assessment. Amendment 1 to the PRIA FEP, Amendment 2 to the American Samoa Archipelago FEP, Amendment 2 to the Mariana FEP, Amendment 3 to the Hawaii Archipelago FEP. Western Pacific Regional Fishery Management Council and NMFS, Honolulu, HI.

Tagami, D.T. and S. Ralston. 1988. An assessment of exploitable biomass and projection of maximum sustainable yield for Heterocarpus laevigatus in the Hawaii Islands. Southwest Fisheries Center Administration Report H-88-14, 22 pp.

2 ECOSYTEM CONSIDERATIONS

2.1 Fishery Ecosystem

2.1.1 Regional Reef Fish Biomass

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

Category:

- ✓ Fishery independent
- ☐ Fishery dependent
- ☐ Biological

Timeframe: Triennial

Jurisdiction:

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

Spatial Scale:

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

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

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

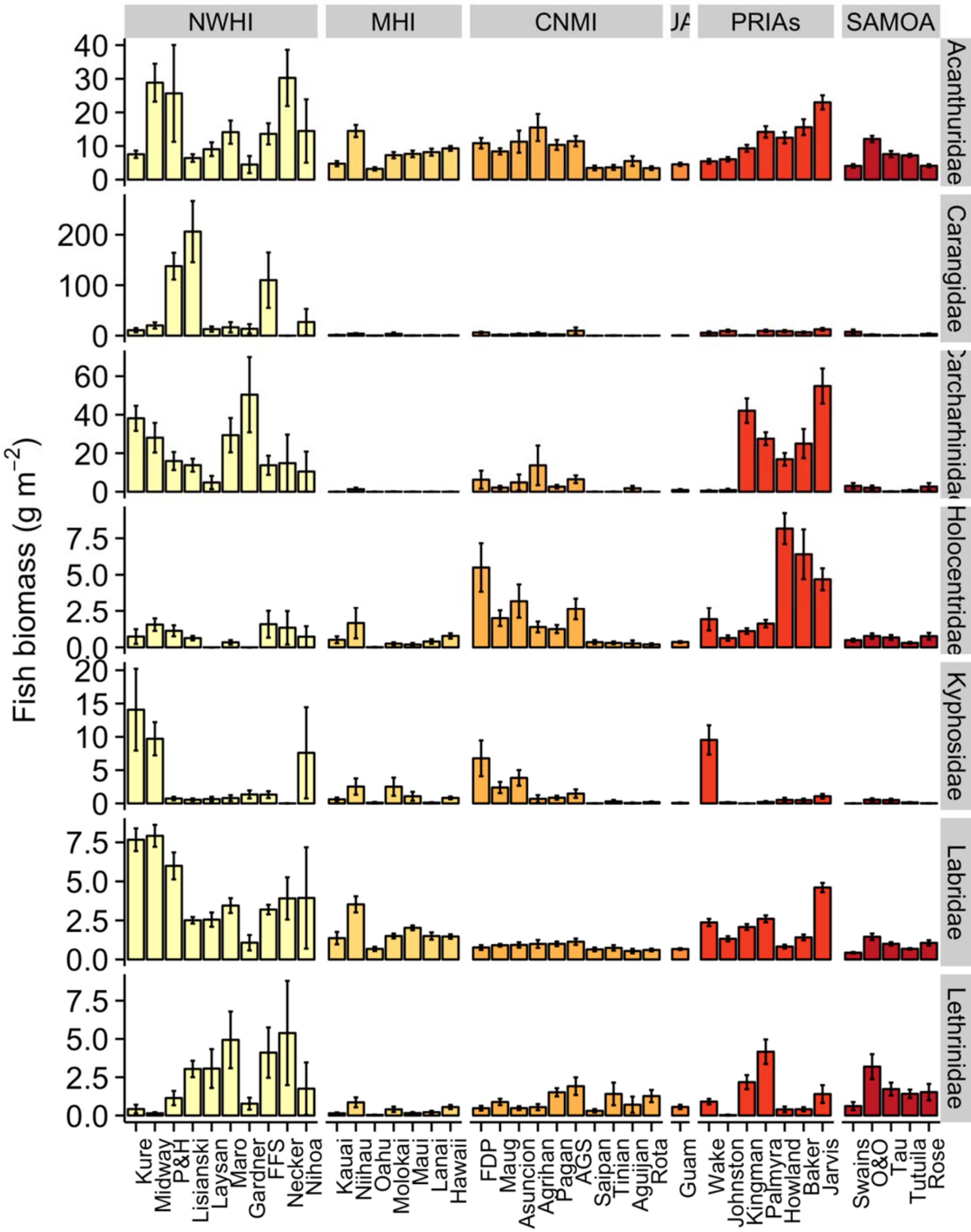
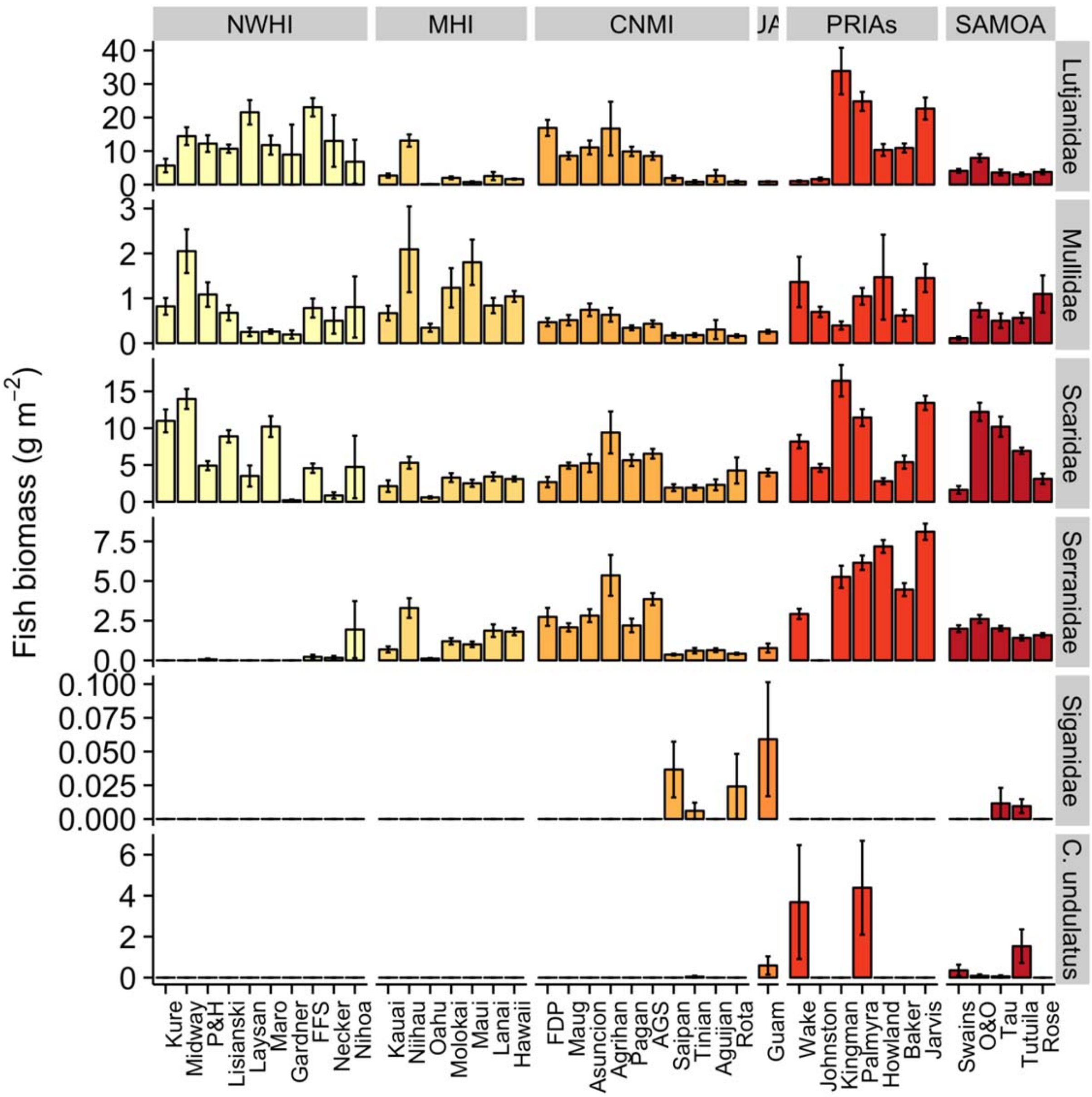


Figure 1. Mean fish biomass by Coral Reef Management Unit Species (CREMUS) grouping per US Pacific reef area. Mean fish biomass (± standard error) per CREMUS grouping per reef area pooled across survey years (2009-2015). Islands ordered within region by latitude. Continues on to next page.


NWHI
MHI
CNMI
JA
PRIAs
SAMOA
Lutjanidae
Mullidae
Scaridae
Serranidae
Siganidae
C. undulatus
Fish biomass (g m−2)
Kure
Midway
P&H
Lisianski
Laysan
Maro
Gardner
FFS
Necker
Nihoa
Kauai
Niihau
Oahu
Molokai
Maui
Lanai
Hawaii
FDP
Maug
Asuncion
Agrihan
Pagan
AGS
Saipan
Tinian
Aguijan
Rota
Guam
Wake
Johnston
Kingman
Palmyra
Howland
Baker
Jarvis
Swains
O&O
Tau
Tutuila
Rose

2.1.2 Main Hawaiian Islands Reef Fish Biomass

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

Category:

- ✓ Fishery independent
- ☐ Fishery dependent
- ☐ Biological

Timeframe: Triennial

Jurisdiction:

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

Scale:

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

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

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

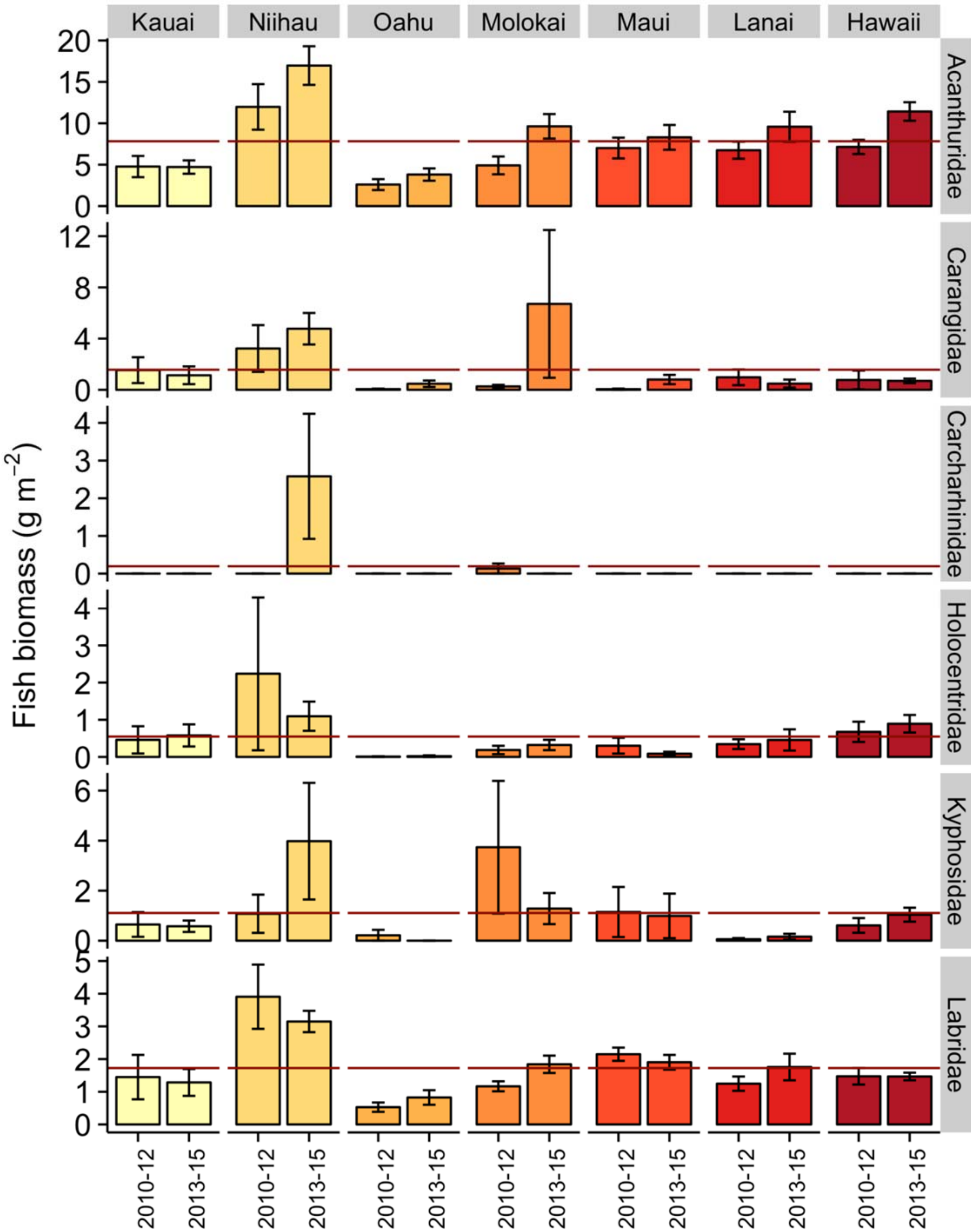
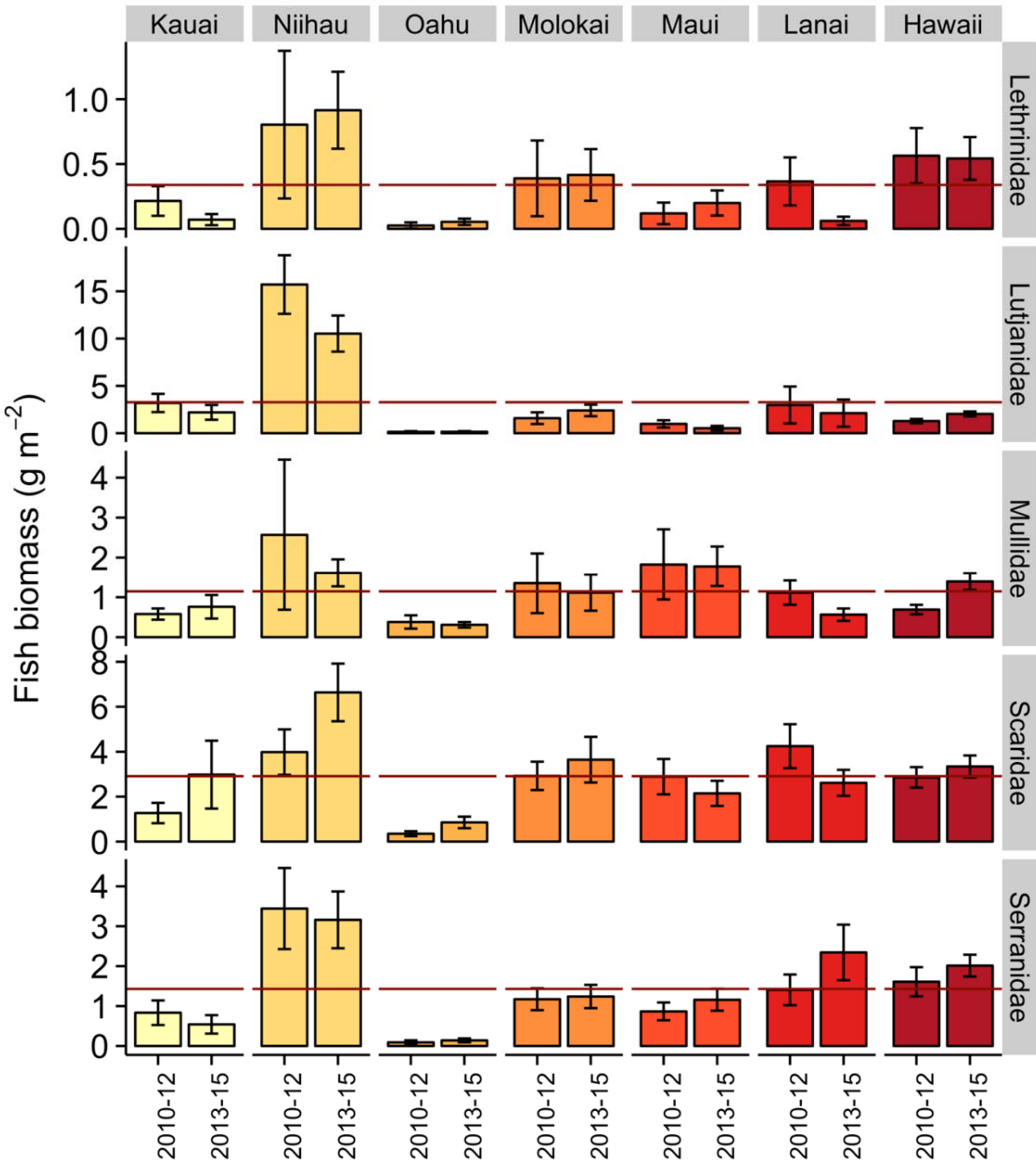


Figure 2. MHI showing the biomass of fish (g m-2 ± SE) per CREMUS grouping per year. The MHI mean estimates are plotted for reference (red line). Continues on to next page.


Kauai
Niihau
Oahu
Molokai
Maui
Lanai
Hawaii
Lethrinidae
Lutjanidae
Mullidae
Scaridae
Serranidae
Fish biomass (g m⁻²)
1.0
0.5
0.0
15
10
5
0
4
3
2
1
0
8
6
4
2
0
4
3
2
1
0
2010-12
2013-15

2.1.3 Archipelagic Mean Fish Size

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

Category:

- ✓ Fishery independent
- ☐ Fishery dependent
- ☐ Biological

Timeframe: Triennial

Jurisdiction:

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

Scale:

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

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

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

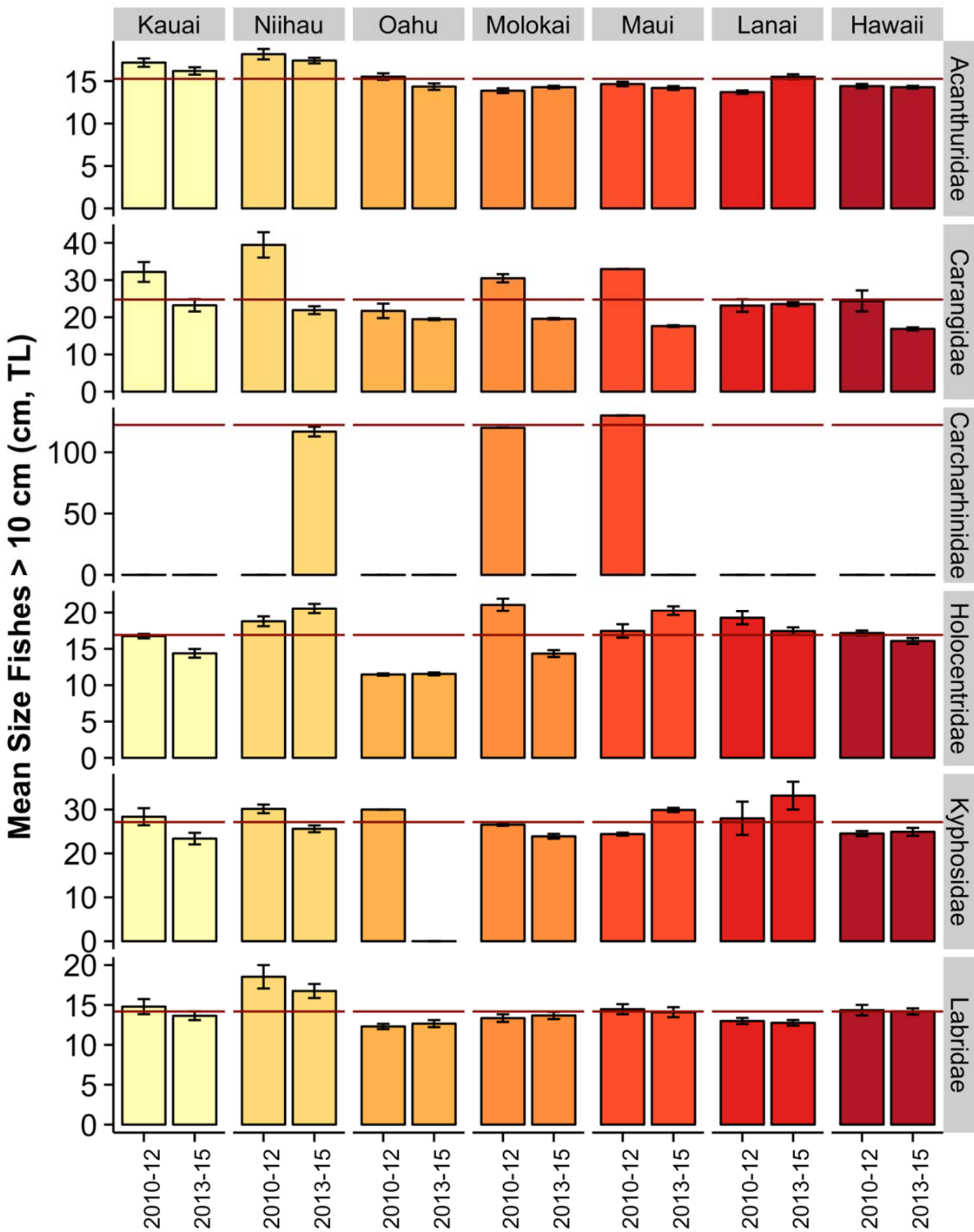
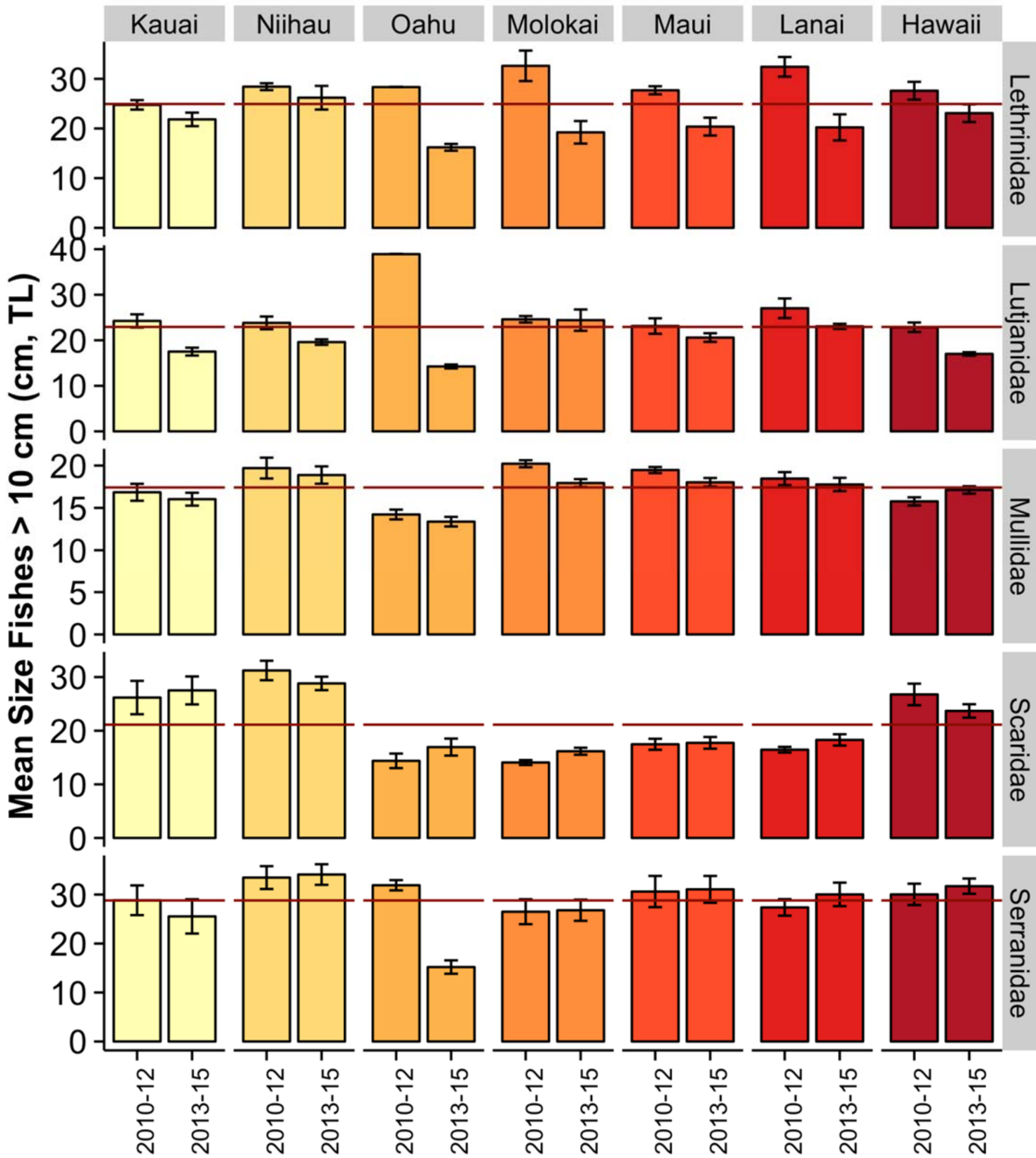


Figure 3. Figure 3. Main Hawaiian Islands mean reef fish size (cm ± SE) per CREMUS grouping per year. The Main Hawaiian Islands mean estimates are plotted for reference (red line). Continues to next page.


Kauai
Niihau
Oahu
Molokai
Maui
Lanai
Hawaii
Lethrinidae
Lutjanidae
Mullidae
Scaridae
Serranidae
Mean Size Fishes > 10 cm (cm, TL)
2010-12
2013-15
0
10
20
30
40
5
15

2.1.4 Reef Fish Population Estimates

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

Category:

- ✓ Fishery independent
- ☐ Fishery dependent
- ☐ Biological

Timeframe: Triennial

Jurisdiction:

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

Scale:

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

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

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

Table 50. Reef fish population estimates for the Main Hawaiian Islands (MHI). Fish species are pooled by CREMUS groupings. Estimated population biomass is for 0-30 m hardbottom habitat only. (n) is number of sites surveyed per island. Each site is surveyed by means of 2-4 7.5 m diameter SPCs - however, those are not considered to be independent samples, so data from those is pooled to site level before other analysis.

Note (1): No Siganidae, *Bolbometopon muricatum* or *Cheilinus undulatus* were observed in MHI

ISLAND	Total Area of reef (Ha)	N	ESTIMATED POPULATION BIOMASS (metric Tonnes) in SURVEY DOMAIN OF <30m HARDBOTTOM					
			Acanthuridae	Carangidae	Carcharhinids	Holocentridae	Kyphosidae	Labridae
Kauai	18,127.1	82	859.6	242.3	-	94.0	111.0	247.7
Niihau	9,265.8	90	1,341.0	370.6	119.6	154.5	234.2	326.9
Oahu	25,118.8	171	804.5	67.1	-	3.8	27.3	170.0
Molokai	12,730.3	147	925.7	444.2	8.5	32.4	319.7	191.4
Maui	11,122.2	140	851.3	47.8	-	21.6	118.9	225.3
Lanai	3,003.7	88	245.3	22.0	-	12.0	3.3	45.1
Hawaii	16,839.8	198	1,563.1	123.6	-	132.0	139.0	247.7
TOTAL	**96,207.6**	**916**	**6,590.5**	**1,317.6**	**128.1**	**450.4**	**953.3**	**1,454.1**

ISLAND	Total Area of reef (Ha)	N	Lethrinidae	Lutjanidae	Mullidae	Scaridae	Serranidae
Kauai	18,127.1	82	25.9	489.0	121.3	385.2	124.6
Niihau	9,265.8	90	79.6	1,215.9	193.8	492.0	305.9
Oahu	25,118.8	171	9.9	36.9	86.5	151.3	29.0
Molokai	12,730.3	147	51.3	254.3	157.1	418.1	153.5
Maui	11,122.2	140	17.7	84.0	200.5	280.0	112.6
Lanai	3,003.7	88	6.4	76.7	25.2	103.0	56.3
Hawaii	16,839.8	198	93.2	279.9	175.5	522.2	305.0
TOTAL	**96,207.6**	**916**	**284.0**	**2,436.8**	**959.8**	**2,351.9**	**1,087.0**

2.1.5 Northwestern Hawaiian Islands Reef Fish Biomass

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

Category:

- ✓ Fishery independent
- ☐ Fishery dependent
- ☐ Biological

Timeframe: Triennial

Jurisdiction:

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

Scale:

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

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

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

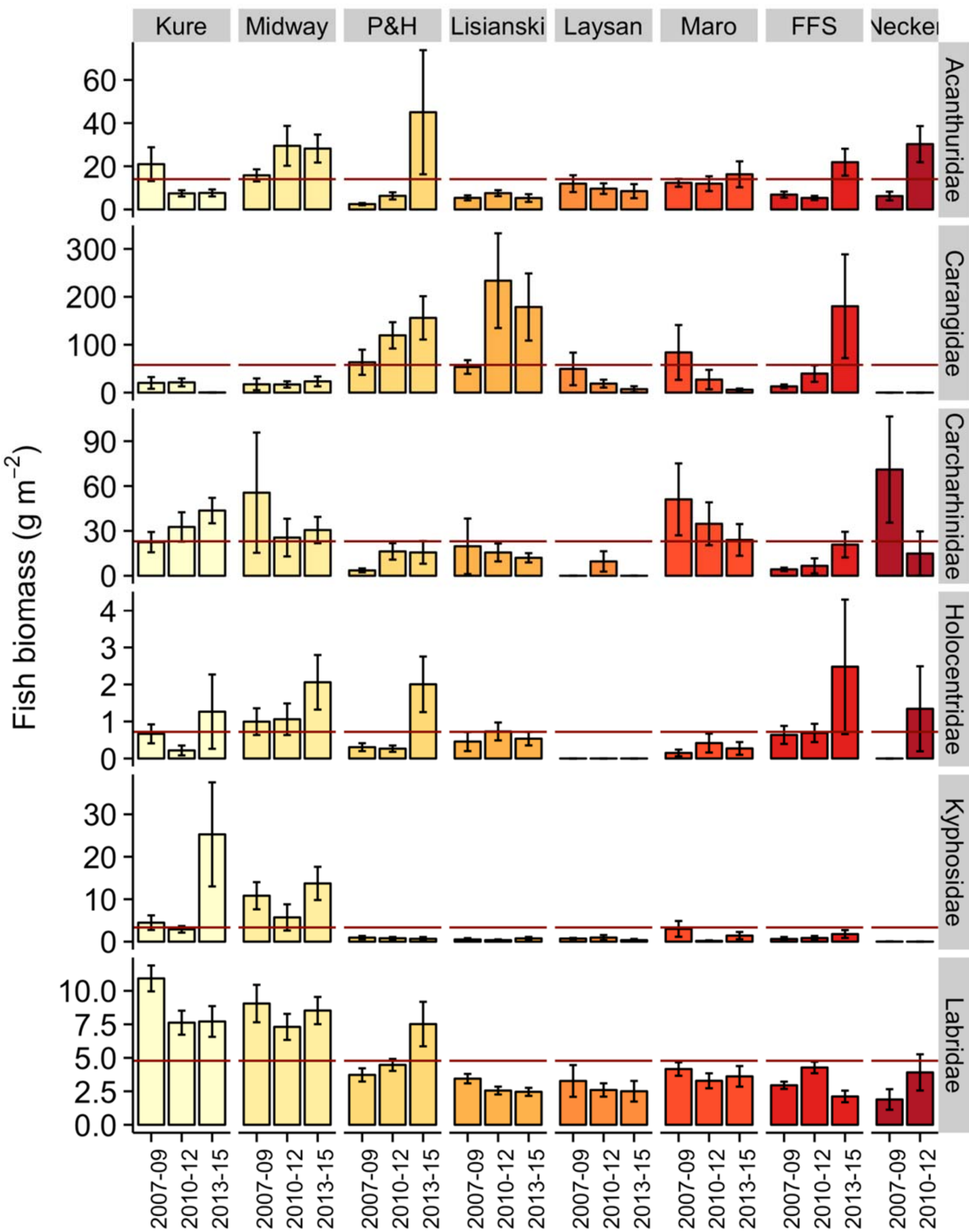
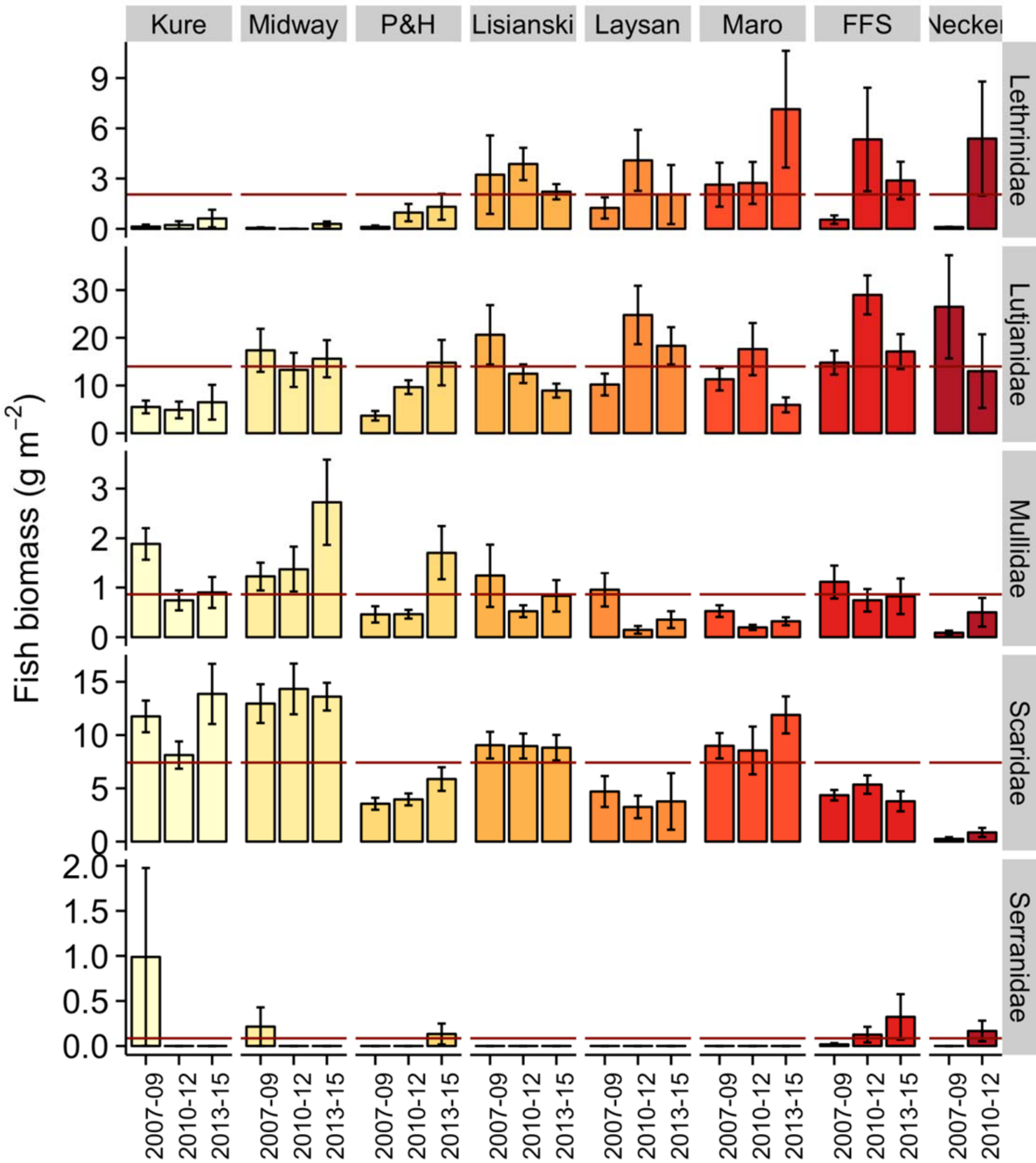


Figure 4. Mean fish biomass by Coral Reef Management Unit Species (CREMUS) grouping per Northwestern Hawaiian Island. Mean fish biomass (± standard error) per CREMUS grouping per reef area pooled across survey years (2009-2015). Islands ordered within region by latitude. Data from Nihoa and Gardner Pinnacles are removed, as data are very limited. Continues to next page.


Kure
Midway
P&H
Lisianski
Laysan
Maro
FFS
Necker
Lethrinidae
Lutjanidae
Mullidae
Scaridae
Serranidae
Fish biomass (g m−2)
2007-09
2010-12
2013-15

2.1.6 **Archipelagic Mean Fish Size**

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

Category:

- ✓ Fishery independent
- ☐ Fishery dependent
- ☐ Biological

Timeframe: Triennial

Jurisdiction:

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

Scale:

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

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

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

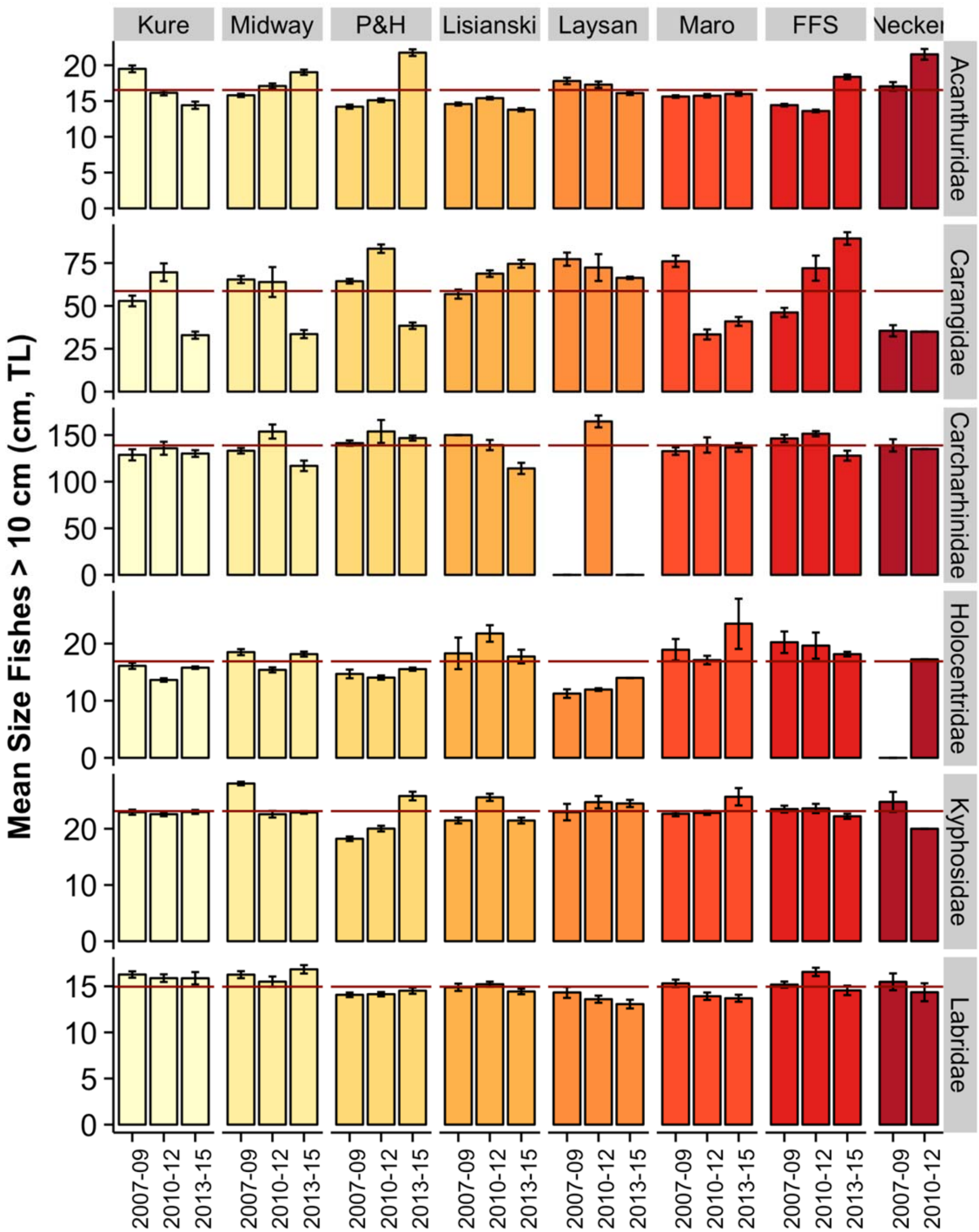
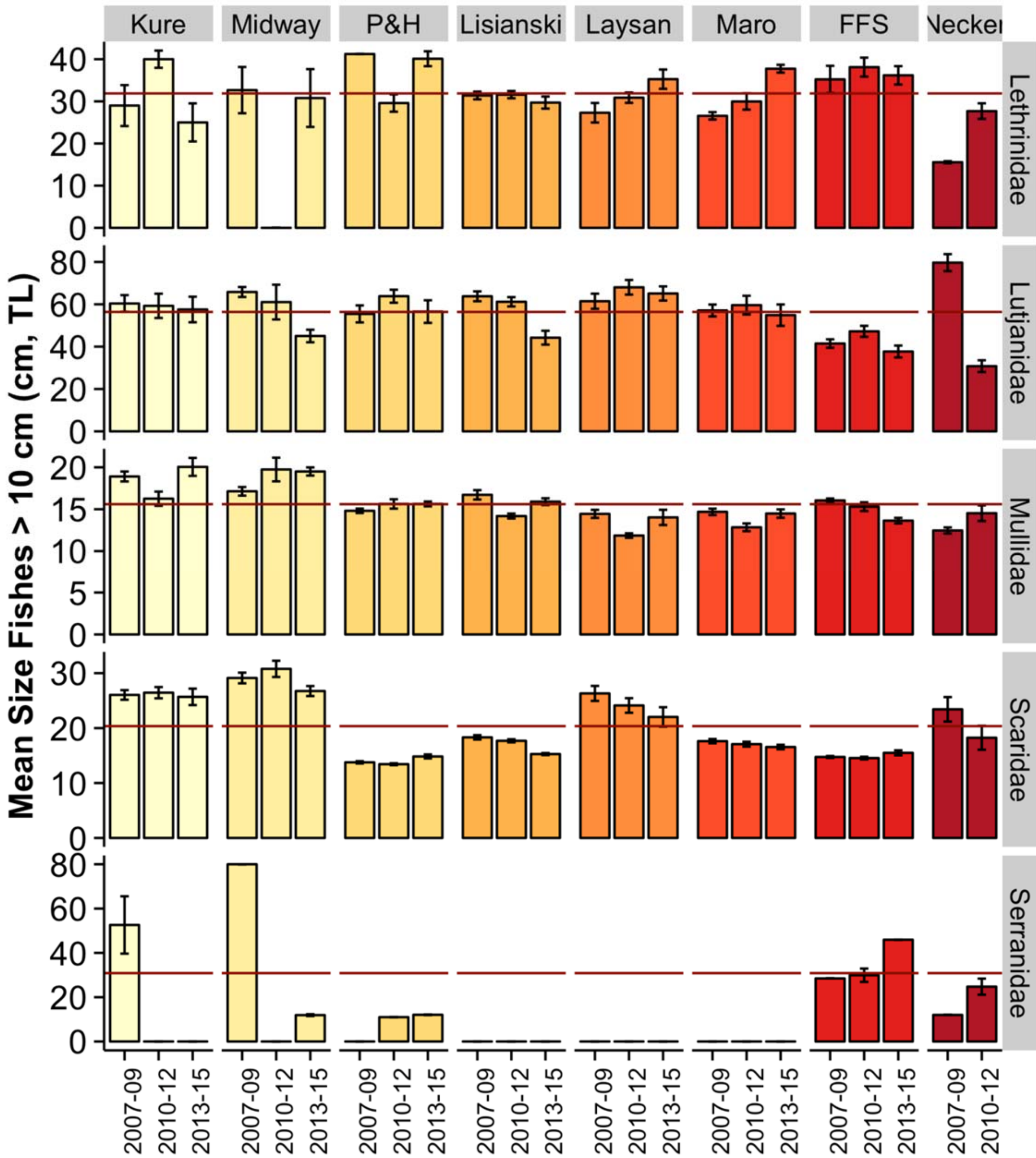


Figure 5. Northwestern Hawaiian Islands mean reef fish size (cm ± SE) per CREMUS grouping per year. The Northwestern Hawaiian Islands mean estimates are plotted for reference (red line). Nihoa and Gardner Pinnacles are removed, as data are very limited. Continues to next page.


Kure
Midway
P&H
Lisianski
Laysan
Maro
FFS
Necker
Lethrinidae
Lutjanidae
Mullidae
Scaridae
Serranidae
Mean Size Fishes > 10 cm (cm, TL)
2007-09
2010-12
2013-15

2.1.7 Reef Fish Population Estimates

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

Category:

- ✓ Fishery independent
- ☐ Fishery dependent
- ☐ Biological

Timeframe: Triennial

Jurisdiction:

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

Scale:

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

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

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

Table 51. Reef fish population estimates for the Northwest Hawaiian Islands. Fish species are pooled by CREMUS groupings. Estimated population biomass is for 0-30 m hardbottom habitat only. (n) is number of sites surveyed per island. Each site is surveyed by means of 2-4 7.5 m diameter SPCs - however, those are not considered to be independent samples, so data from those is pooled to site level before other analysis.

			ESTIMATED POPULATION BIOMASS (metric Tonnes) in SURVEY DOMAIN OF <30m HARDBOTTOM					
ISLAND	Total Area of reef (Ha)	N	Acanthuridae	Carangidae	Carcharhinids	Holocentridae	Kyphosidae	Labridae
Kure	3,699.4	53	279.0	399.3	1,410.2	27.4	521.0	283.6
Midway	4,995.6	78	1,440.5	1,008.2	1,401.5	77.9	485.2	395.6
Pearl & Hermes	17,812.1	113	4,570.0	24,530.7	2,839.1	202.2	130.7	1,067.8
Lisianski	30,954.9	105	1,985.5	63,822.4	4,268.3	196.1	171.6	776.7
Laysan	3,399.6	31	307.8	441.5	162.9	-	22.0	86.7
Maro	34,192.6	42	4,827.9	5,676.8	10,040.6	117.7	274.1	1,179.6
Gardner	31,733.2	12	1,423.4	4,315.8	15,991.0	-	426.3	340.7
French Frigate	27,797.4	85	3,781.5	30,580.0	3,814.6	440.9	367.8	888.5
Necker	636.6	8	192.6	0.1	94.4	8.6	0.0	24.9
Nihoa	409.9	8	59.3	110.9	43.0	3.0	31.1	16.1
TOTAL	**155,631**	**535**	**21,137.0**	**146,910.5**	**35,152.7**	**1,262.1**	**2,597.5**	**5,499.4**

ISLAND	Total Area of reef (Ha)	N	Lethrinidae	Lutjanidae	Mullidae	Scaridae	Serranidae
Kure	3,699.4	53	15.5	210.2	30.4	406.7	-
Midway	4,995.6	78	7.3	721.3	102.4	697.8	-
Pearl & Hermes	17,812.1	113	203.1	2,176.3	193.1	875.3	11.9
Lisianski	30,954.9	105	941.3	3,311.5	209.6	2,752.9	-
Laysan	3,399.6	31	104.2	732.6	8.5	119.3	-
Maro	34,192.6	42	1,689.0	4,028.1	88.3	3,495.6	-
Gardner	31,733.2	12	245.6	2,839.8	61.5	64.4	1.3
French Frigate	27,797.4	85	1,142.2	6,407.8	217.5	1,269.8	62.5
Necker	636.6	8	34.3	82.8	3.2	5.5	1.1
Nihoa	409.9	8	7.2	27.9	3.3	19.4	8.0
TOTAL	**155,631**	**535**	**4,815.7**	**20,907.9**	**1,028.0**	**11,024.8**	**94.6**

Note (1): No Siganidae, *Bolbometopon muricatum* or *Cheilinus undulatus* were observed in NWHI

ISLAND	Total Area of reef (Ha)	N	ESTIMATED POPULATION BIOMASS (metric Tonnes) in SURVEY DOMAIN OF <30m HARDBOTTOM					
			Acanthuridae	Carangidae	Carcharhinids	Holocentridae	Kyphosidae	Labridae
Kure	3,699.4	53	279.0	399.3	1,410.2	27.4	521.0	283.6
Midway	4,995.6	78	1,440.5	1,008.2	1,401.5	77.9	485.2	395.6
Pearl & Hermes	17,812.1	113	4,570.0	24,530.7	2,839.1	202.2	130.7	1,067.8
Lisianski	30,954.9	105	1,985.5	63,822.4	4,268.3	196.1	171.6	776.7
Laysan	3,399.6	31	307.8	441.5	162.9	-	22.0	86.7
Maro	34,192.6	42	4,827.9	5,676.8	10,040.6	117.7	274.1	1,179.6
Gardner	31,733.2	12	1,423.4	4,315.8	15,991.0	-	426.3	340.7
French Frigate	27,797.4	85	3,781.5	30,580.0	3,814.6	440.9	367.8	888.5
Necker	636.6	8	192.6	0.1	94.4	8.6	0.0	24.9
Nihoa	409.9	8	59.3	110.9	43.0	3.0	31.1	16.1
TOTAL	**155,631**	**535**	**21,137.0**	**146,910.5**	**35,152.7**	**1,262.1**	**2,597.5**	**5,499.4**

ISLAND	Total Area of reef (Ha)	N	Lethrinidae	Lutjanidae	Mullidae	Scaridae	Serranidae
Kure	3,699.4	53	15.5	210.2	30.4	406.7	-
Midway	4,995.6	78	7.3	721.3	102.4	697.8	-
Pearl & Hermes	17,812.1	113	203.1	2,176.3	193.1	875.3	11.9
Lisianski	30,954.9	105	941.3	3,311.5	209.6	2,752.9	-
Laysan	3,399.6	31	104.2	732.6	8.5	119.3	-
Maro	34,192.6	42	1,689.0	4,028.1	88.3	3,495.6	-
Gardner	31,733.2	12	245.6	2,839.8	61.5	64.4	1.3
French Frigate	27,797.4	85	1,142.2	6,407.8	217.5	1,269.8	62.5
Necker	636.6	8	34.3	82.8	3.2	5.5	1.1
Nihoa	409.9	8	7.2	27.9	3.3	19.4	8.0
TOTAL	**155,631**	**535**	**4,815.7**	**20,907.9**	**1,028.0**	**11,024.8**	**94.6**

Note (1): No Siganidae, *Bolbometopon muricatum* or *Cheilinus undulatus* were observed in NWHI

2.2 Human Dimensions

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

2.3 Protected Species

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

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

2.3.1 Indicators for Monitoring Protected Species Interactions in the Hawaii FEP Fisheries

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

2.3.1.1 FEP Conservation Measures

No specific regulations are in place to mitigate protected species interactions in the bottomfish, precious coral, coral reef ecosystem and crustacean fisheries currently active and managed under this FEP. Destructive gear such as bottom trawls, bottom gillnets, explosives and poisons are prohibited under this FEP, and these provide benefit to protected species by preventing potential interactions with non-selective fishing gear.

The original Crustacean Fishery Management Plan (FMP) and subsequent amendments included measures to minimize potential impacts of the Northwestern Hawaiian Islands (NWHI) component of the spiny lobster fishery to Hawaiian monk seals, such as specification of trap gear design and prohibition of nets. The Bottomfish and Seamount Groundfish FMP began requiring protected species workshops for the NWHI bottomfish fishery participants in 1988. These fisheries are no longer active due to the issuance of Executive Orders 13178 and 13196 and the subsequent Presidential Proclamations 8031 and 8112, which closed the fisheries within 50 nm around the NWHI.

2.3.1.2 Endangered Species Act Consultations

Hawaii FEP fisheries are covered under the following consultations under section 7 of the ESA, through which NMFS has determined that these fisheries are not likely to jeopardize or adversely affect any ESA-listed species or critical habitat in the Hawaii Archipelago.

Bottomfish Fishery

In a Biological Opinion (BiOp) covering MHI bottomfish fishery, dated March 18, 2008, NMFS determined that the MHI bottomfish fishery is not likely to jeopardize the green turtle and included an incidental take statement (ITS) of two animals killed per year from collisions with bottomfish vessels. The 2008 BiOp also concluded that the fishery is not likely to adversely affect any four other sea turtle species (loggerhead, leatherback, olive ridley, and hawksbill turtles) and seven marine mammal species (humpback, blue, fin, Northern right whale, sei and sperm whales, and the Hawaiian monk seal).

In 2013, NMFS re-initiated consultation under ESA in response to listing of MHI insular false killer whale distinct population segment under the ESA. In a modification to the 2008 BiOp dated August 7, 2013, NMFS determined that commercial and non-commercial bottomfish fisheries in the MHI are not likely to adversely affect MHI insular false killer whale because of the spatial separation between the species and bottomfishing activities, the low likelihood of collisions, and the lack of observed or reported fishery interactions were among other reasons.

In August 2015, NMFS revised the Hawaiian monk seal critical habitat in the NWHI and designated new critical habitat in the main Hawaiian Islands (MHI). An informal consultation completed by NMFS on March 1, 2016 concluded that the Hawaii bottomfish fishery is not likely to adversely affect monk seal critical habitat.

Crustacean Fishery
An informal consultation completed by NMFS on December 5, 2013 concluded that the Hawaii crustacean fisheries are not likely to affect five sea turtle species (North Pacific loggerhead DPS, leatherback, olive ridley, green and hawksbill turtles) and eight marine mammal species (humpback, blue, fin, Northern right whale, sei and sperm whales, MHI insular DPS false killer whales and the Hawaiian monk seal). An informal consultation completed by NMFS on March 1, 2016 concluded that the Hawaii crustacean fishery is not likely to adversely affect monk seal critical habitat.

Coral Reef Ecosystem Fishery
An informal consultation completed by NMFS on September 25, 2013 concluded that the Hawaii coral reef ecosystem fisheries are not likely to affect five sea turtle species (North Pacific loggerhead DPS, leatherback, olive ridley, green and hawksbill turtles) and eight marine mammal species (humpback, blue, fin, Northern right whale, sei and sperm whales, MHI insular DPS false killer whales and the Hawaiian monk seal). An informal consultation completed by NMFS on March 1, 2016 concluded that the Hawaii coral reef ecosystem fishery is not likely to adversely affect monk seal critical habitat.

Precious Coral Fishery
An informal consultation completed by NMFS on December 5, 2013 concluded that the Hawaii precious coral fisheries are not likely to affect five sea turtle species (North Pacific loggerhead DPS, leatherback, olive ridley, green and hawksbill turtles) and eight marine mammal species (humpback, blue, fin, Northern right whale, sei and sperm whales, MHI insular DPS false killer whales and the Hawaiian monk seal). An informal consultation completed by NMFS on March 1, 2016 concluded that the Hawaii precious coral fishery is not likely to adversely affect monk seal critical habitat.

2.3.1.3 Non-ESA Marine Mammals
The MMPA requires NMFS to annually publish a List of Fisheries (LOF) that classifies commercial fisheries in one of three categories based on the level of mortality and serious injury of marine mammals associated with that fishery. According to the 2016 LOF (81 FR 20550, April 8, 2016), the bottomfish (HI bottomfish handline), precious coral (HI black coral diving), coral fish (HI spearfishing), and crustacean (HI crab trap, lobster trap, shrimp trap, crab net,

Kona crab loop net, lobster diving) fisheries are classified as Category III fisheries (i.e. a remote likelihood of or no known incidental mortality and serious injury of marine mammals).

2.3.2 Status of Protected Species Interactions in the Hawaii FEP Fisheries

Bottomfish Fishery

Fisheries operating under the Hawaii FEP currently do not have federal observers on board. The NWHI component of the bottomfish fishery had observer coverage from 1990 to 1993 and 2003 to 2005.

The observer program for the NWHI bottomfish fishery between 1990-1993 reported a moderate level of depredation from non-endangered seabirds in the bottomfish fishery, with Laysan and black-footed albatrosses described as aggressively stealing bait from hooks during deployment and retrieval of bottomfish gear (Nitta 1999). However, no seabird injuries or mortalities were observed between 1990-1993 while fishermen were fishing for bottomfish. The 1990-1993 observer coverage also documented depredation by Hawaiian monk seals and bottlenose dolphins, but no injuries or mortalities were observed for either species.

During the 2003-2005 observer coverage in the NWHI bottomfish fishery, eight interactions with seabirds not listed under the ESA were observed across six trips (Table 52). Six of the interactions occurred during trolling operations and two during bottomfishing operations. Of the two interactions, one occurred with a black-footed albatross, and the other occurred with a brown booby. Hookings or entanglements with sea turtles and marine mammals were not observed during this period.

Table 52. Observed takes of protected species in the NWHI bottomfish fishery observer program, 2003-2005. Take data are based on vessel arrival dates.

Year	Vessels with Observers	Observer Coverage (%)	Seabirds						Sea turtles	Marine mammals
			Laysan albatross	Black-footed albatross	Brown booby	Red-footed booby	Unidentified booby	Short-tailed albatross		
2003[a]	4	33.3	0	0	0	0	0	0	0	0
2004	14	18.3	1[b]	1[c]	1[c]	0	2[b]	0	0	0
2005	13	25.0	1[b]	0	1[b]	1[b]	0	0	0	0

[a] The Hawaii-based bottomfish fishery began monitoring under the observer program in October, 2003.

[b] Protected species interactions occurred during trolling operations.

[c] Protected species interactions occurred during bottomfish operations.

Source: 2003-2005 PIRO Observer Program Annual and Quarterly Status Reports Hawaii Bottomfish Fishery

To date, there have been no reported interactions between MHI bottomfish fisheries and ESA-listed species of sea turtles, marine mammals, and seabirds. Furthermore, the commercial and non-commercial bottomfish fisheries in the MHI are not known to have the potential for a large and adverse effect on non ESA-listed marine mammals. Although these species of marine mammals occur in Exclusive Economic Zone (EEZ) waters where the fisheries operate and depredation of bait or catch by dolphins (primarily bottlenose dolphins) has been known to occur in the bottomfish fishery (Kobayashi and Kawamoto 1995), there have been no observed or reported takes between the fishery and marine mammals.

The 2008 BiOp included an ITS of two green turtle mortalities per year from collisions with bottomfish vessels. There have not been any reported or observed collisions of bottomfish vessels with green turtles, and data are not available to attribute stranded turtle mortality source to bottomfish vessels. However, the BiOp analysis to determine the estimated level of take from vessel collisions was based on an estimated 71,800 bottomfish fishing trips per year. The total annual number of commercial and non-commercial bottomfishing trips since 2008 has been less than 3,500 per year. Therefore, the potential for collisions with bottomfish vessels is substantially lower than was estimated in the 2008 BiOp.

Based on fishing effort and other characteristics described in Sections 1.1 and 1.2, no notable changes have been observed in the fishery. There is no other information to indicate that impacts to protected species from this fishery have changed in recent years.

Crustacean Fishery

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

Since 1986, there have been no reports of direct interactions between the NWHI lobster fishery and Hawaiian monk seals. However, in 1986 near Necker Island, one Hawaiian monk seal died as a result of entanglement with a bridle rope from a lobster trap. Modifications to bridle ropes were subsequently made and the Council recommended regulations to improve the ability to respond to any future reports of interactions between monk seals and lobster fishing gear. There have been no other reports of Hawaiian monk seal entanglements or other interactions since 1987 (WPRFMC 2009).

Based on fishing effort and other characteristics described in Section 1.4, no notable changes have been observed in the fishery. There is no other information to indicate that impacts to protected species from this fishery have changed in recent years.

Coral Reef Fishery

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

Based on fishing effort and other characteristics described in Section 1.3, no notable changes have been observed in the fishery. There is no other information to indicate that impacts to protected species from this fishery have changed in recent years.

Precious Coral Fishery

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

Based on fishing effort and other characteristics described in Section 1.6, no notable changes have been observed in the fishery. There is no other information to indicate that impacts to protected species from this fishery have changed in recent years.

2.3.3 **Identification of research, data and assessment needs**

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

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

2.3.4 **References**

Kobayashi, D., and K. Kawamoto. 1995. Evaluation of shark, dolphin, and monk seal interactions with Northwestern Hawaiian Island bottomfishing activity: A comparison of two time periods and an estimate of economic impacts. Fisheries Research. 23:11–22.

Nitta, E. 1999. Draft: Summary report: Bottomfish observer trips in the Northwestern Hawaiian Islands, October 1990 to December 1993. Honolulu, HI: NMFS Pacific Islands Area Office, Pacific Islands Protected Species Program.

WPRFMC (Western Pacific Regional Fishery Management Council). 2009. Fishery Ecosystem Plan for the Hawaii Archipelago. September 24, 2009.

2.4 Climate and Oceanic Indicators

2.4.1 **Introduction**

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

- Emerging scientific and community understanding of the impacts of changing climate conditions on fishery resources, the ecosystems that sustain those resources and the communities that depend upon them;

- Recent Federal Directives including the 2010 implementation of a National Ocean Policy that identified Resiliency and Adaptation to Climate Change and Ocean Acidification as one of nine National priorities; the development of a Climate Science Strategy by the National Marine Fisheries Service (NMFS) in 2015 and the ongoing development of Pacific Regional Climate Science program;

- The Council's own engagement with the National Oceanic and Atmospheric Administration (NOAA) as well as jurisdictional fishery management agencies in American Samoa, the Commonwealth of the Northern Mariana Islands, Guam, Hawaii as well as fishing industry representatives and local communities in those jurisdictions; and

- Deliberations of the Council's Marine Planning and Climate Change Committee.

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

2.4.2 **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 (PIRCA) and the Ocean and Coasts chapter of the 2014 report on a Pilot Indicator System prepared by the National Climate Assessment and Development Advisory Committee (NCADAC).

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

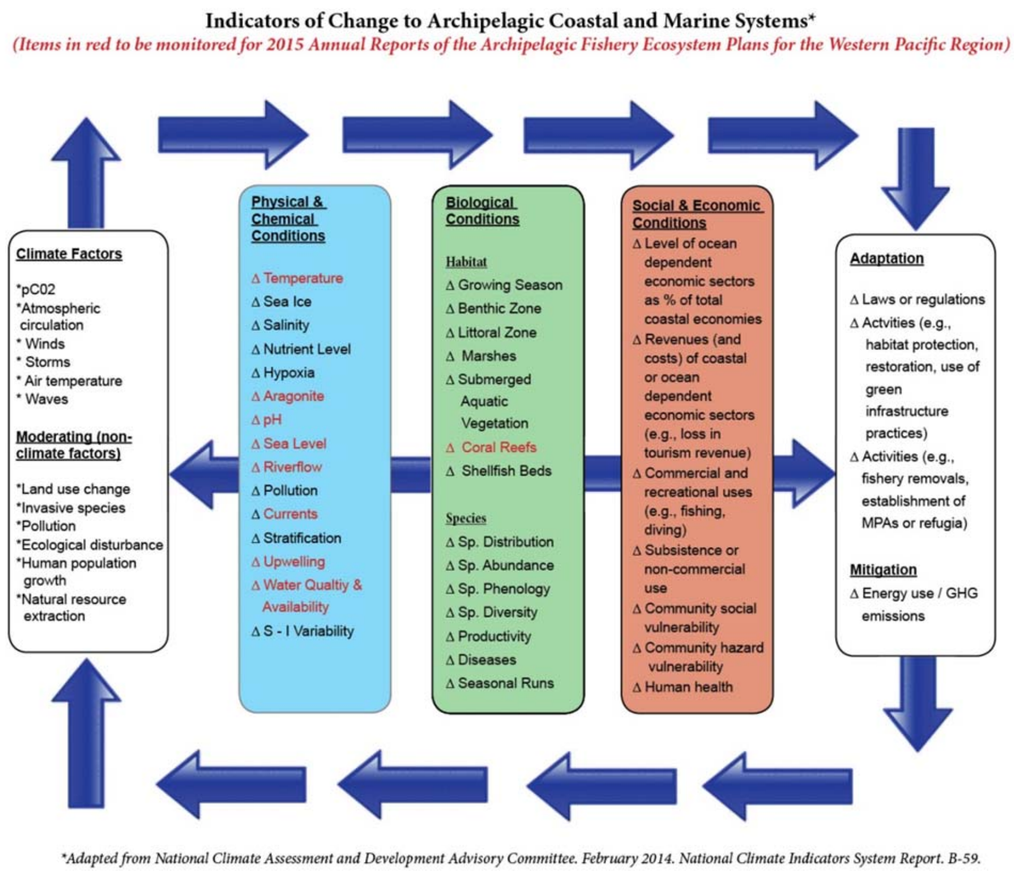


Figure 6. Indicators of change to archipelagic coastal and marine systems.

As described in the 2014 NCADAC report, the conceptual model represents a "simplified representation of climate and non-climate stressors in coastal and marine ecosystems." For the purposes of this Annual Report, the modified Conceptual Model allows the Council and its partners to identify indicators of interest to be monitored on a continuing basis in coming years. The indicators shown in red were considered for inclusion in the 2015 Annual Report; the specific indicators used in the Report are listed in Section 2.3. Other indicators will be added over time as datasets become available and understanding of the nature of the causal chain from stressors to impacts emerges.

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

2.4.3 **Selected Indicators**

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

- Be fisheries-relevant and informative
- Build intuition about current conditions in light of changing climate
- Provide historical context and
- Recognize patterns and trends.

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

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

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

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

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

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

Sea Level (Sea Surface Height) and Anomaly – Rising sea levels can result in a number of coastal impacts, including inundation of infrastructure, increased damage resulting from storm-driven waves and flooding, and saltwater intrusion into freshwater supplies. NOTE that no water level gauges are available in Pacific Remote Island Areas (PRIA) so only regional information on this indicator are included.

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

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

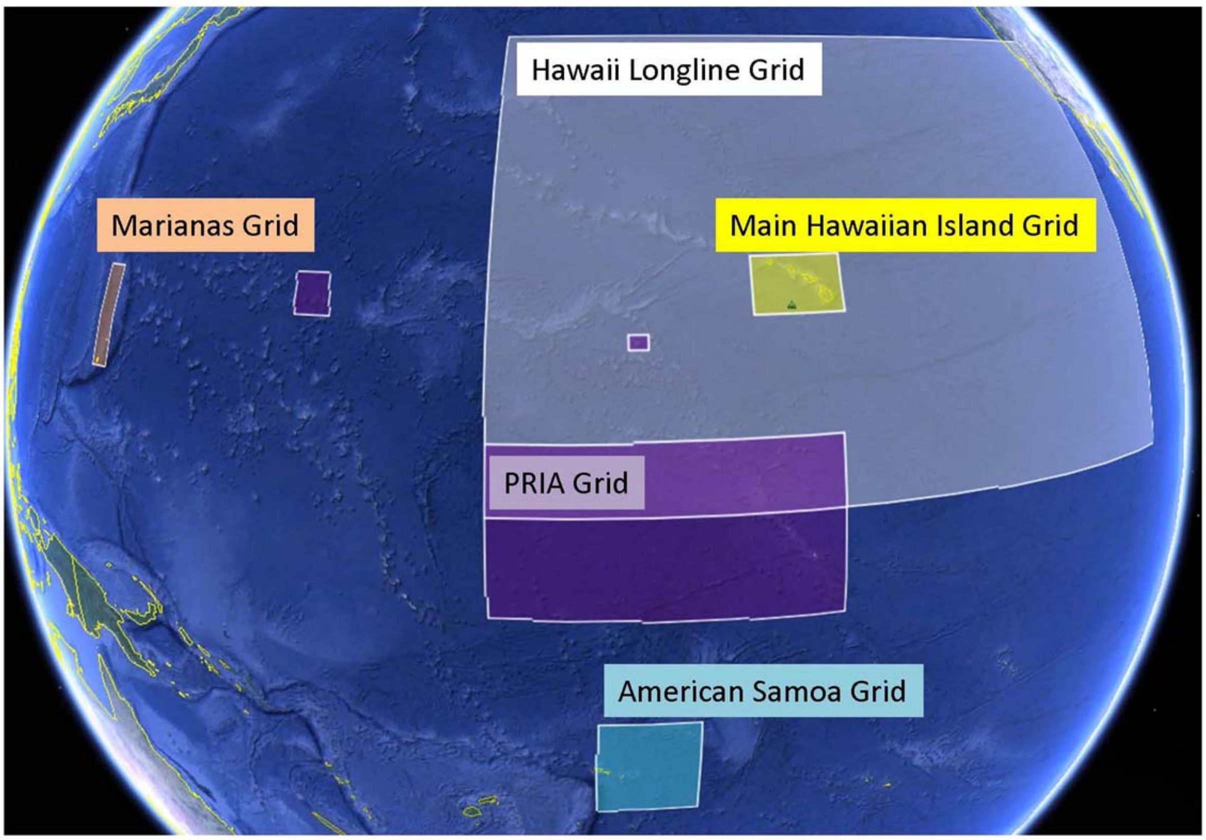


Figure 7. Regional Spatial Grids.

Table 53. Hawaii climate and ocean indicator summary.

Indicator	Definition and Rationale	Indicator Status
Atmospheric Concentration of Carbon Dioxide (CO_2)	Atmospheric concentration CO_2 at Mauna Loa Observatory. Increasing atmospheric CO_2 is a primary measure of anthropogenic climate change.	Trend: increasing exponentially 2015: time series maximum 400.83 ppm
Oceanic pH	Ocean surface pH at Station ALOHA. Ocean pH provides a measure of ocean acidification. Increasing ocean acidification limits the ability of marine organisms to	Trend: pH is decreasing at a rate of 0.039 pH units per year, equivalent to 0.4% increase in acidity per year

Indicator	Definition and Rationale	Indicator Status
	build shells and other hard structures.	
Oceanic Niño Index (ONI)	Sea surface temperature anomaly from Niño 3.4 region (5°N - 5°S, 120° - 170°W). This index is used to determine the phase of the El Niño – Southern Oscillation (ENSO), which has implications across the region, affecting migratory patterns of key commercial fish stocks which in turn affect the location, safety, and costs of commercial fishing.	2015: Strong El Niño
Sea Surface Temperature[1] (SST)	Satellite remotely-sensed sea surface temperature. SST is projected to rise, and impacts phenomena ranging from winds to fish distribution.	SST in waters surrounding the Hawaiian Islands ranged from 26-27°C on leeward shores with waters on the windward shores ranging between 25-26°C, reflecting a positive anomaly in all waters ranging from 0.5-1.0º C
Tropical Cyclones	Measures of tropical cyclone occurrence, strength, and energy. Tropical cyclones have the potential to significantly impact fishing operations.	Eastern Pacific, 2015: 18 named storms, time series maximum 9 major hurricanes. **This is the first year since reliable record keeping began in 1971 that the eastern Pacific saw nine major hurricanes.**
		Central Pacific, 2015: 14 named storms, time series maximum 5 major hurricanes
		Western Pacific, 2015: 27 named storms
Sea Level/Sea Surface Height	Monthly mean sea level time series, including extremes. Data from satellite altimetry & in situ tide gauges. Rising sea levels can result in a number of coastal impacts, including inundation of infrastructure, increased damage resulting from storm-driven waves and flooding, and saltwater intrusion into freshwater supplies.	In 2015, sea level in Honolulu was slightly above the mean sea level trend which continues to increase annually. The 2015 increase in Hawaii is highly correlated with El Niño.
Wave Energy	WaveWatch III (WW3) Global Wave Model"run by UH Department of Ocean Resources & Engineering in collaboration with NOAA/NCEP & NOAA/NWS-Pacific Wave forcing can have major implications for both coastal ecosystems and pelagic fishing operations.	Significant wave heights varied from between 1.0-2.0m on the Big Island highest off the southern and eastern shores with Maui and Oahu showing a range between 1.0-1.5m and Kauai showing a range between 1.5-2.0m.

[1] 2015 data are incomplete.

2.4.3.1 Atmospheric Concentration of Carbon Dioxide (CO_2)) Mauna Loa.

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

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

Timeframe: Yearly (by month)

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

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

Measurement Platform: In-situ Station

Rationale: Atmospheric carbon dioxide is a measure of what human activity has already done to affect the climate system through greenhouse gas emissions. It provides quantitative information in a simplified, standardized format that decision makers can easily understand. This indicator demonstrates that the concentration (and, in turn, the warming influence) of greenhouse gases in the atmosphere has increased substantially over the last several decades. In 2015, the annual mean concentration of $C0_2$ was 400.83 ppm. In 1959, the onset year it was 315.97 ppm. It passed 350 ppm in 1988.

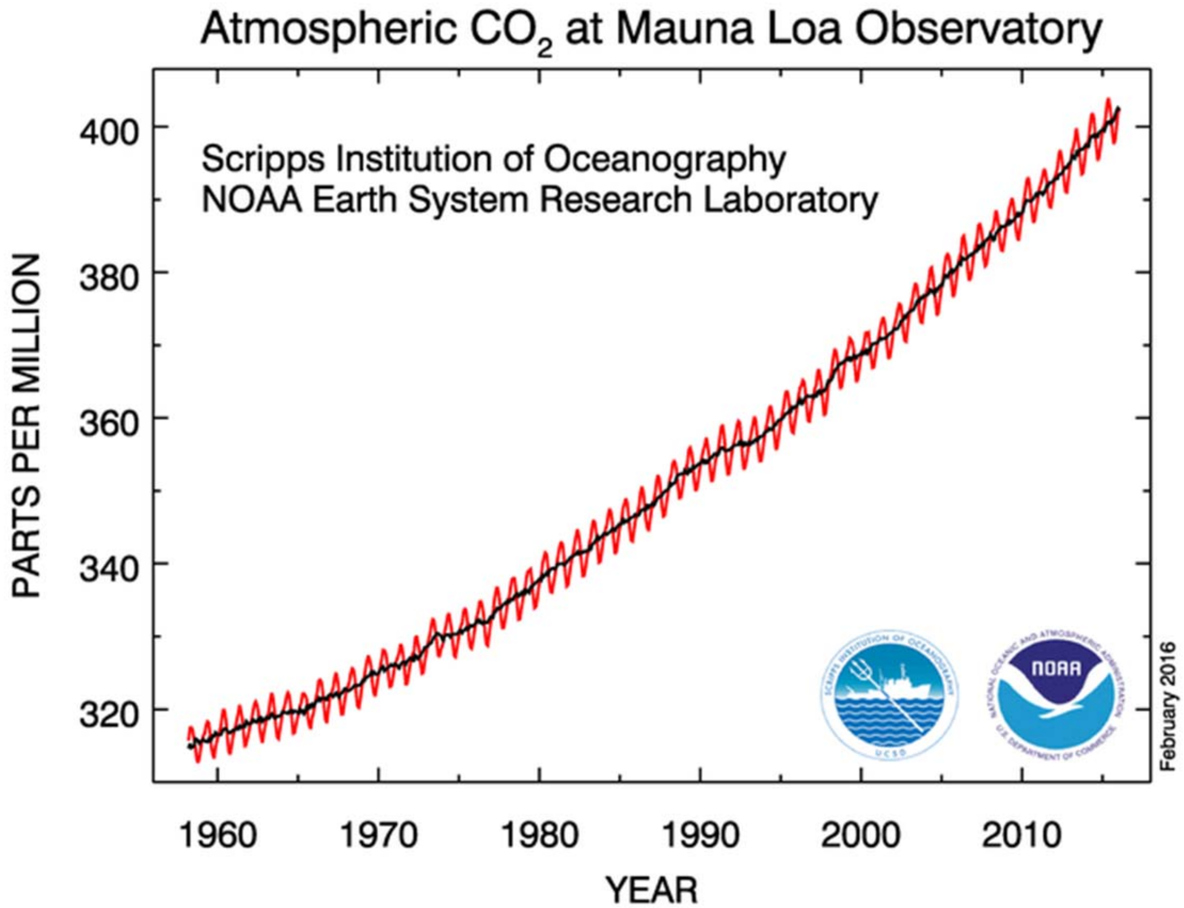


Figure 8. Monthly mean atmospheric carbon dioxide at Mauna Loa Observatory, Hawaii. The carbon dioxide data (red curve), measured as the mole fraction (ppm). in dry air, on Mauna Loa. The black curve represents the seasonally corrected data.

2.4.3.2 Ocean pH:

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

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

Timeframe: Updated Monthly

Region/Location: North Oahu.

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

Measurement Platform: Oceanographic research station, shipboard collection.

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

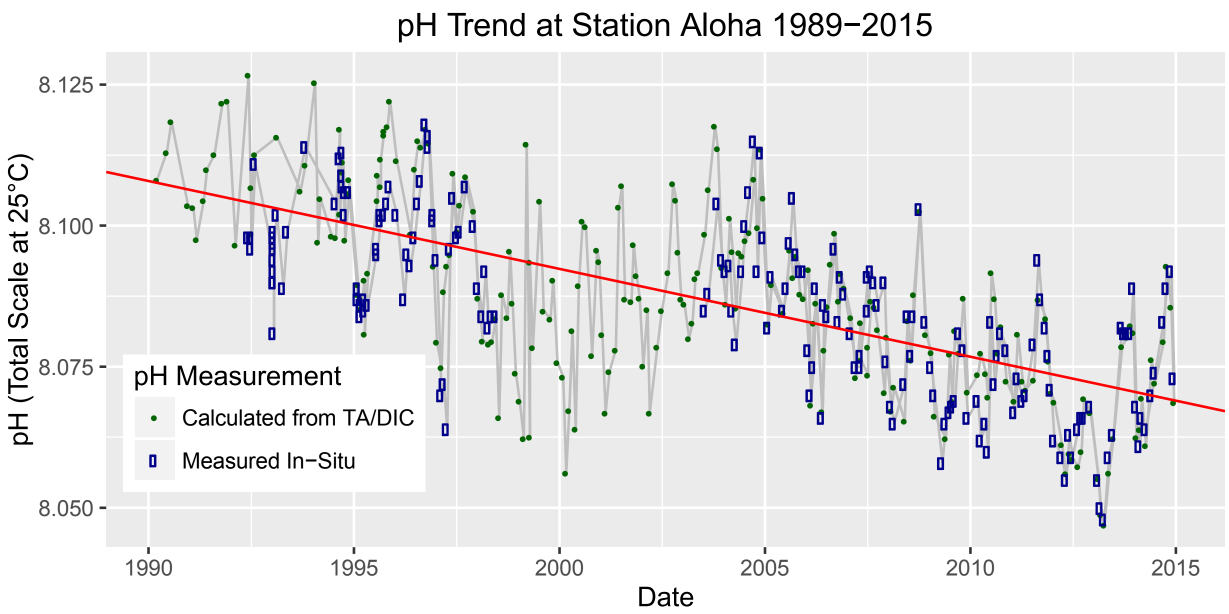


Figure 9. pH Trend at Station Aloha, 1989-2015.

2.4.3.3 Oceanic Niño Index (ONI)

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

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

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

Timeframe: Every three months.

Region/Location: Niño 3.4 Region: 5°S - 5°N, 120°-170°W

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

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

Rationale:

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

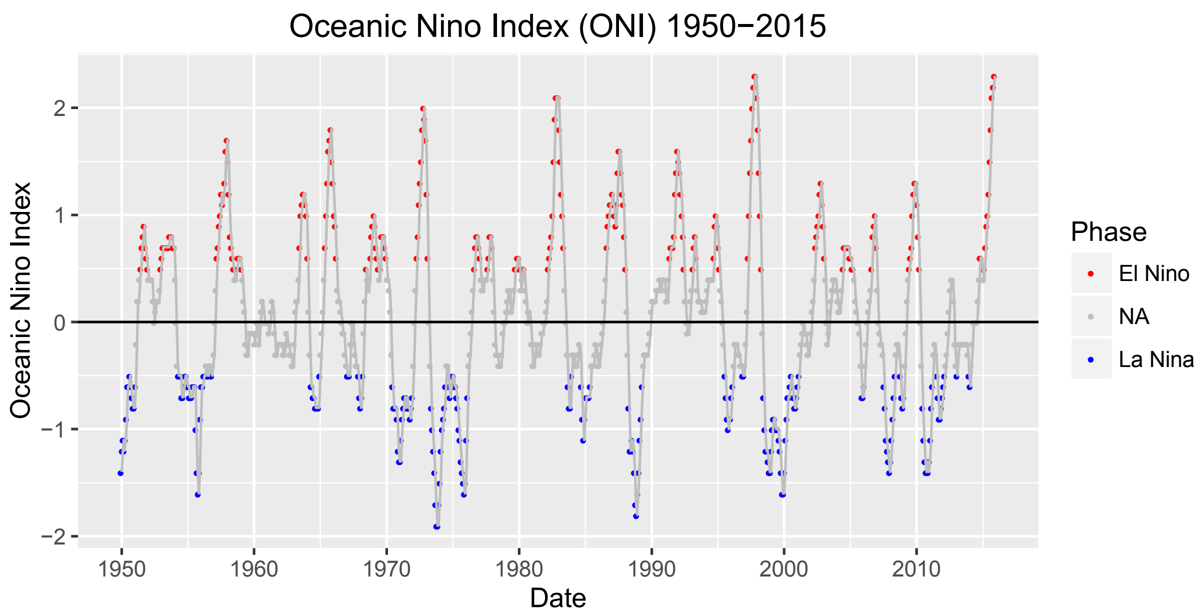


Figure 10. Oceanic Nino Index, 1950-2015.

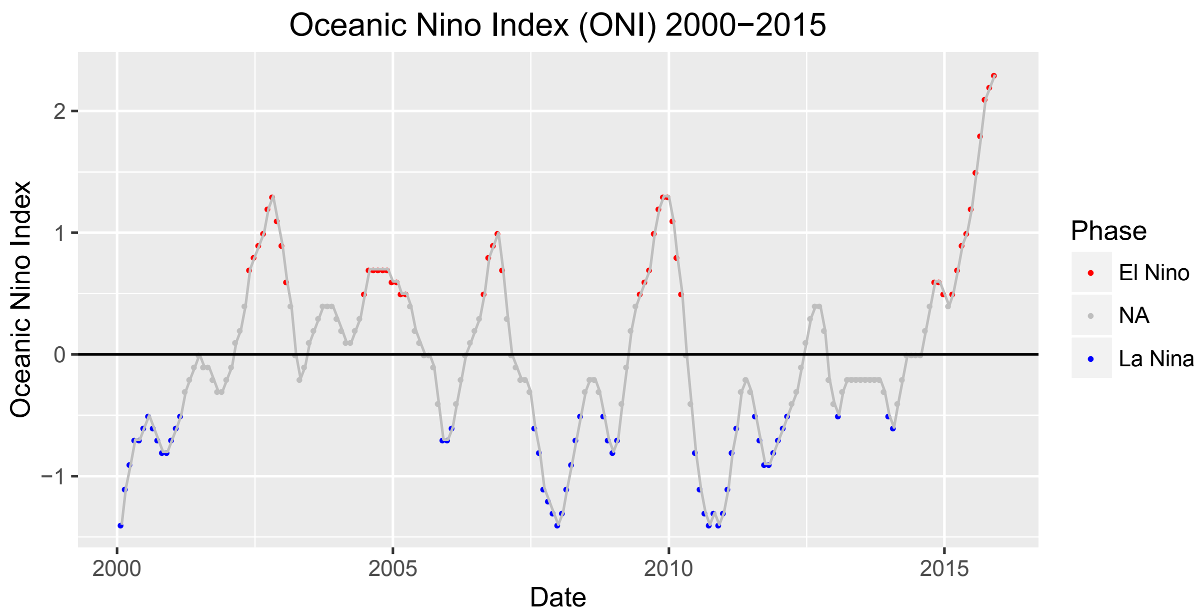
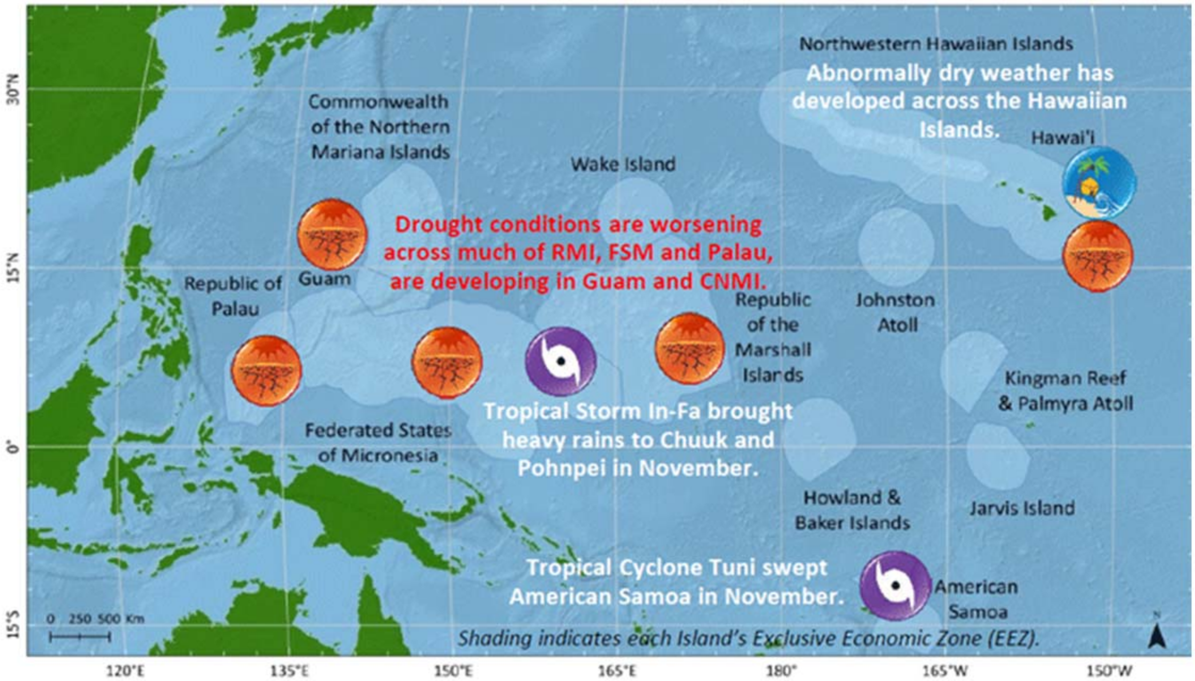


Figure 11. Oceanic Nino Index, 2000-2015.

The 2015-2016 El Niño
From: http://www.pacificcis.org/dashboard



Significant Events and Archipelagic Impacts

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

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

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

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

Figure 12. 2015-2016 El Nino event infographic.

2.4.3.4 Sea Surface Temperature

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

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

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

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

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

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

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

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

Region/Location: Global.

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

Measurement Platform: *AVHRR, POES Satellite*

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

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

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

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

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

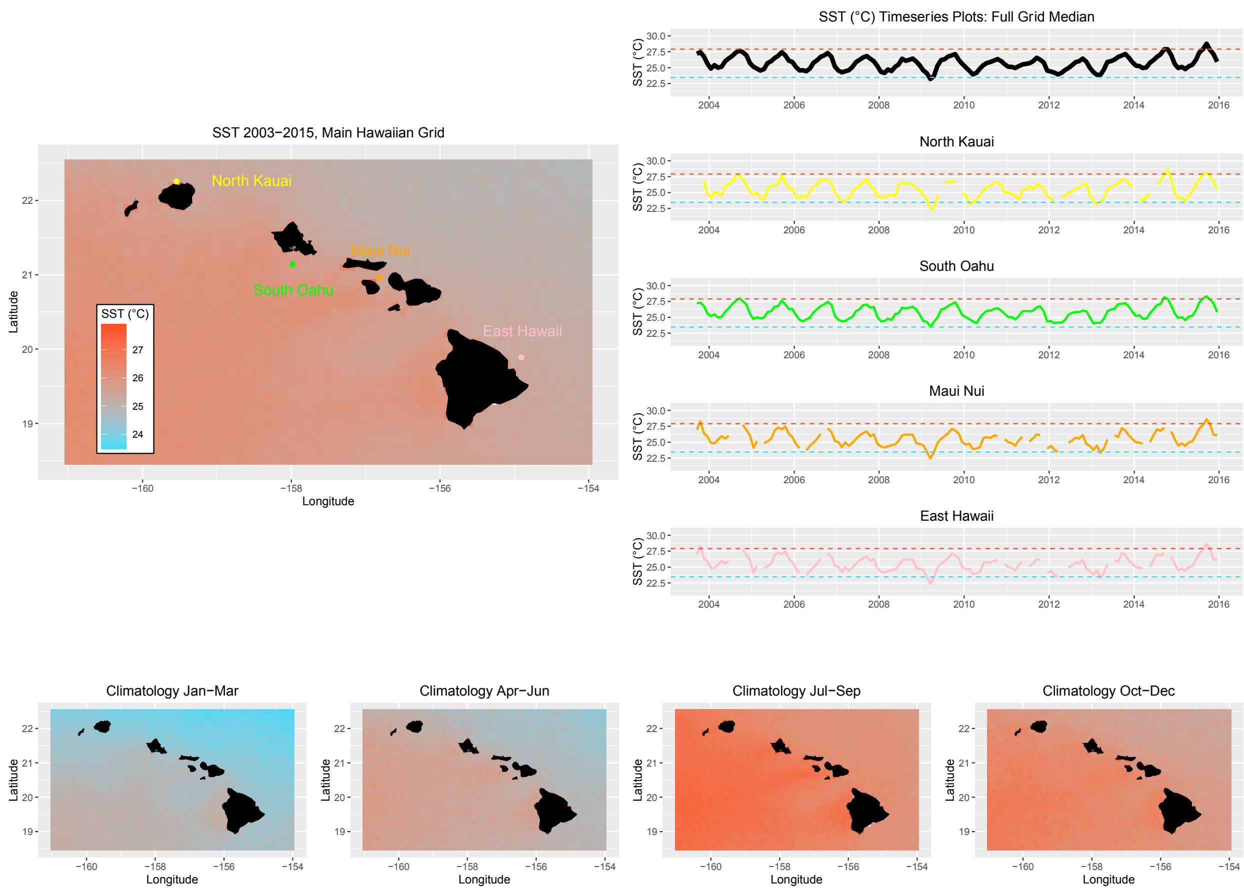


Figure 13. Sea Surface Temperature plots, including 2003-2015 aggregate, timeseries by island, and season climatology.

2.4.3.5 Sea Surface Temperature Anomaly

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

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

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

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

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

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

Region/Location: Global.

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

Measurement Platform: *POES, AVHRR Satellite*

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

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

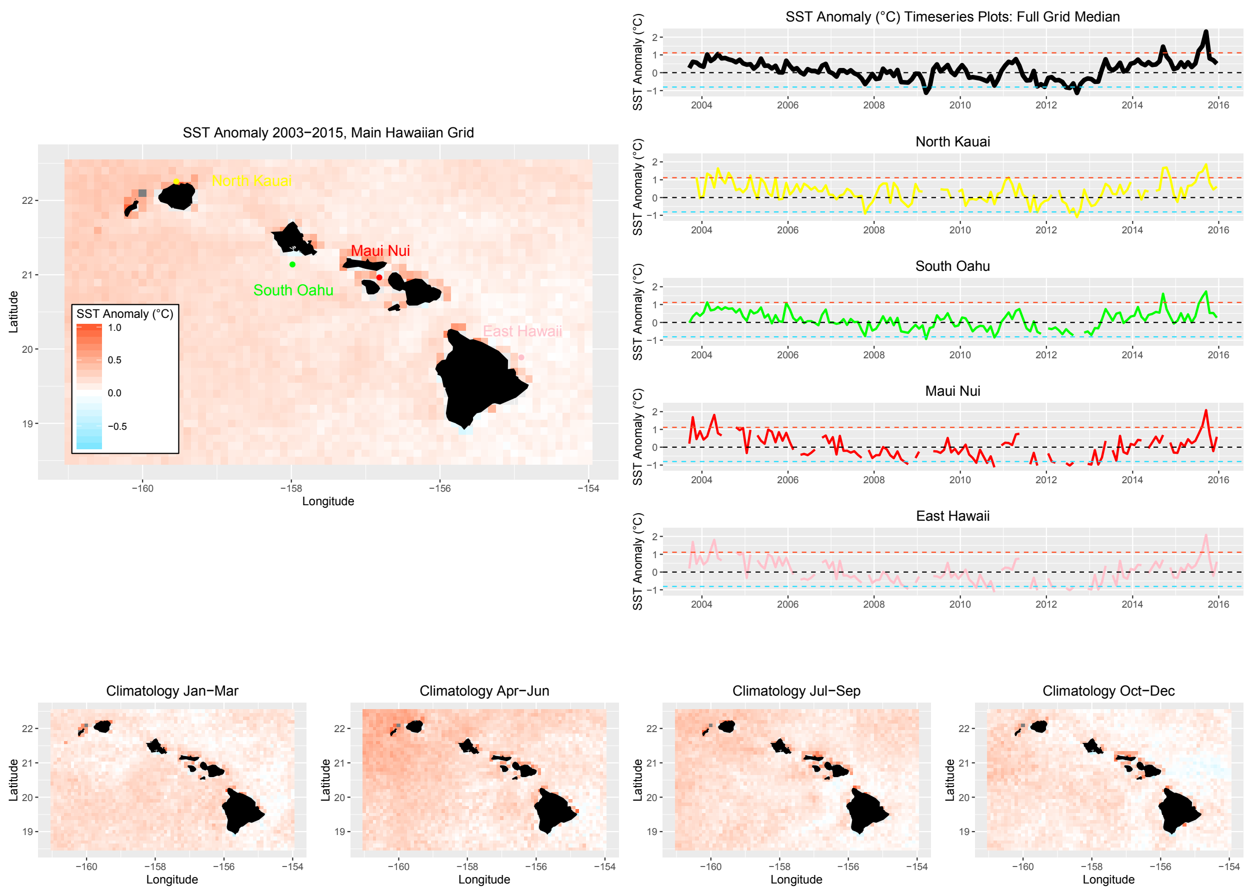


Figure 14. Sea surface temperature anomaly plots, including aggregate, time series by island, and seasonal climatology.

2.4.3.6 Heavy Weather (Tropical Cyclones)

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

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

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

Timeframe: Yearly

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

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

Measurement Platform: Satellite

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

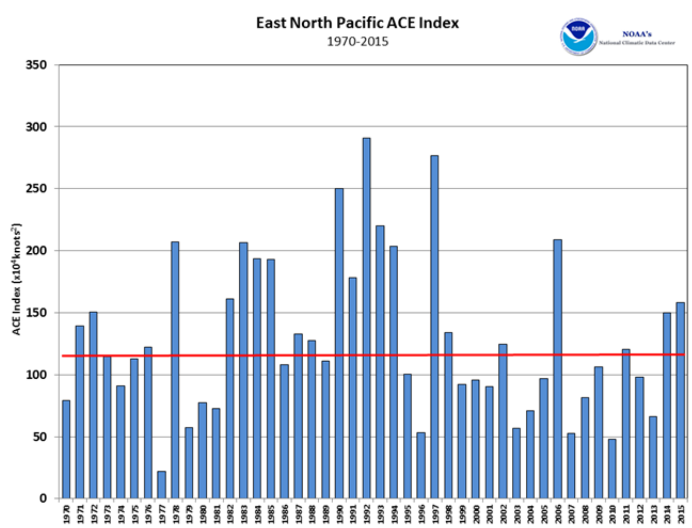


Figure 15. 2015 East Pacific Tropical Cyclone ACE 1970-2015. Source: NOAA's National Hurricane Center

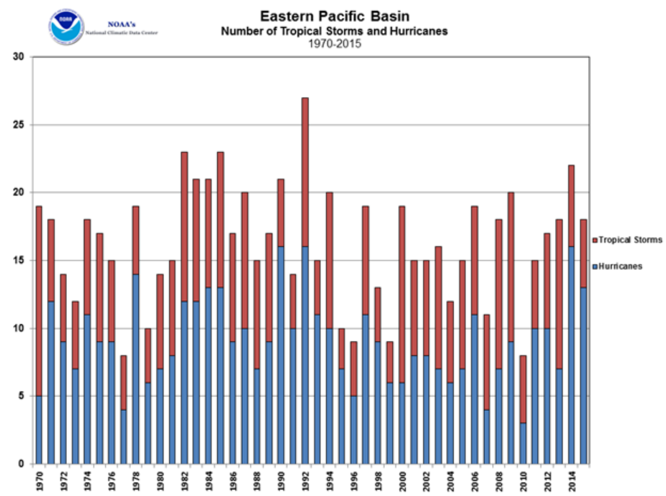


Figure 16. East Pacific tropical cyclone count 1970-2015. Source: NOAA's National Hurricane Center

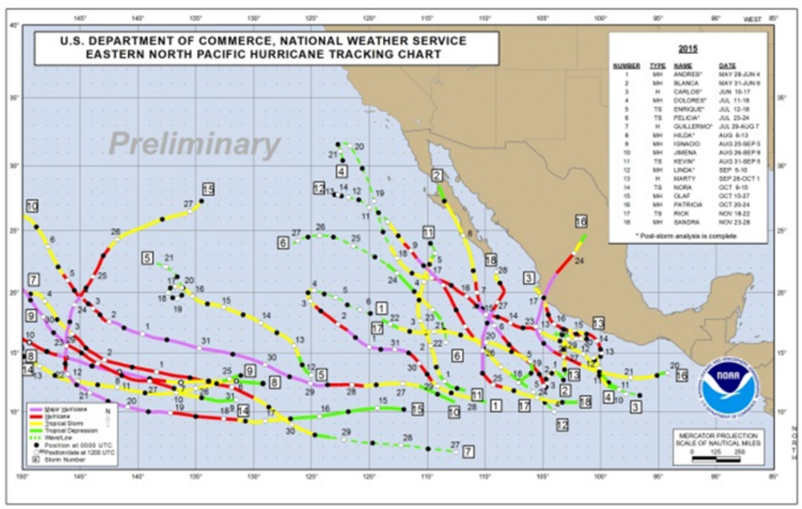


Figure 17. 2015 Eastern Pacific Tropical Cyclone Tracks. Source: NOAA's National Hurricane Center

The NOAA National Centers for Environmental Information, State of the Climate: Hurricanes and Tropical Storms for Annual 2015, published online January 2016, notes that "the 2015 East Pacific hurricane season had 18 named storms, including 13 hurricanes, nine of which became major. The 1981-2010 average number of named storms in the East Pacific is 16.5, with 8.9 hurricanes, and 4.3 major hurricanes. This is the first year since reliable record keeping began in 1971 that the eastern Pacific saw nine major hurricanes. The Central Pacific also saw an above-average tropical cyclone season, with 14 named storms, eight hurricanes, and five major hurricanes, the most active season since reliable record-keeping began in 1971. Three major hurricanes (Ignacio, Kilo and Jimena) were active across the two adjacent basins at the same time, the first time this occurrence has been observed. The ACE index for the East Pacific basin during 2015 was 158 ($x10^4$ $knots^2$), which is above the 1981-2010 average of 132 ($x10^4$ $knots^2$) and the highest since 2006. The Central Pacific basin ACE during 2015 was 124 ($x10^4$ $knots^2$)." Inserted from: http://www.ncdc.noaa.gov/sotc/tropical-cyclones/201513

Cyclone Tracks 2015 (http://weather.unisys.com/hurricane)

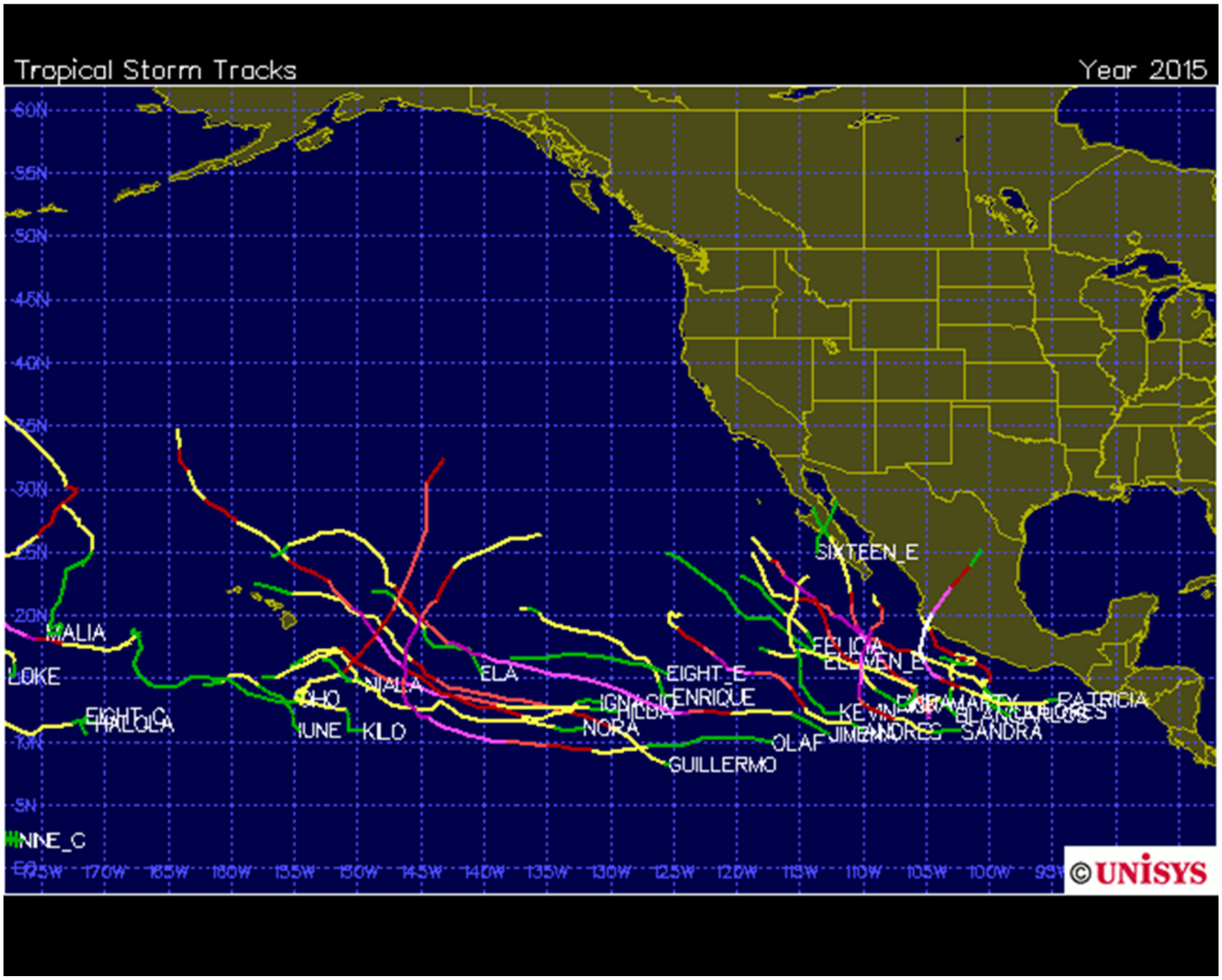


Figure 18. Eastern Pacific Cyclone Tracks in 2015. Source: http://weather.unisys.com/hurricane/e_pacific/2015.

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

2.4.3.7 Sea Level (Sea Surface Height and Anomaly)

Description: Monthly mean sea level time series, including extremes

Timeframe: Monthly

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

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

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

Sea Surface Height and Anomaly from NOAA Ocean Service, Tides and Currents, Sea Level Trends https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=1612340

Measurement Platform: Satellite and *in situ* tide gauges

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

2.4.3.7.1 Basin-Wide Perspective

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

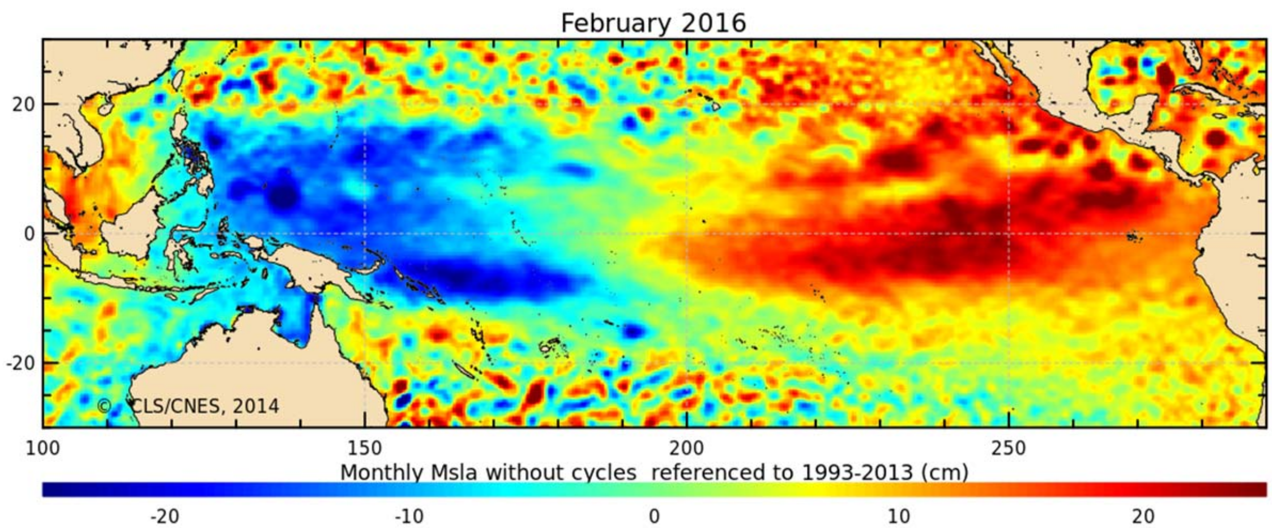
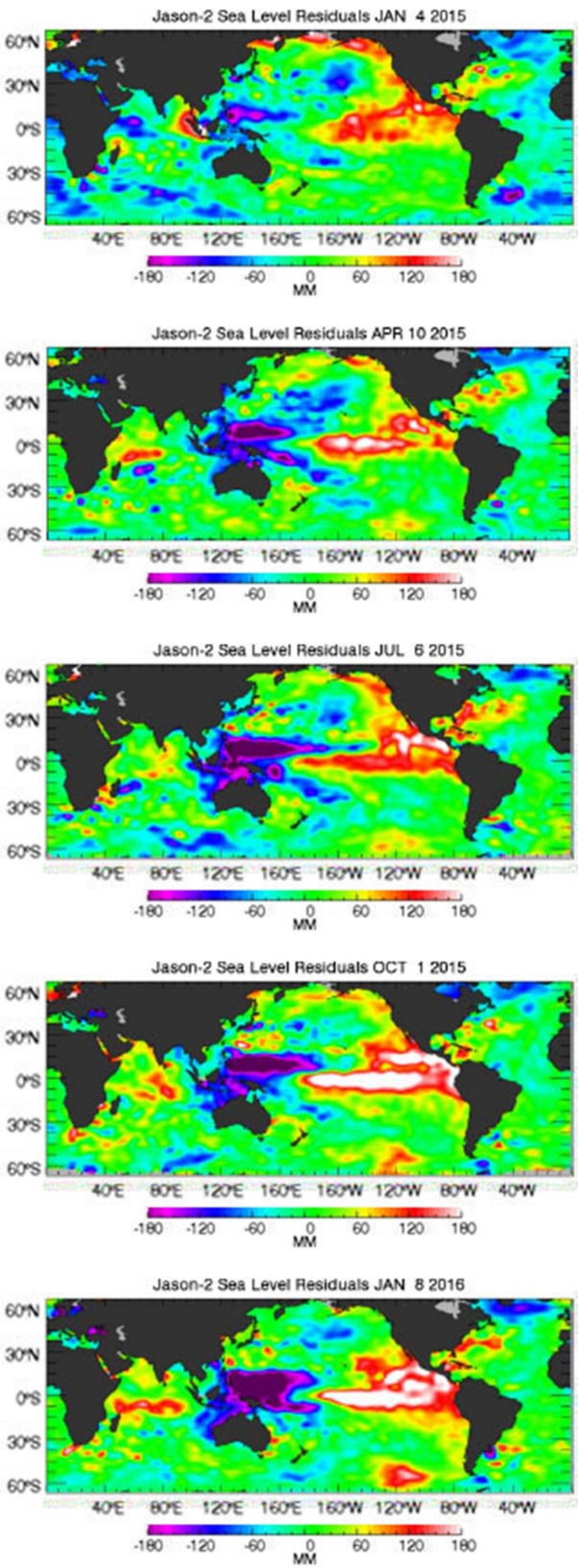
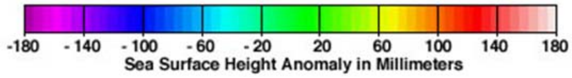


Figure 19. Mean sea level anomaly for February 2016.



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



2.4.3.7.2 Local Sea Level

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

The following figures and descriptive paragraphs were inserted from https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=1612340.

Figure 20 shows the monthly mean sea level without the regular seasonal fluctuations due to coastal ocean temperatures, salinities, winds, atmospheric pressures, and ocean currents. The long-term linear trend is also shown, including its 95% confidence interval. The plotted values are relative to the most recent Mean Sea Level datum established by CO-OPS. The calculated trends for all stations are available as a table in millimeters/year and in feet/century (0.3 meters = 1 foot).

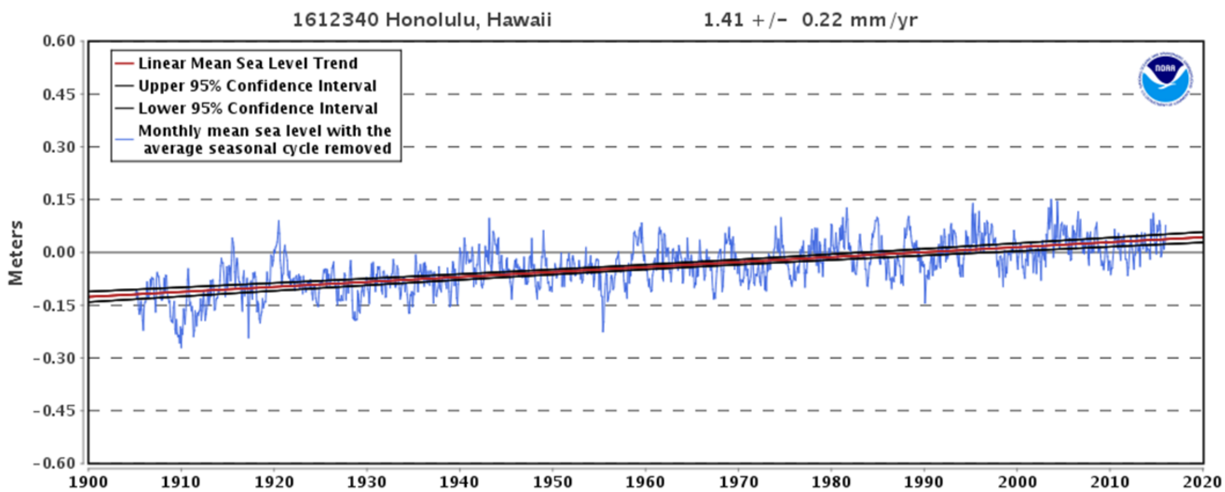


Figure 20. Local sea level in Honolulu, HI 1900-2015.

Figure 21 shows the interannual variation of monthly mean sea level and the five-month running average. The average seasonal cycle and linear sea level trend have been removed. Interannual variation is caused by irregular fluctuations in coastal ocean temperatures, salinities, winds, atmospheric pressures, and ocean currents. The interannual variation for many Pacific stations is closely related to the El Niño Southern Oscillation (ENSO).

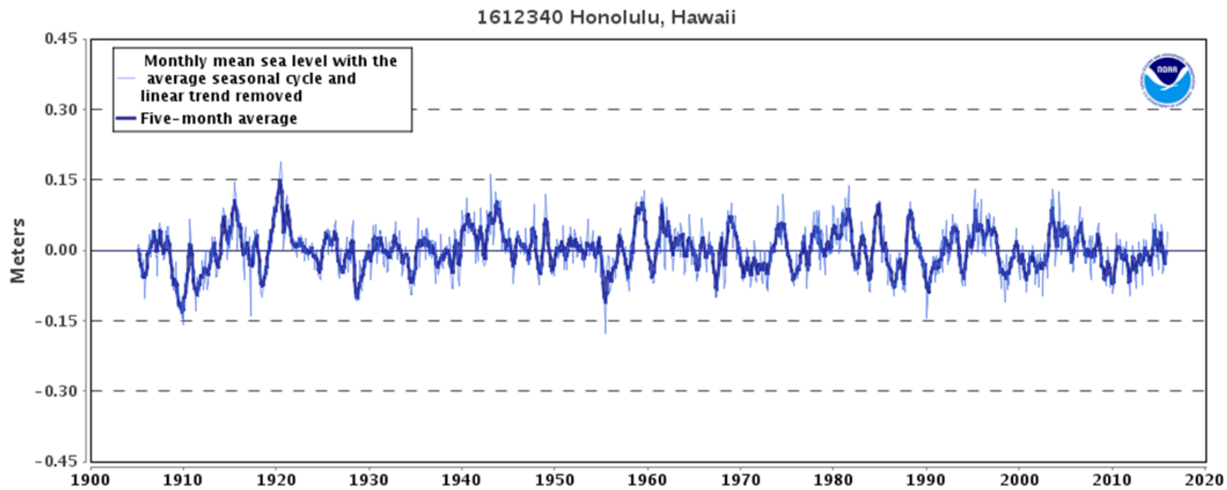
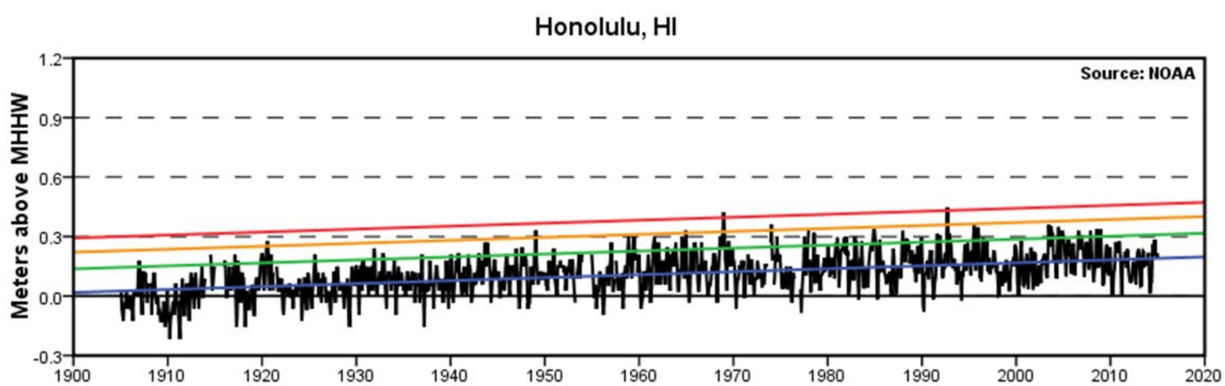


Figure 21. Monthly mean sea level and five-month average sea level at Honolulu, HI 1900-2015.

The monthly extreme water levels include a Mean Sea Level (MSL) trend of 1.5 millimeters/year with a 95% confidence interval of +/- 0.25 millimeters/year based on monthly MSL data from 1905 to 2006 - which is equivalent to a change of 0.49 feet in 100 years. Figure 22 shows the monthly highest and lowest water levels with the 1%, 10%, 50%, and 99% annual exceedance probability levels in red, orange, green, and blue. The plotted values are in meters relative to the Mean Higher High Water (MHHW) or Mean Lower Low Water (MLLW) datums established by CO-OPS (1 foot = 0.3 meters). On average, the 1% level (red) will be exceeded in only one year per century, the 10% level (orange) will be exceeded in ten years per century, and the 50% level (green) will be exceeded in fifty years per century. The 99% level (blue) will be exceeded in all but one year per century, although it could be exceeded more than once in other years.



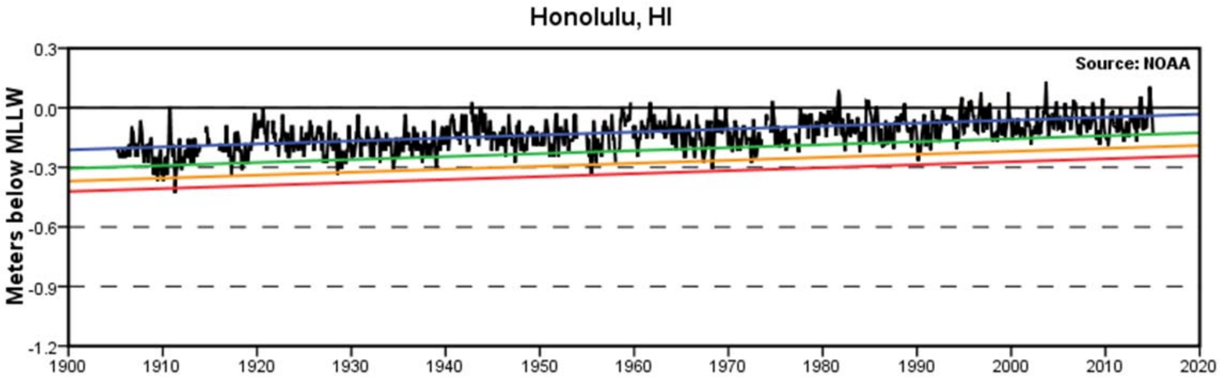


Figure 22. Average sea level above mean high high water and below mean low low water at Honolulu, HI 1900-2015.

2.4.3.8 Wave Watch 3 Global Wave Model

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

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

Timeframe: 2010-2016, Daily data.

Region/Location: Global.

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

Measurement Platform: Global Forecast System Winds, WW3 model

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

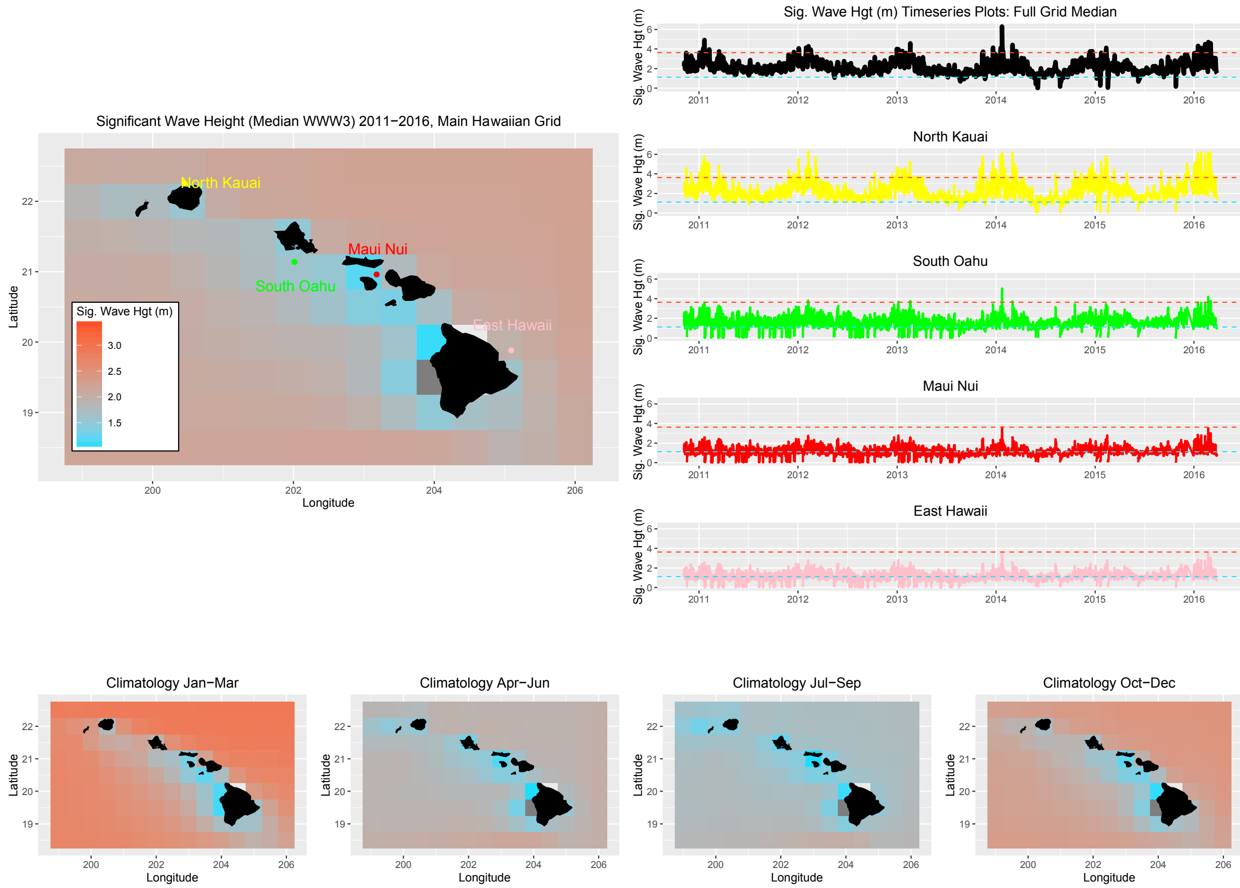


Figure 23. Wave watch summary for the Main Hawaiian Islands regional grid.

2.4.4 Observational and Research Needs

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

- Emphasize the importance of continuing the climate and ocean indicators used in this report so that a consistent, long-term record can be maintained;
- Develop agreements among stakeholders and research partners to ensure the sustainability, availability and accessibility of climate and ocean indicators, their associated datasets and analytical methods used in this and future reports;
- Improve monitoring and understanding of the impacts of changes in ocean temperature, pH and ocean acidity, ocean oxygen content and hypoxia, and sea level rise through active collaboration by all fishery stakeholders and research partners;
- Develop, test and provide access to additional climate and ocean indicators that can improve the Archipelagic Conceptual Model;
- Explore the connections among sea surface conditions, stratification and mixing;

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

- Cultural knowledge and practices for adapting to changing climate in the past and how they might contribute to future climate adaptation.

2.4.5 A Look to the Future

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

2.5 Essential Fish Habitat - Hawaii

2.5.1 Introduction

The Magnuson-Stevens Fishery Conservation and Management Act includes provisions concerning the identification and conservation of essential fish habitat (EFH), and under the EFH final rule, habitat areas of particular concern (HAPC) (50 Code of Federal Regulations [CFR] 600.815). The Magnuson-Stevens Act defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Habitat Areas of Particular Concern (HAPC) are those areas of EFH identified pursuant to 50 CFR 600.815(a)(8), and meeting one or more of the following considerations: (1) ecological function provided by the habitat is important; (2) habitat is sensitive to human-induced environmental degradation; (3) development activities are, or will be, stressing the habitat type; or (4) the habitat type is rare.

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

The EFH Final Rule strongly recommends regional fisheries management councils and NMFS to conduct a review and revision of the EFH components of fisheries management plans every 5 years (600.815(a)(10)). The council's FEPs state that new EFH information should be reviewed, as necessary, during preparation of the annual reports by the Plan Teams. Additionally, the EFH Final Rule states, "Councils should report on their review of EFH information as part of the annual Stock Assessment and Fishery Evaluation (SAFE) report prepared pursuant to §600.315(e)." The habitat portion of the annual report is designed to meet the FEP requirements and EFH Final Rule guidelines regarding EFH reviews.

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

2.5.1.1 EFH Information

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

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

2.5.1.2 Habitat Objectives of FEP

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

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

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

2.5.1.3 Response to Previous Council Recommendations

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

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

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

There are no additional outstanding Hawaii habitat recommendations for the plan team.

2.5.2 Habitat Use by MUS and Trends in Habitat Condition

The Hawaiian Archipelago is an island chain in the central North Pacific Ocean. It runs for approximately 1,500 miles in a northwest direction, from Hawaii Island in the southeast to Kure Atoll in the northwest and is among the most isolated island areas in the world. The chain can be divided according to the large and mountainous Main Hawaiian Islands (MHI) (Hawaii, Maui, Lanai, Molokai, Kahoolawe, Oahu, Kauai, and Niihau) and the small, low-lying Northwest Hawaiian Islands (NWHI), which include Necker, French Frigate Shoals, Laysan, and Midway atoll. The largest of the MHI is Hawaii Island at just over 4,000 square miles – the largest in Polynesia, while Kahoolawe is the smallest, at 44.6 square miles.

The archipelago developed as the Pacific plate moved slowly over a hotspot in the Earth's mantle. Thus, the islands on the northwest end of the archipelago are older; it is estimated that Kure Atoll is approximately 28 million years old while Hawaii Island is approximately 400,000 years old. The highest point in Hawaii is Mauna Kea, at approximately 13,800 feet.

The MHI are all in tropical latitudes. The archipelago becomes subtropical at about French Frigate Shoals (23° 46’ N). The climate of the Hawaiian Islands is generally tropical, but there is great climactic variation, due primarily to elevation and leeward vs. windward areas. Easterly trade winds bring much of the rain, and so the windward sides of all the islands are typically wetter. The south and west (leeward) sides of the islands tend to be drier. Hawaii receives the majority of its precipitation from October to April, while drier conditions generally prevail from May to September. Tropical storms and hurricanes occur in the northern hemisphere hurricane and typhoon season, which runs from June through November.

There is fairly little shallow water habitat in Hawaii, owing to the islands’ steep rise from the abyssal deep. However, there are some larger areas, such as Penguin Bank between Oahu and Molokai, which are relatively shallow. Hawaii has extensive coral reef habitat, though the MHI, because they are much younger, have more fringing reef habitat than the NWHI, which has more shallow reef habitat overall.

Essential fish habitat in the Hawaiian Archipelago for the four MUS comprises all substrate from the shoreline to the 700 m isobath. The entire water column is described as EFH from the shoreline to the 700 m isobath, and the water column to a depth of 400 m is described as EFH from the 700 m isobath to the limit or boundary of the exclusive economic zone (EEZ). While the coral reef ecosystems surrounding the islands in the MHI and NWHI have been the subject of a comprehensive monitoring program through the PIFSC Coral Reef Ecosystem Program (CREP) biennially since 2002, surveys are focused on the nearshore environments surrounding the islands, atolls and reefs (PIBHMC).

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

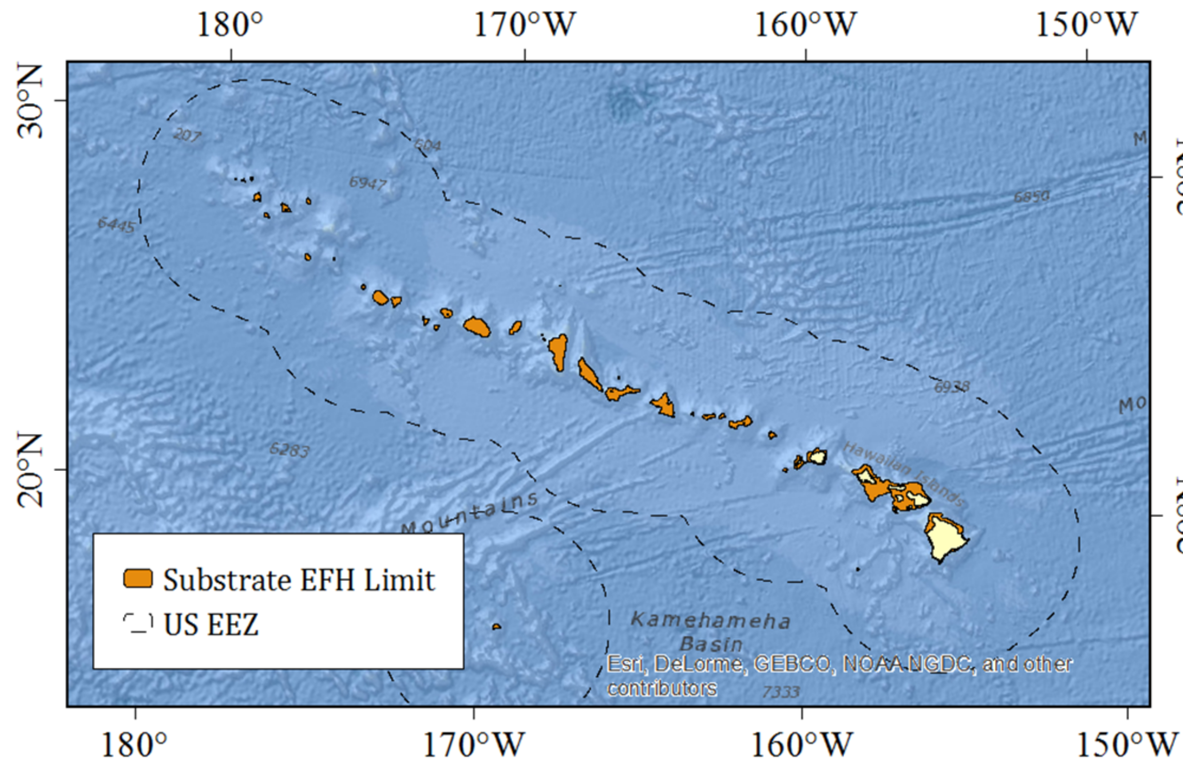


Figure 24. Substrate EFH limit of 700 m isobath around the islands and surrounding banks of the Hawaiian Archipelago. Data Source: GMRT.

2.5.2.1 Habitat Mapping

Interpreted IKONOS benthic habitat maps in the 0 – 30 m depth range have been completed for all islands in the MHI and NWHI (CRCP 2011). While there are gaps in multibeam coverage in the MHI (CRCP 2011), 60 m resolution bathymetry and backscatter are available from the Falkor for much of the NWHI (MHI Multibeam Bathymetry and Backscatter Synthesis).

Table 54. Summary of habitat mapping in the MHI

Depth Range	Timeline/Mapping Product	Progress	Source
0-30 m	IKONOS Benthic Habitat Maps	All islands complete	CRCP 2011
	2000-2010 Bathymetry	84%	DesRochers 2016
	2011-2015 Multibeam Bathymetry	4%	DesRochers 2016
	2011-2015 Satellite	5%	DesRochers 2016

	WorldView 2 Bathymetry		
0-150 m	Multibeam Bathymetry	Gaps exist around Maui, Lanai, and Kahoolawe. Access restricted at Kahoolawe.	CRCP 2011
30-150 m	2000-2010 Bathymetry	86%	DesRochers 2016
	2011-2015 Multibeam Bathymetry	2%	DesRochers 2016
Over all multibeam depths	Derived Products	Few exist	CRCP 2011

Table 55. Summary of habitat mapping in the NWHI.

Depth Range	Timeline/Mapping Product	Progress	Source
0-30 m	IKONOS Benthic Habitat Maps	All islands complete	CRCP 2011
	2000-2010 Bathymetry	6%	DesRochers 2016
	2011-2015 Multibeam Bathymetry	-	DesRochers 2016
	2011-2015 Satellite WorldView 2 Bathymetry	-	DesRochers 2016
30-150 m	2000-2010 Bathymetry	49%	DesRochers 2016
	2011-2015 Multibeam Bathymetry	4%	DesRochers 2016

The land and seafloor area surrounding the islands of the MHI as well as primary data coverage are reproduced from CRCP 2011 in Figure 25.

ISLAND CODE	KAL	NII	KAU	OAH	MOL	LAN	MAI	MOI	KAH	NUI	HAW
SHAPE & RELATIVE SIZE											
LAND AREA (km²)	<1	187	1437	1549	670	365	1886	<1	116		10442
SEA FLOOR AREA 0-30 m (km²)	3	108	242	423	199	55	197	?	4		202
SEA FLOOR AREA 30-150 m (km²)	62	182	297	467	*	*	*	*	*	2801	699
BATHYMETRY 0-30 m (km²)	0	41	237	422	144	17	178	?	0		134
BATHYMETRY 30-150 m (km²)	19	181	292	454	*	*	*	*	*	2346	584
OPTICAL COVERAGE 0-30 m (km)	4	41	45	44	30	32	66	1	0		91
OPTICAL COVERAGE 30-150 m (km)	0	13	11	23	*	*	*	*	*	161	0

? unknown
— no data
*combined and presented as Maui Nui

Figure 25. MHI Land and Seafloor Area and Primary Data Coverage from CRCP 2011.

The land and seafloor area surrounding the islands of the MHI as well as primary data coverage are reproduced from CRCP 2011 in Figure 26.

ISLAND CODE	KUR	MID	PHR	NEV	LIS	PIO	NHS	LAY	MAR	RAI	GAR	SRW	BBW	BBM	BBB	FFS	NEC	TWI	WNB	NIH
LAND AREA (km^2)	<1	6	<1	0	2	0	0	4	0	0	0	0	0	0	0	<1	<1	0	0	<1
SEA FLOOR AREA 0-30 m (km^2)	83	102	467	0	1004	306	0	488	1075	128	1269	250	3	<1	0	678	1028	0	0	<1
SEA FLOOR AREA 30-150 m (km^2)	218	236	276	90	226	125	360	69	696	310	1136	124	142	135	23	244	473	63	320	573
BATHYMETRY 0-30 m (km^2)	25	24	23	0	0	<1	0	0	73	0	<1	<1	2	<1	0	222	8	0	<1	<1
BATHYMETRY 30-150 m (km^2)	218	180	251	34	125	54	20	58	588	0	126	40	142	135	23	214	312	13	165	163
OPTICAL COVERAGE 0-30 m (km)	32	43	63	0	57	0	0	14	40	1	4	0	<1	<1	0	106	8	0	0	0
OPTICAL COVERAGE 30-150 m (km)	21	13	20	0	8	0	0	<1	2	<1	<1	1	3	<1	<1	90	6	0	0	0

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

Figure 26. NWHI Land and Seafloor Area and Primary Data Coverage from CRCP 2011.

2.5.2.2 Benthic Habitat

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

2.5.2.2.1 RAMP Indicators

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

Towed-diver surveys are typically 50 minutes long and cover about 2-3 km 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. (PIFSC Website, 2016).

Table 56. Mean percent cover of live coral from RAMP sites collected from towed-diver surveys in the MHI

	2005	2006	2008	2010
Hawaii		18.38	17.11	22.1
Kauai	6.06	12.27	7.04	6.04
Kaula		6.9		
Lanai	30.48	26.61	22.42	23.34
Maui	18.99	20.33	12.06	14.62
Molokai	35.66	6.96	6.92	52.17
Niihau	5.03	2.39	2.29	2.26
Oahu	9.36	12.21	9.45	8.19

Table 57. Mean percent cover of macroalgae from RAMP sites collected from towed-diver surveys in the MHI

	2005	2006	2008	2010
Hawaii		5.46	1.01	1.05
Kauai	35.67	27.92	16.45	16.25
Kaula		5.94		
Lanai	7.38	13.18	17.13	11.14
Maui	17.84	16.24	12.04	2.13
Molokai	23.31	24.22	12.71	4.75
Niihau	41.3	14.57	2.58	2.22
Oahu	37.03	27.41	12.58	13.03

Table 58. Mean percent cover of crustose coralline algae from RAMP sites collected from towed-diver surveys in the MHI

Row Labels	2005	2006	2008	2010
Hawaii		14.82	16.09	6.94
Kauai	3.67	2.94	4.14	1.71
Kaula		7.4		
Lanai	2.42	1.31	3.72	2.82
Maui	4.37	4.83	6.82	4.31
Molokai	3.71	3.79	5.24	4.19
Niihau	10.87	6.68	8.05	1.88
Oahu	13.95	2.74	4.28	2.42

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

Row Labels	2000	2001	2002	2003	2004	2006	2008	2010
French Frigate	27.23	5	14.22	13.47	11.29	18.25	15.23	13.28
Gardner	3			2.5	1.65			
Kure	7.3		9.61	12.34	12.63	17.2	17.6	14.57

Laysan	9.96		9.76	4	7.33	6.96	8.43	
Lisianski	28.17		24.29	15.2	26.81	27.22	25.69	27.56
Maro	27.38	18.31	13.77	16.54	25.59	22.67	19.78	
Midway			5.58	3.06	1.24	3.91	2.66	
Necker	6.5			14.52		14.92		
Nihoa	3.89							
Pearl & Hermes	15.82		10.71	6.47	9.45	11.64	10.79	8.25
Raita		2.5						

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

	2000	2001	2002	2003	2004	2006	2008	2010
French Frigate	0	10.5	30.13	29.05	23.15	17.33	17.81	18.42
Gardner	0			73.63	26.94			
Kure	0		38.84	42.79	29.84	23.14	26.22	12.99
Laysan	0		26.9	47.03	30.63	28.66	25.7	
Lisianski	0		20.04	24.61	17.14	21.46	20.83	13.85
Maro	0	17.01	20.39	17.69	30.01	20.79	18.19	
Midway			42.28	44.9	24.86	11.02	19.93	
Necker	0			23.39		33.51		
Nihoa	0							
Pearl & Hermes	0		36.94	41.51	114.87	33.56	33.79	36.96
Raita		68.83						

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

	2000	2001	2002	2003	2004	2006	2008	2010
French Frigate	0	0	8.55	8.56	2.52	9.46	8.55	1.87
Gardner	0			9.13	1.5			
Kure	0		3.38	7.65	5.87	7.31	6.91	4.11
Laysan	0		3.95	11.17	5.11	10.21	7.93	
Lisianski	0		14.21	7.97	12.11	17.19	17.42	11.78
Maro	0	13.95	15.17	12.89	4.36	16.54	15.29	
Midway			7.58	3.69	7.17	5.8	5.62	
Necker	0			7.86		1.48		
Nihoa	0							
Pearl & Hermes	0		14.13	14.38	11.84	10.07	12.43	7.61
Raita		0.42						

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 Ecosystem and Climate Change section for information related to oceanography and water quality.

2.5.3 Report on Review of EFH Information

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

2.5.4 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:

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

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

2.5.4.1 Precious Corals

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

Table 62. Level of EFH available for Hawaii precious corals management unit species complex.

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

Species	Pelagic phase (larval stage)	Benthic phase
Black Coral		
Antipathes dichotoma	0	4
A. grandis	0	4
A. ulex	0	2

2.5.4.2 Bottomfish and Seamount Groundfish

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

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

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

2.5.4.3 Crustaceans

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

Table 64. Level of EFH information available for Hawaii crustaceans management unit species complex.

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

2.5.4.4 Coral Reef

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

2.5.5 **Research and Information Needs**

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

2.5.5.1 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 (CPUE, percent immature) for the Guam/NMI deep-water and shallow-water bottomfish complexes
- High resolution maps of bottom topography/currents/water masses/primary productivity
- Habitat utilization patterns for different life history stages and species

2.5.5.3 Crustaceans Fishery

- Identification of post-larval settlement habitat of all CMUS

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

2.5.5.4 Precious Corals Fishery

- Distribution, abundance and status of precious corals in Hawaii

2.5.6 **References**

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2.6 Marine Planning

2.6.1 Introduction

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

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

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

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

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

2.6.1.1 MSA and NEPA Implementation

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

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

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

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

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

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

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

2.6.1.2 Stakeholder in Non-fishing Activities

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

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

2.6.1.3 Member of the Pacific Islands Regional Planning Body

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

The Council is a member of the Pacific Islands (PI) RPB and as such, the interests of the Council will be incorporated into the CMS plan. It is through the Council member that the Council may submit recommendations to the PI RPB. Section 2.6.5 contains a summary of the PI RPB progress to date in developing a CMS plan for the Pacific Islands region.

2.6.1.4 Organization of the Report

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

2.6.2 **Marine Managed Areas**

2.6.2.1 MMAs established under FMPs

Council-established marine managed areas (MMAs) were compiled in Table 65 from 50 CFR § 665, Western Pacific Fisheries, the Federal Register, and Council amendment documents. Geodesic areas were calculated in square kilometers in ArcGIS 10.2. These marine managed areas are shown in the Spatial Management Areas Established under FMPs map in the maps section. There are no standing Council recommendations indicating review deadlines for Hawaii protected areas.

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

Name	FEP	Island	50 CFR /FR /Amendment Reference	Marine Area (km^2)	Fishing Restriction	Goals	Most Recent Evaluation	Review Deadline
Pelagic Restrictions								
NWHI Longline Protected Species Zone	Pelagic (Hawaii)	NWHI	665.806(a)(1) 56 FR 52214 Pelagic FMP Am. 3	351,514.00	Longline fishing prohibited	Prevent longline interaction with monk seals	1991	-
MHI Longline Prohibited Area	Pelagic (Hawaii)	MHI	665.806(a)(2) 57 FR 7661 Pelagic FMP Am. 5	248,682.38	Longline fishing prohibited	Prevent gear conflicts between longline vessels and troll/handline vessels	1992	-
Bottomfish Restrictions								
Hancock Seamounts Ecosystem Management Area (HSEMA)	Hawaii Archipelago	NW of Midway Island	HSEMA: 665.209 75 FR 52921 Moratorium: 51 FR 27413 Bottomfish FMP	60,826.75	Moratorium	The intent of the continued moratorium is to facilitate rebuilding of the armorhead stock, and the intent of the ecosystem management area is to facilitate research on armorhead and other seamount groundfish	2010	-
Precious Coral Permit Areas								

Name	FEP	Island	50 CFR /FR /Amendment Reference	Marine Area (km^2)	Fishing Restriction	Goals	Most Recent Evaluation	Review Deadline
Keahole Point	Hawaii Archipelago	Hawaii Island	665.261(2)(i) 73 FR 47098 Precious Corals FMP Am. 7	2.7	Fishing by permit only	Manage harvest	2008	-
Kaena Point	Hawaii Archipelago	Oahu	665.261(2)(ii) 73 FR 47098 Precious Corals FMP Am. 7	2.7	Fishing by permit only	Manage harvest	2008	-
Makapuu	Hawaii Archipelago	Oahu	665.261(1)(i) 73 FR 47098 Precious Corals FMP Am. 7	43.15	Fishing by permit only	Manage harvest	2008	-
Brooks Bank	Hawaii Archipelago	NWHI	665.261(2)(iii) 73 FR 47098 Precious Corals FMP Am. 7	43.15	Fishing by permit only	Manage harvest	2008	-
180 Fathom Bank	Hawaii Archipelago	NWHI	665.261(2)(iv) 73 FR 47098 Precious Corals FMP Am. 7	43.15	Fishing by permit only	Manage harvest	2008	-
Westpac Bed	Hawaii Archipelago	NWHI	665.261(3) 73 FR 47098 Precious Corals FMP Am. 7	43.15	Fishing prohibited	Manage harvest	2008	-

Name	FEP	Island	50 CFR /FR /Amendment Reference	Marine Area (km^2)	Fishing Restriction	Goals	Most Recent Evaluation	Review Deadline
Auau Channel	Hawaii Archipelago	Maui Nui	665.261(1)(ii) 73 FR 47098 Precious Corals FMP Am. 7	728.42	Fishing by permit only	Harvest quota for black coral of 5,000 kg every two years for federal and state waters	2008	-

2.6.2.2 Other MPAs in the Region

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

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

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

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

Table 66. Marine Protected Areas in the Western Pacific Region from the MPA Inventory unless otherwise noted

Site ID	Name	State	Marine Area (km^2)	Fishing Restrictions
MNM1	Papahanaumokuakea Marine National Monument	Marine National Monuments	363,687.00	Commercial and Recreational Fishing Prohibited
NMF34	Longline Protected Species Zone	National Marine Fisheries Service	351,514.00	Commercial Fishing Restricted
NMF7	Hancock Seamount	National Marine Fisheries Service	61,051.80	Commercial and Recreational Fishing Restricted
NMS9	Hawaiian Islands Humpback Whale National Marine Sanctuary	National Marine Sanctuaries	3,554.97	Restrictions Unknown
NWR71	Midway Atoll National Wildlife Refuge	National Wildlife Refuge System	2,365.30	Commercial and Recreational Fishing Prohibited
HI48	Penguin Bank Bottomfish Restricted Fishing Area	Hawaii	270.00	Commercial and Recreational Fishing Restricted
HI27	West Hawaii Regional Fishery Management Area	Hawaii	227.52	Commercial Fishing Restricted
HI34	Kaho'olawe Island Reserve	Hawaii	202.94	Commercial Fishing Prohibited, Recreational Fishing Restricted
HI49	Makapu'u Point Bottomfish Restricted Fishing Area	Hawaii	190.25	Commercial and Recreational Fishing Restricted
HI45	Mokumana - Umalei Point Bottomfish Restricted Fishing Area	Hawaii	161.58	Commercial and Recreational Fishing Restricted
HI43	Lele'iwi Point Bottomfish Restricted Fishing Area	Hawaii	118.35	Commercial and Recreational Fishing Restricted
HI53	Ka'ula Rock Bottomfish Restricted Fishing Area	Hawaii	86.34	Commercial and Recreational Fishing Restricted

Site ID	Name	State	Marine Area (km^2)	Fishing Restrictions
HI50	Ka'ena Bottomfish Restricted Fishing Area	Hawaii	85.36	Commercial and Recreational Fishing Restricted
HI47	Kaluapapa Bottomfish Restricted Fishing Area	Hawaii	60.77	Commercial and Recreational Fishing Restricted
HI42	Ka Lae (South Point) Bottomfish Restricted Fishing Area	Hawaii	53.73	Commercial and Recreational Fishing Restricted
HI46	Moku Ho'oniki, Moloka'i - Lipoa Point. Maui Bottomfish Restricted Fishing Area	Hawaii	51.44	Commercial and Recreational Fishing Restricted
HI51	Makahu'ena Bottomfish Restricted Fishing Area	Hawaii	51.08	Commercial and Recreational Fishing Restricted
NPS23	Kalaupapa National Historical Park	National Park Service	43.29	Commercial and Recreational Fishing Restricted
HI52	Ni'ihau Bottomfish Restricted Fishing Area	Hawaii	40.97	Commercial and Recreational Fishing Restricted
NMF23	WestPac Bed	National Marine Fisheries Service	39.47	Commercial and Recreational Fishing Prohibited
HI11	Ahihi-Kinau Natural Area Reserve	Hawaii	8.40	Commercial and Recreational Fishing Prohibited
NPS39	War in the Pacific National Historical Park	National Park Service	7.77	Commercial and Recreational Fishing Restricted
HI24	Kona Coast Fishery Management Area	Hawaii	7.06	Commercial and Recreational Fishing Restricted
HI23	Hilo Bay, Wailoa River, Wailuku River Fishery Management Area	Hawaii	6.19	Commercial and Recreational Fishing Restricted
NPS24	Kaloko-Honokohau National Historical Park	National Park Service	5.20	Commercial and Recreational Fishing Restricted

Site ID	Name	State	Marine Area (km^2)	Fishing Restrictions
HI6	Kiholo Bay Fishery Management Area	Hawaii	2.66	Commercial and Recreational Fishing Restricted
HI69	Kahekili Herbivore Fisheries Management Area	Hawaii	1.84	Commercial and Recreational Fishing Restricted
HI63	Honolulu Harbor Fishery Management Area	Hawaii	1.56	Commercial and Recreational Fishing Restricted
HI2	Puako Bay, Puako Reef Fishery Management Area	Hawaii	1.37	Commercial and Recreational Fishing Restricted
HI18	Kealakekua Bay Marine Life Conservation District	Hawaii	1.24	Commercial and Recreational Fishing Restricted
HI16	Manele-Hulopoe Marine Life Conservation District	Hawaii	1.12	Commercial and Recreational Fishing Restricted
HI14	Old Kona Airport Marine Life Conservation District	Hawaii	1.06	Commercial and Recreational Fishing Restricted
HI12	Pupukea Marine Life Conservation District	Hawaii	1.03	Commercial and Recreational Fishing Restricted
HI1	Waikiki-Diamond Head Fishery Management Area	Hawaii	0.97	Commercial and Recreational Fishing Restricted
HI66	Pokai Bay Fishery Management Area	Hawaii	0.88	Commercial and Recreational Fishing Restricted
HI17	Lapakahi Marine Life Conservation District	Hawaii	0.54	Commercial and Recreational Fishing Restricted
NWR158	Pearl Harbor National Wildlife Refuge	National Wildlife Refuge System	0.42	Restrictions Unknown
HI20	Hanauma Bay Marine Life Conservation District	Hawaii	0.41	Commercial and Recreational Fishing Prohibited

Site ID	Name	State	Marine Area (km^2)	Fishing Restrictions
HI28	Hanamaulu Bay, Ahukini Recreational Pier Fishery Management Area	Hawaii	0.37	Commercial and Recreational Fishing Restricted
HI15	Molokini Shoal Marine Life Conservation District	Hawaii	0.36	Commercial and Recreational Fishing Restricted
NPS43	Puukohola Heiau National Historic Site	National Park Service	0.35	Commercial and Recreational Fishing Restricted
HI13	Waikiki Marine Life Conservation District	Hawaii	0.32	Commercial and Recreational Fishing Prohibited
HI22	Moku-o-loe Island (Coconut Island) Marine Laboratory Refuge	Hawaii	0.30	Commercial and Recreational Fishing Prohibited
HI64	Ala Wai Canal Fishery Management Area	Hawaii	0.22	Commercial and Recreational Fishing Restricted
HI62	Wai'opae Tidepools Marine Life Conservation District	Hawaii	0.20	Commercial and Recreational Fishing Prohibited
HI19	Honolua-Mokuleia Bay Marine Life Conservation District	Hawaii	0.18	Commercial and Recreational Fishing Prohibited
HI65	Waialua Bay (Haleiwa Harbor) Fishery Management Area	Hawaii	0.16	Commercial and Recreational Fishing Restricted
HI9	Kaunakakai Harbor Fishery Management Area	Hawaii	0.15	Commercial and Recreational Fishing Restricted
HI21	Waialea Bay Marine Life Conservation District	Hawaii	0.14	Commercial and Recreational Fishing Restricted
HI4	Nawiliwili Harbor Fishery Management Area	Hawaii	0.14	Commercial and Recreational Fishing Restricted

Site ID	Name	State	Marine Area (km^2)	Fishing Restrictions
HI10	Paiko Lagoon Wildlife Sanctuary	Hawaii	0.12	Commercial and Recreational Fishing Prohibited
HI3	Port Allen Fishery Management Area	Hawaii	0.10	Commercial and Recreational Fishing Restricted
HI7	Keauhou Bay Fishery Management Area	Hawaii	0.08	Commercial and Recreational Fishing Restricted
HI68	Kapalama Canal Fishery Management Area	Hawaii	0.05	Commercial and Recreational Fishing Restricted
HI29	Kailua Bay Fishery Management Area	Hawaii	0.04	Commercial and Recreational Fishing Restricted
HI26	Kahului Harbor Fishery Management Area	Hawaii	0.04	Commercial and Recreational Fishing Restricted
HI5	Manele Harbor Fishery Management Area	Hawaii	0.02	Commercial and Recreational Fishing Restricted
HI67	He'eia Kea Wharf Fishery Management Area	Hawaii	0.01	Commercial and Recreational Fishing Restricted
HI25	Waimea Bay, Waimea Recreational Pier Fishery Management Area	Hawaii	0.01	Commercial and Recreational Fishing Restricted
HI8	Kawaihae Harbor Fishery Management Area	Hawaii	0.01	Commercial and Recreational Fishing Restricted
-	False Killer Whale Longline Exclusion Zone (from MMPA regs)	National Marine Fisheries Service	-	Fishing Prohibited

2.6.3 Activities and Facilities

The following section includes activities or facilities associated with known uses and predicted future uses. The Plan Team will add to this section as new facilities are proposed and/or built.

2.6.3.1 Aquaculture facilities

Hawaiʻi has one permitted offshore aquaculture facility. The information in

Table 67 was transferred from the Joint NMFS and U.S. Army Corps of Engineers EFH Assessment for the Proposed Issuance of a Permit to Authorize the Use of a Net Pen and Feed Barge Moored in Federal Waters West of the Island of Hawaii to Fish for a Coral Reef Ecosystem Management Unit Species, *Seriola rivoliana* (RIN 0648-XD961).

Table 67. Aquaculture facilities.

Name	Size	Location	Species	Stage
Kampachi Farms	Shape: Cylindrical Height: 33 ft Diameter: 39 ft Volume: 36,600 ft^3	5.5 nautical miles (nm) west of Keauhou Bay and 7 nm south-southwest of Kailua Bay, off the west coast of Hawaiʻi Island 19 deg 33 min N 156 deg 04 min W. mooring scope is 10,400 foot radius.	*Seriola rivoliana*	Draft EA public comment period closed February 16, 2016 (81 FR 4021)

2.6.3.2 Alternative energy facilities

Hawaiʻi has three proposed wind energy facilities in Federal waters and several existing alternative energy facilities. The information in Table 68 is from various sources.

Table 68. Alternative Energy Facilities and Development

Name	Type	Location	Impact to Fisheries	Stage of Development	Source
AWH Oʻahu Northwest Project	408 MW Wind	12 miles W of Kaʻena Pt, Oʻahu	Hazard to navigation; benthic impacts from cables	BOEM Call for Information published	BOEM Hawaii
AWH Oʻahu South Project	408 MW Wind	17 miles S of Waikiki, Oʻahu	Hazard to navigation; benthic impacts from cables; close to Penguin Bank	BOEM Call for Information published	BOEM Hawaii
Progression Hawaii Offshore Wind, Inc.	400 MW Wind	SSE of Barber's Pt and SW of Waikiki, Oʻahu	Hazard to navigation; in popular trolling area; benthic impacts from cables	BOEM Call for Information published	Progression Energy BOEM Lease Application, BOEM, Hawaii
Natural Energy Laboratory of Hawaiʻi	120 kW OTEC Test Site/ 1 MW Test Site	West Hawaiʻi	Intake	120 kW operational; Between DEA and FEA/FONSI for 1 MW Test Site using existing infrastructure	http://nelha.hawaii.gov/energy-portfolio/ Draft Environmental Assessment, NELHA, July 2012
Honolulu Sea Water Air Conditioning	SWAC	Four miles S of Kakaʻako, Oʻahu	Benthic impacts; intake	USACE ROD signed; completion in early 2017.	http://honoluluswac.com/pressroom.html
Marine Corps Base Hawaiʻi Wave Energy	Shallow- and Deep-Water Wave Energy	1, 2 and 2.5 km N of Mokapu,	Hazard to navigation	Shallow is operational; deep is under construction	Final Environmental Assessment, NAVFACPAC, January 2014

Test Site		O'ahu			
Hawaii Interisland Energy Transmission Cable	Transmission	Maui to O'ahu	Benthic impacts	Planning is stalled and dependent on NextEra/HECO merger outcome	IEEE Spectrum article

2.6.3.3 Military training and testing activities and impacts

The Department of Defense major planning activities in the region are summarized below. Maps of the Hawaii-Southern California Range Complex from the Hawaii Range Complex FEIS are included in the maps section.

Action	Description	Phase	Impacts
Hawaii-Southern California Training and Testing	Increase naval testing and training activities	DEIS Expected Spring 2017	Likely access and habitat impacts

2.6.4 Incidents Contributing to Cumulative Impact

The Coast Guard and NOAA Office of Response and Restoration respond to marine pollution events related to vessels. The following table of incidents since 201 is from selected oil spills off US coastal waters and other incidents where NOAA's Office of Response and Restoration (OR&R) provided scientific support for the spill response (NOAA OR&R). These incidents are included in the overview maps of the map section.

Table 69. NOAA ORR Incident Response since 2011

Name	Location	Date	Commodity	Cause	Other Cause/Notes
TUG NALANI	Off Barbers Point, HI	1/22/2015	Diesel	Sunken Vessel	
Molasses Spill	Honolulu Harbor, HI	9/10/2013	molasses	Other / Unknown	
Downed Military Aircraft	North Shore, Oahu	1/15/2016	JP5 fuel	Collision	
Mystery Sheen	Oahu, HI	3/27/2013	Sheen	Other / Unknown	
Hurricane Iselle	Hawaii	8/6/2014		Collision	

2.6.5 Pacific Islands Regional Planning Body Report

The Pacific Islands Regional Planning Body (PI RPB) will meet on March 30-31, 2016, to discuss a number of items. The PI RPB will be brought up to date on the planning activities in American Samoa and then will discuss how much participation the PI RPB would like to have in the development of the American Samoa Ocean Plan, given cross membership. The PI RPB will discuss its operations in the bigger context of efforts associated with climate change, planning efforts, and GIS efforts, as well as discuss a capacity assessment to inform the needs of the PI RPB. PI RPB members will then discuss their data and tools needs, as well as their stakeholder engagement progress.

The American Samoa Ocean Planning Team is meeting on March 28, 29, and April 1, 2016, to finalize their vision for the ocean in American Samoa and develop draft goals and objectives for their ocean plan.

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2.6.7 Maps

1. Spatial Management Areas Established under FMPs
2. Large, Regulated Commercial Fishing Areas of the Western Pacific Region
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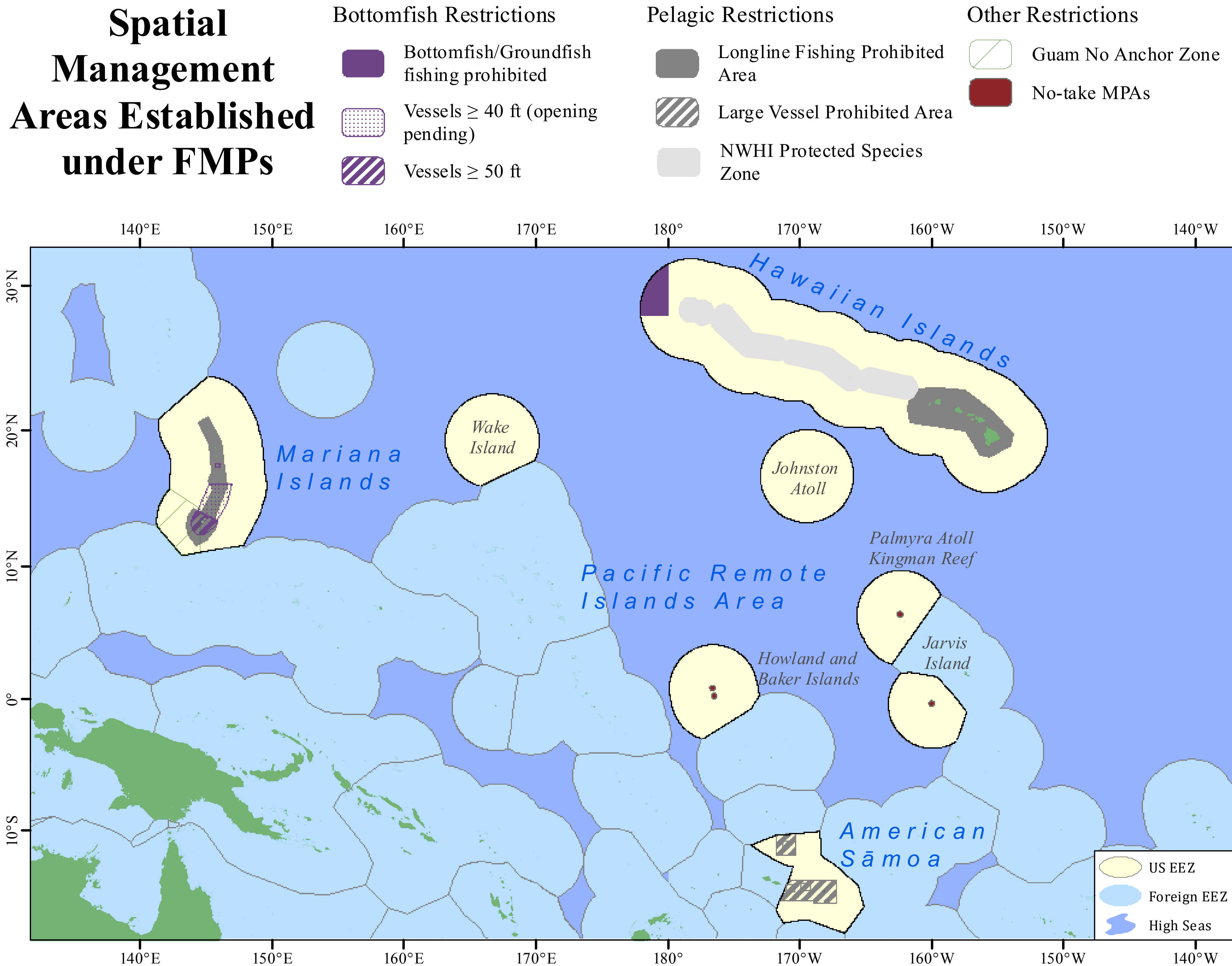
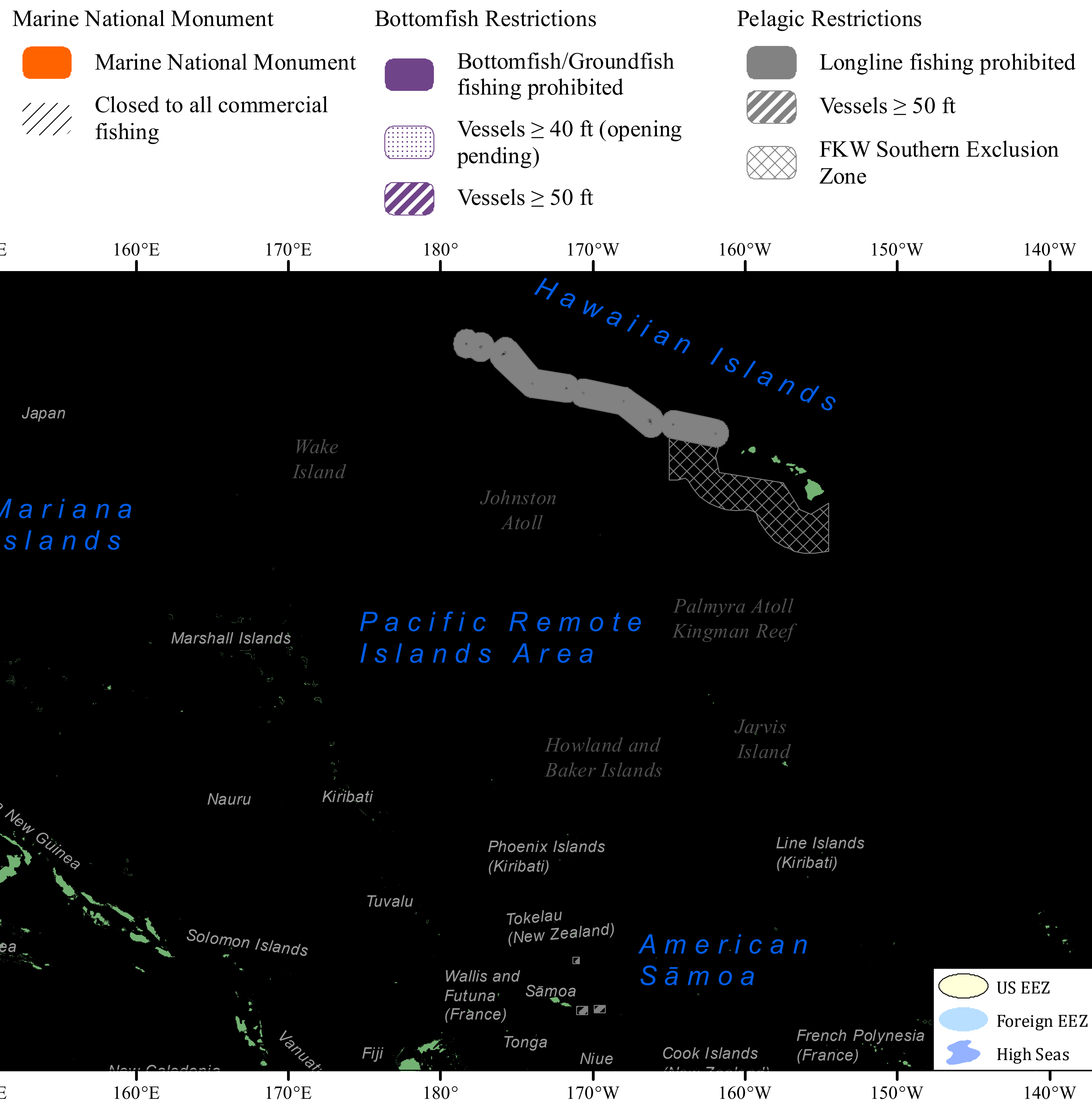
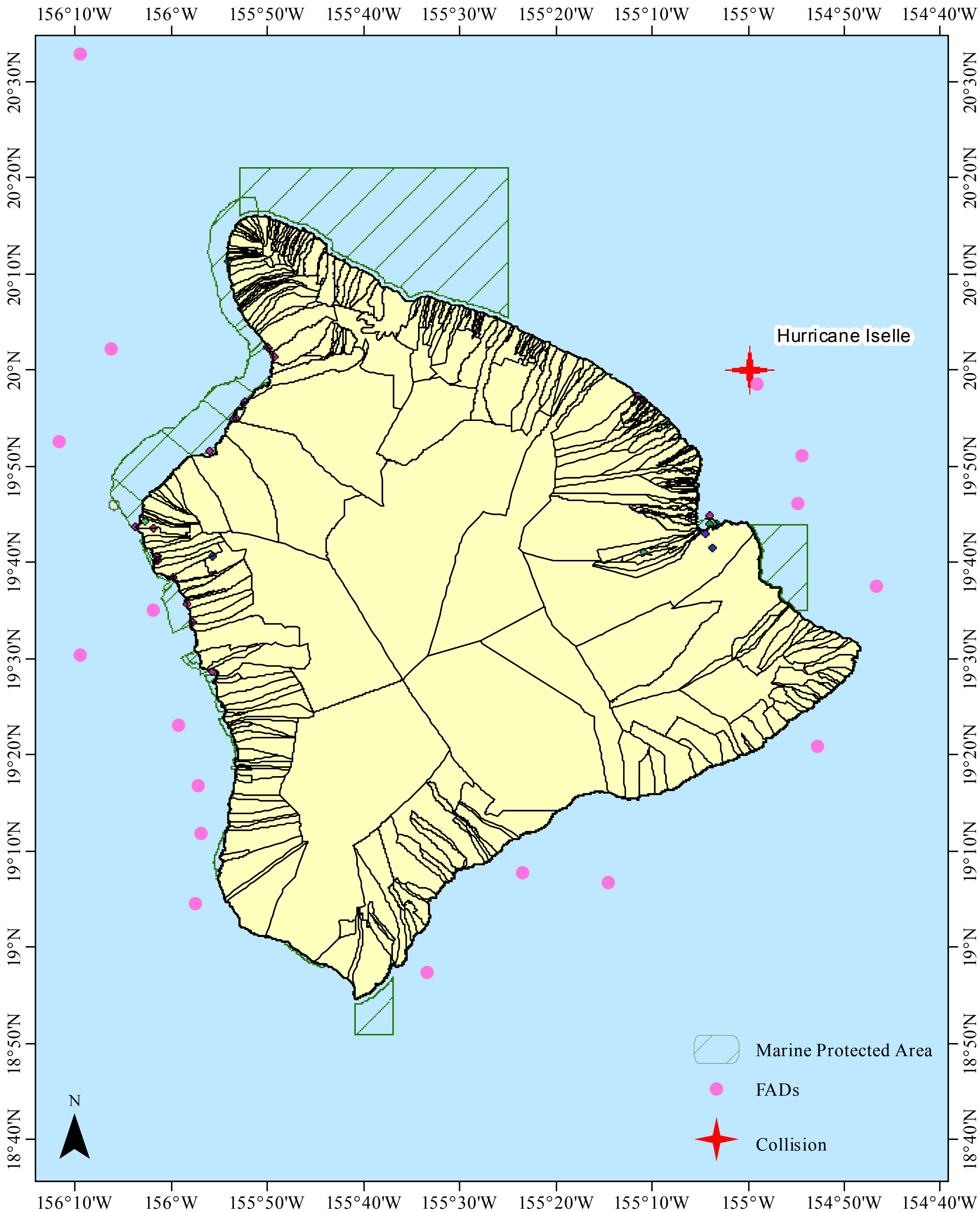
4. Maui County, Hawai`i Overview Map
5. O`ahu, Hawai`i Overview Map
6. Kaua`i County, Hawai`i Overview Map
7. Unsolicited Least Requests (from BOEM Hawai`i Website)
8. Hawai`i Range Complex Overview (from HRC FEIS)
9. EIS/OEIS Study Area: Hawai`i Range Complex Including the Hawai`i Operating Area and Temporary Operating Area (from HRC FEIS)
10. EIS/OEIS Study Area: Hawai`i Range Complex Open Ocean, Offshore and Land Areas (from HRC FEIS)
11. EIS/OEIS Study Area: Hawai`i Range Complex Including Temporary Operating Area (from HRC FEIS)
12. Hawai`i Range Complex Study Area and Support Locations, Kaua`i, Ni`ihau, and Ka`ula, Hawai`i (from HRC FEIS)
13. Hawai`i Range Complex Study Area and Support Locations, O`ahu, Hawai`i (from HRC FEIS)
14. Hawai`i Range Complex Study Area and Support Locations, Maui, Moloka`i, and Lana`i, Hawai`i (from HRC FEIS)
15. Hawai`i Range Complex Study Area and Support Locations, Island of Hawai`i (from HRC FEIS)


Spatial Management Areas Established under FMPs
Bottomfish Restrictions
Bottomfish/Groundfish fishing prohibited
Vessels ≥ 40 ft (opening pending)
Vessels ≥ 50 ft
Pelagic Restrictions
Longline Fishing Prohibited Area
Large Vessel Prohibited Area
NWHI Protected Species Zone
Other Restrictions
Guam No Anchor Zone
No-take MPAs
Hawaiian Islands
Mariana Islands
Wake Island
Johnston Atoll
Palmyra Atoll Kingman Reef
Pacific Remote Islands Area
Jarvis Island
Howland and Baker Islands
American Sāmoa
US EEZ
Foreign EEZ
High Seas
140°E
150°E
160°E
170°E
180°
170°W
160°W
150°W
140°W
30°N
20°N
10°N
0°
10°S

Large, Regulated Commercial Fishing Areas of the US EEZ, Western Pacific Region

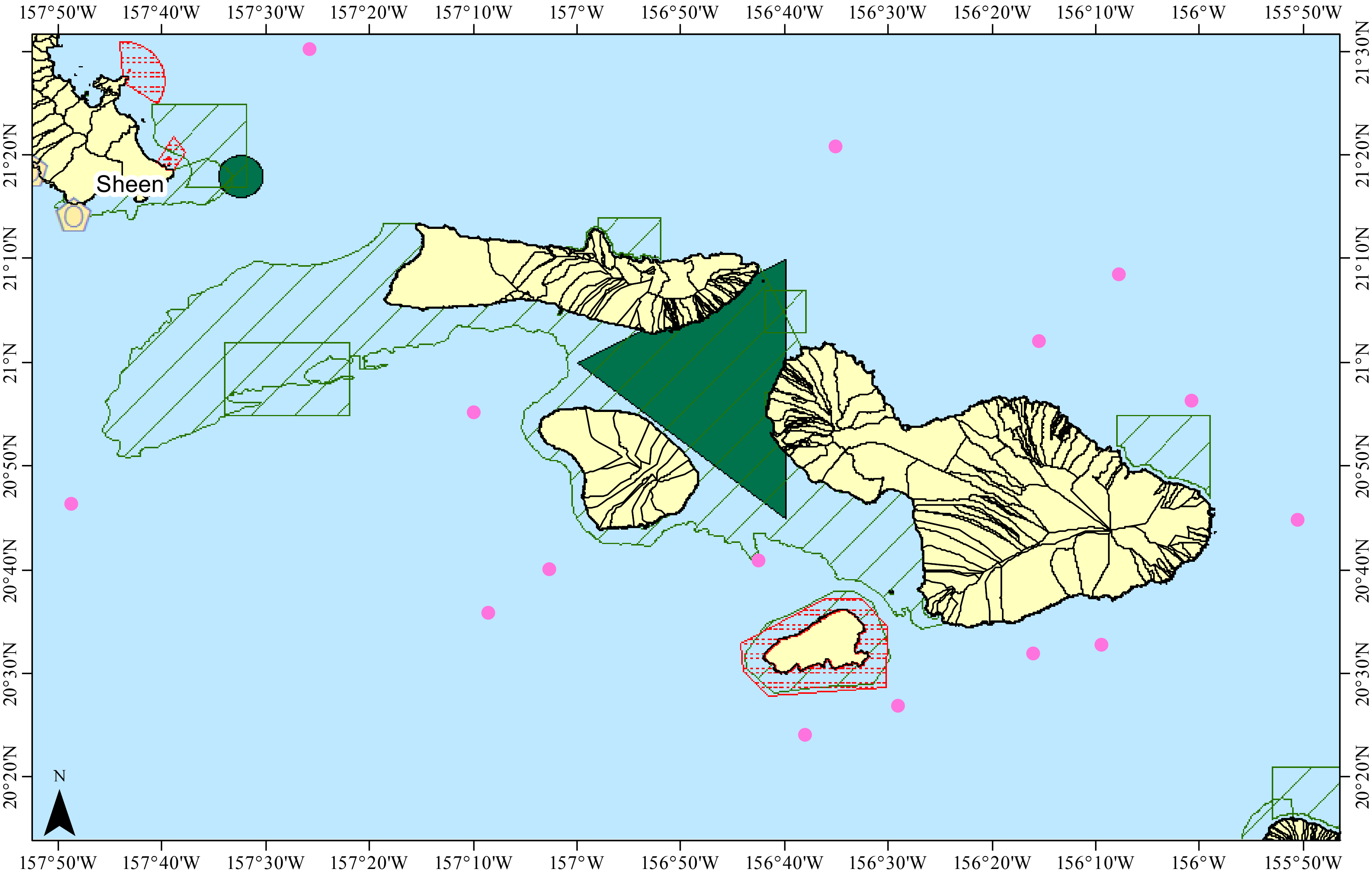




Marine Planning Annual Report

Overview Map

Hawai`i Island, Hawai`i

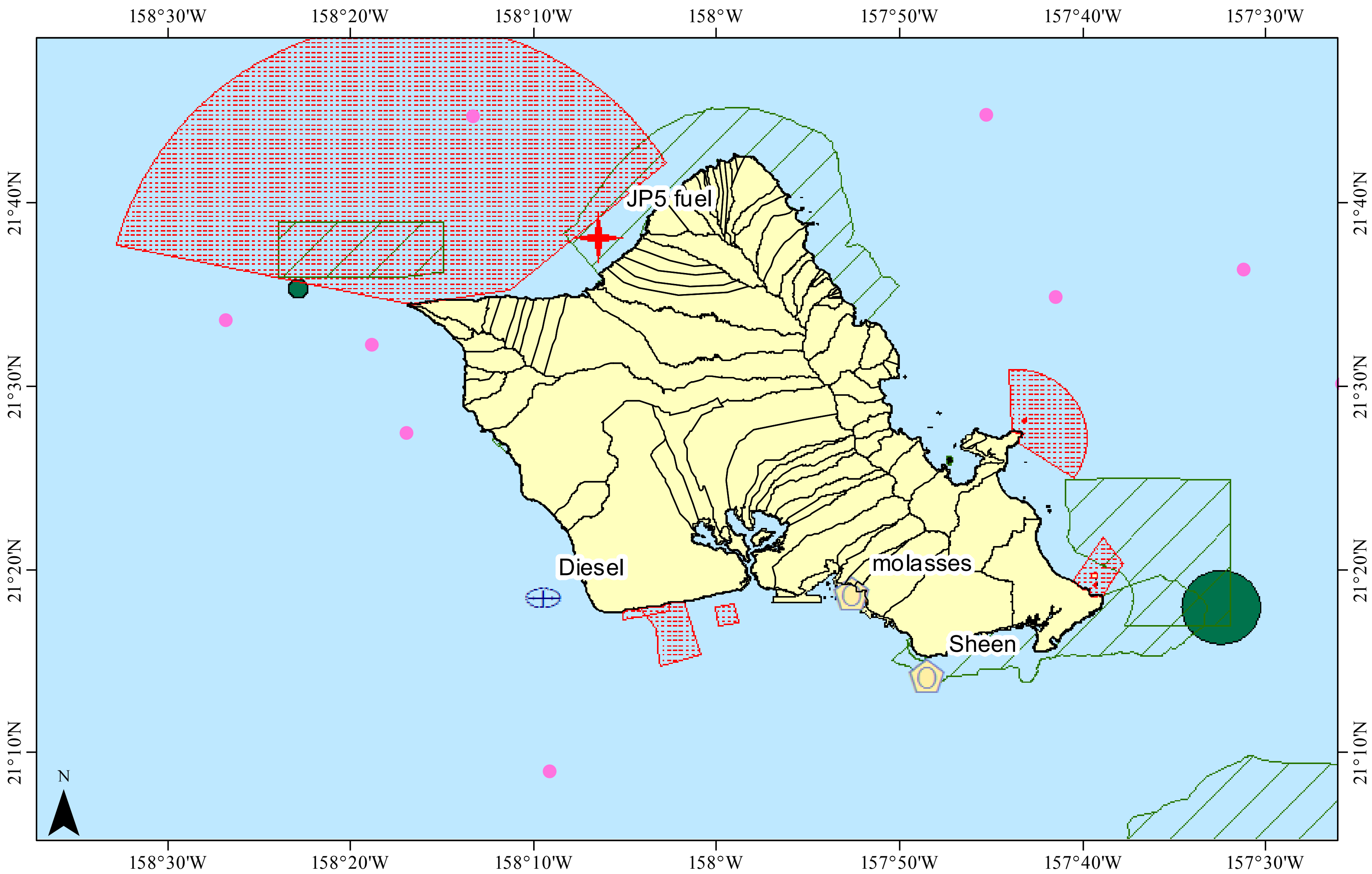


Marine Planning Annual Report

Overview Map

Maui County, Hawai`i

Marine Protected Area
Surface Danger Zones
Precious Coral Bed
FADs
Other / Unknown

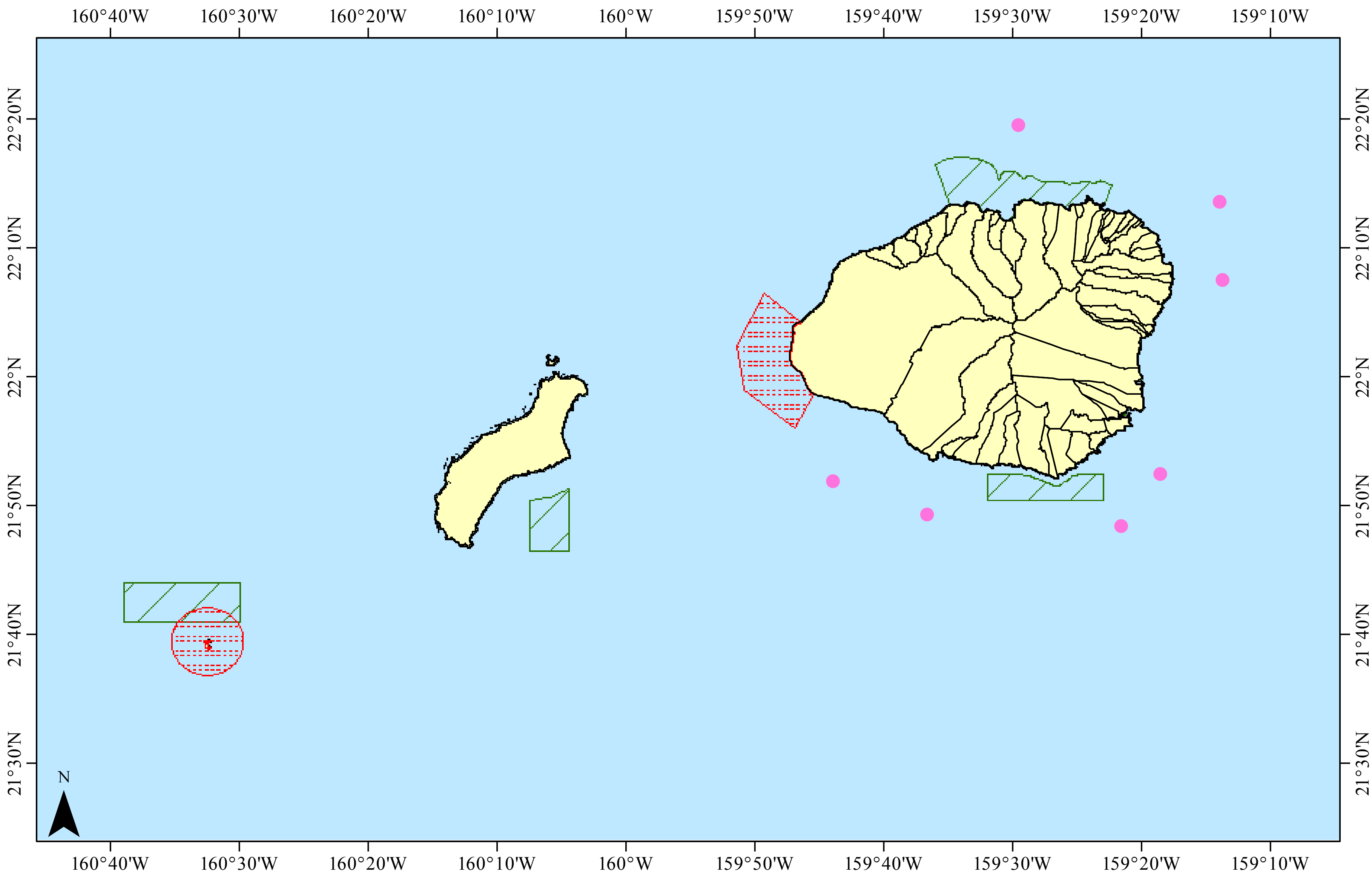


Marine Planning Annual Report

Overview Map

O`ahu, Hawai`i

Marine Protected Area
Surface Danger Zones
Precious Coral Bed
FADs
Collision
Other / Unknown
Sunken Vessel



Marine Planning Annual Report

Overview Map

Kaua`i County, Hawai`i

Marine Protected Area

Surface Danger Zones

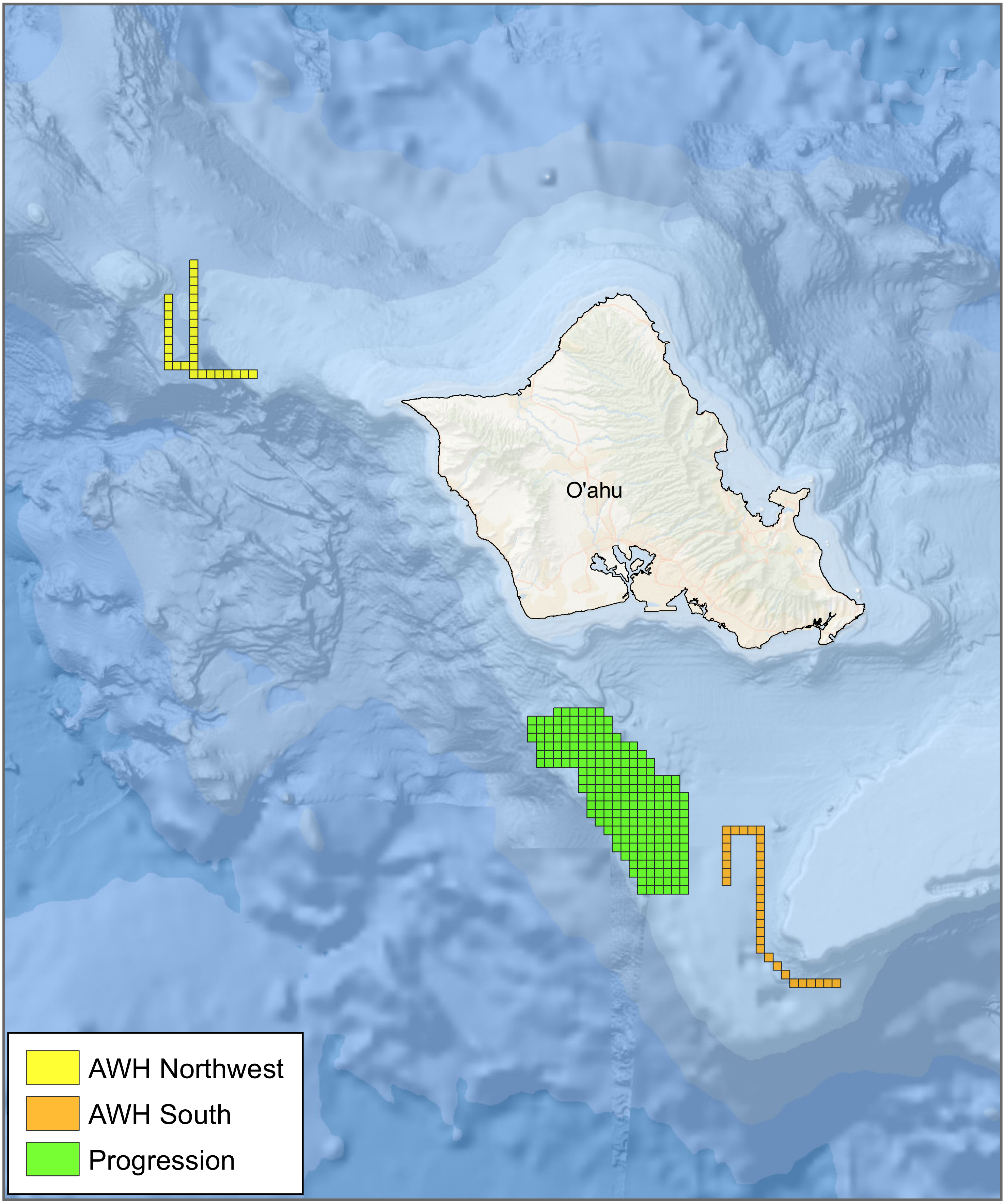
FADs

BOEM
Bureau of Ocean Energy Management

Bureau of Ocean Energy Management

Pacific Outer Continental Shelf (OCS) Region

Unsolicited Lease Requests



Coordinate System: WGS 84: UTM Zone 4N
Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other
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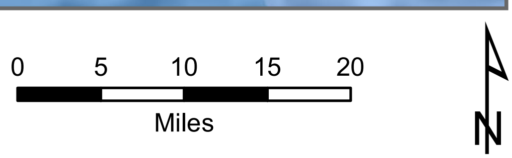
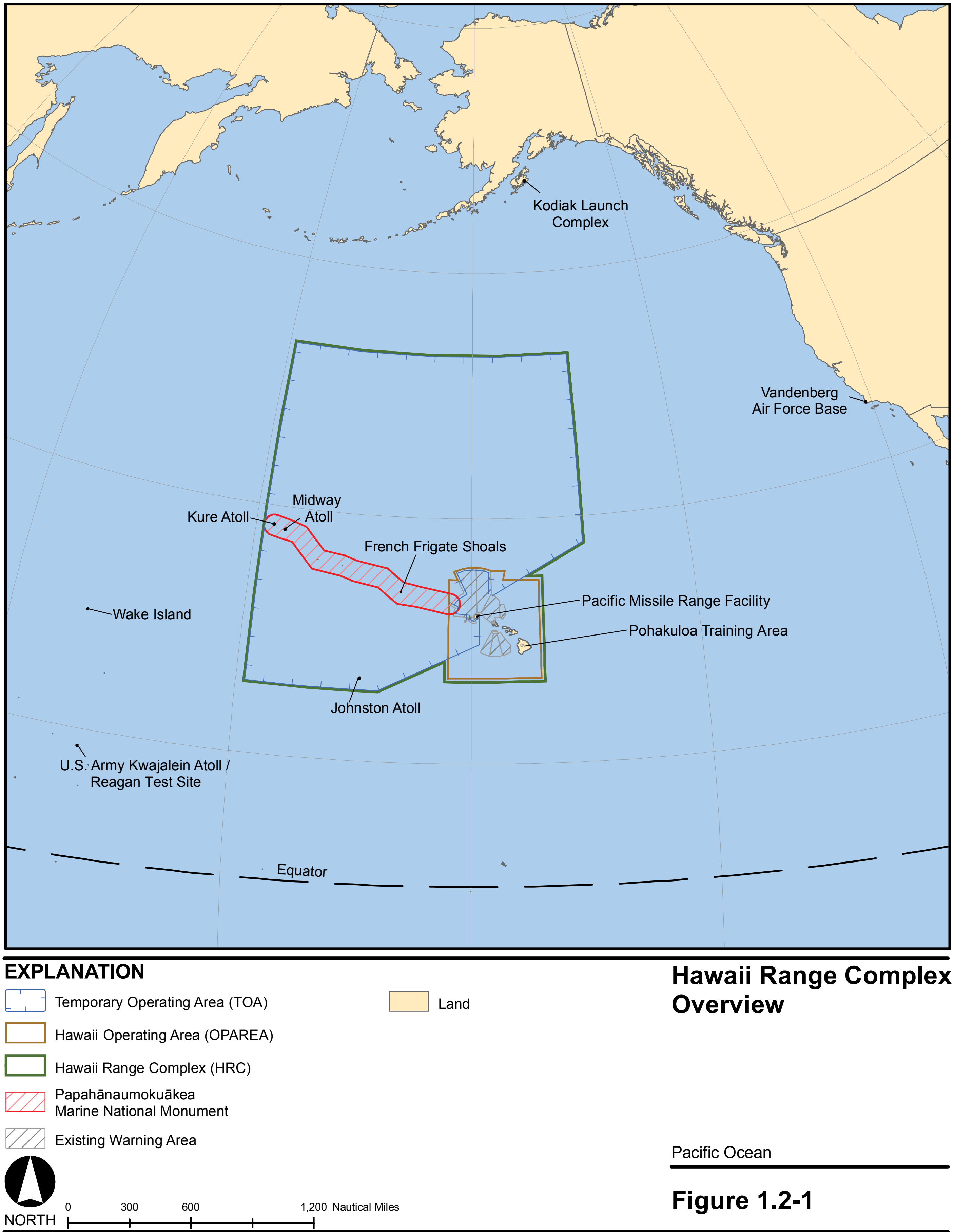
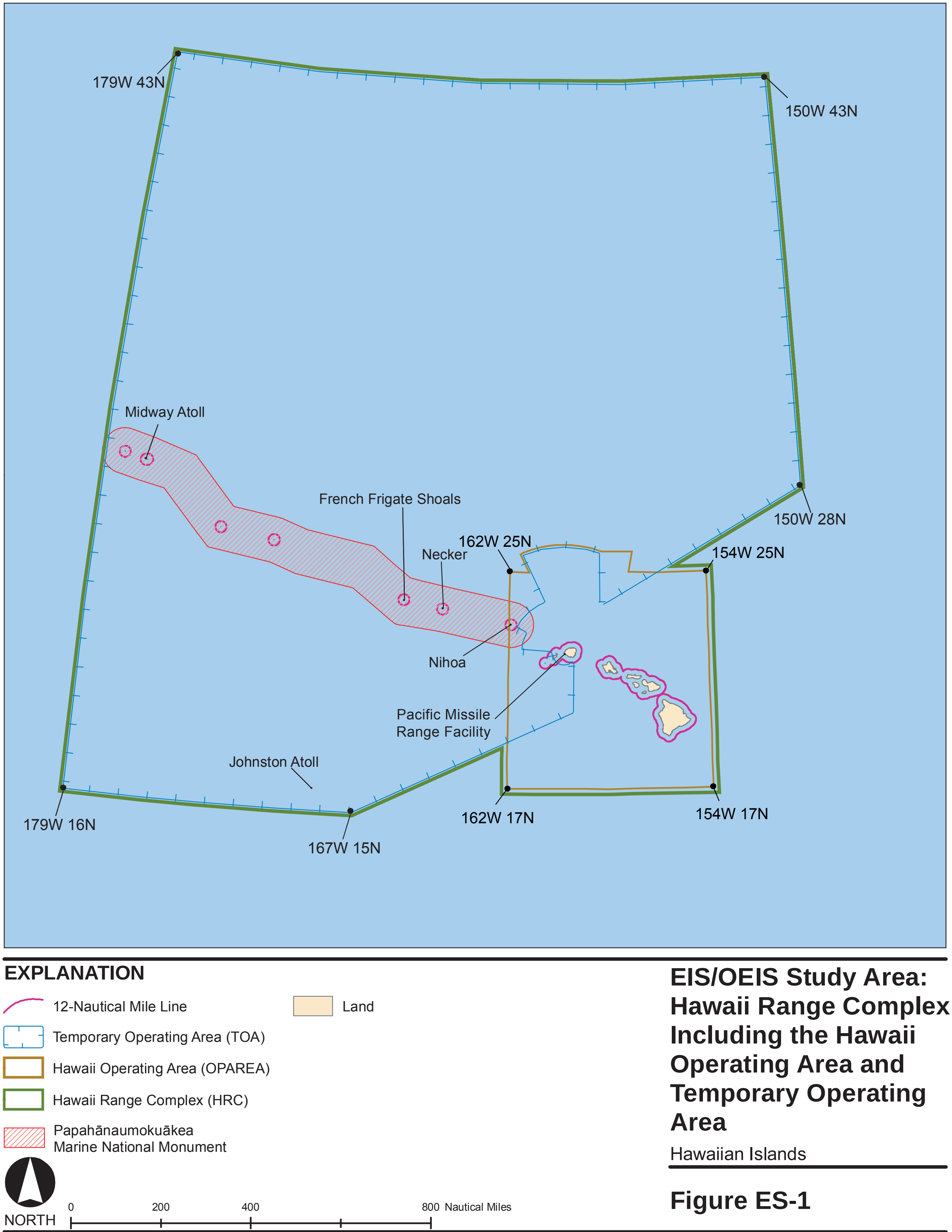




Hawaii Range Complex Overview

Pacific Ocean

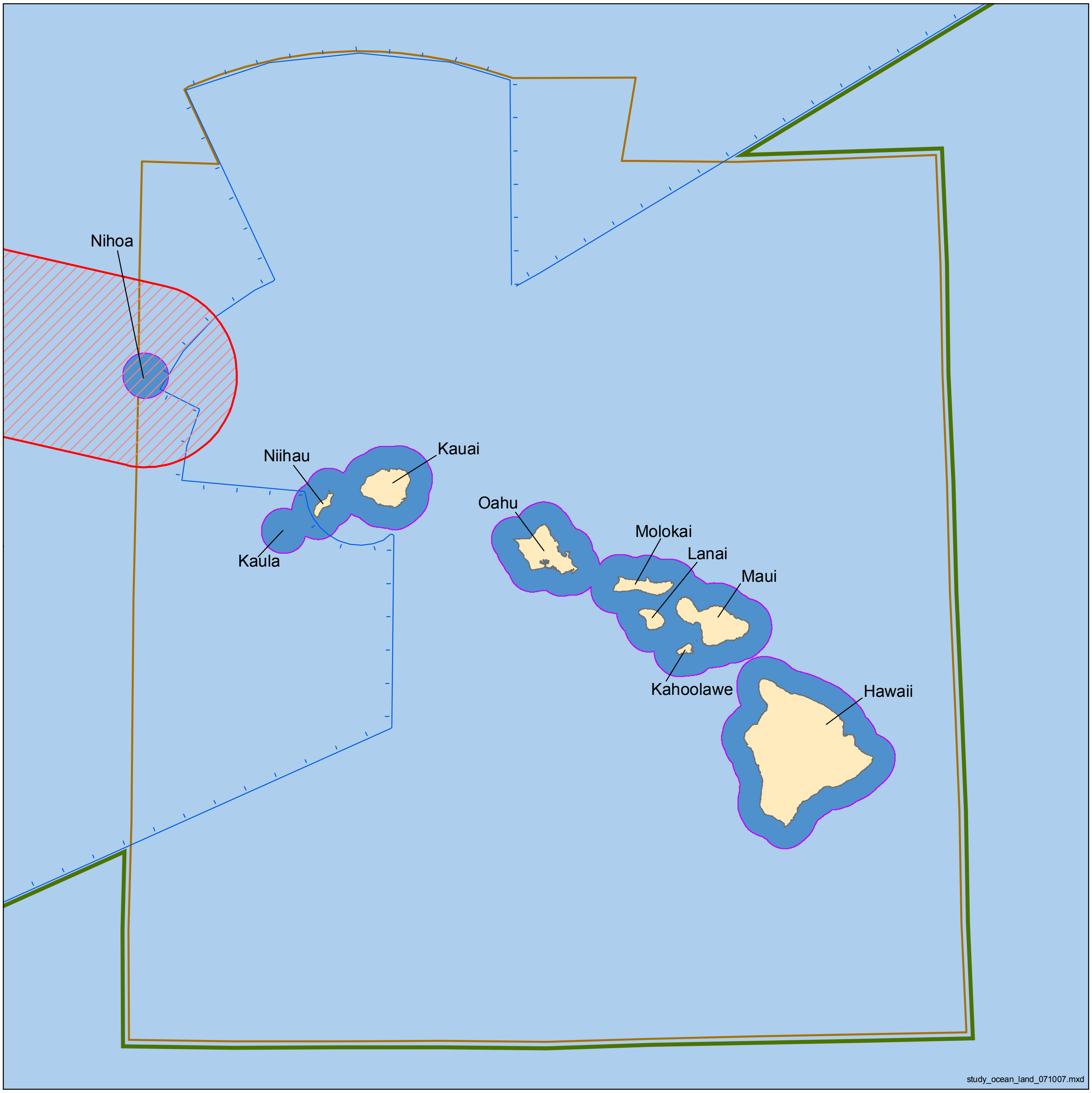
Figure 1.2-1



EIS/OEIS Study Area: Hawaii Range Complex Including the Hawaii Operating Area and Temporary Operating Area

Hawaiian Islands

Figure ES-1



EXPLANATION

12-Nautical Mile Line
Temporary Operating Area (TOA)
Hawaii Operating Area (OPAREA)
Hawaii Range Complex (HRC)
Papahānaumokuākea Marine National Monument
Offshore
Open Ocean
Land

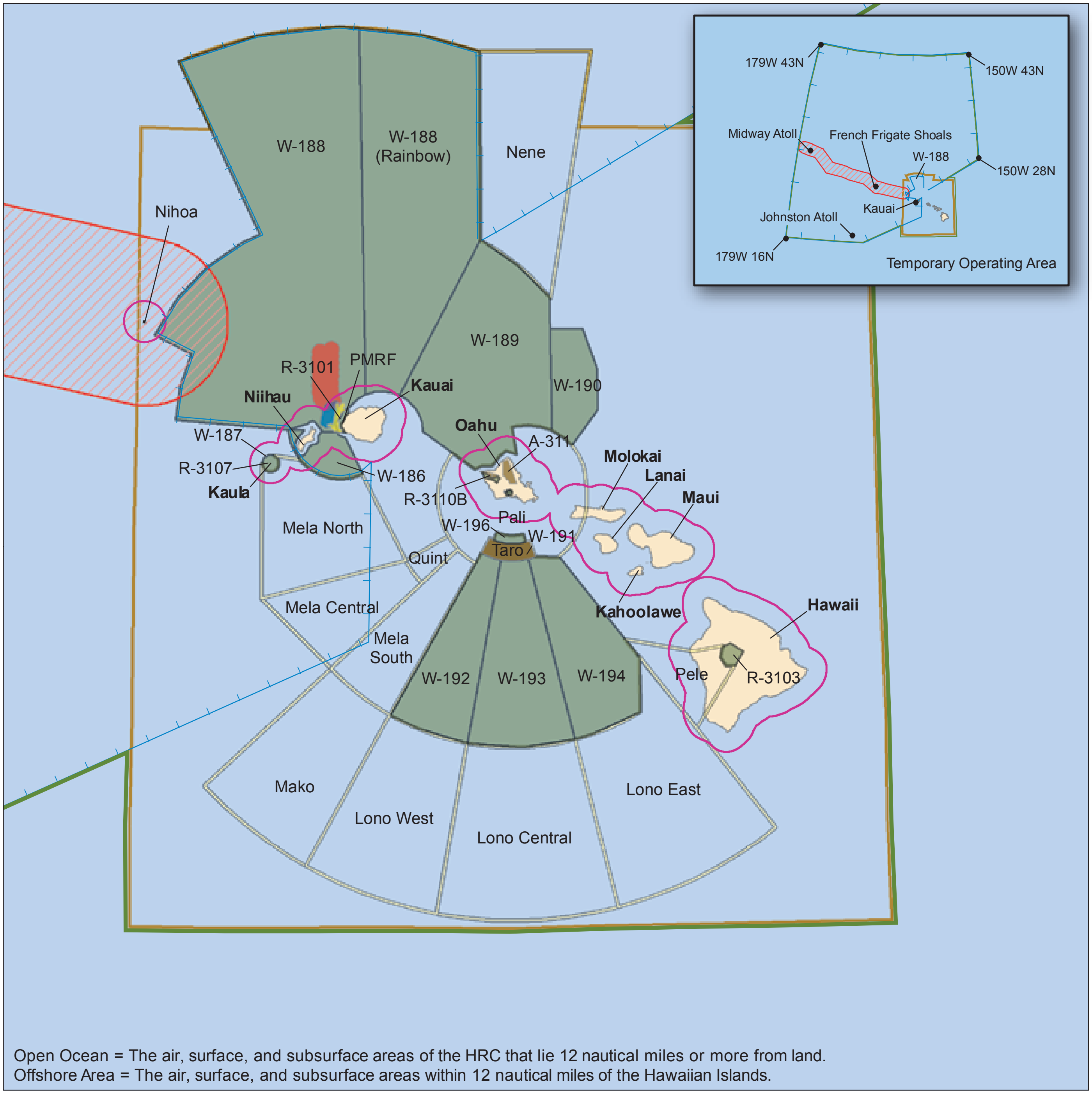
NORTH

0 50 100 200 Nautical Miles

EIS/OEIS Study Area: Hawaii Range Complex Open Ocean, Offshore and Land Areas

Hawaiian Islands

Figure 1.2-2



EXPLANATION

- 12-Nautical Mile Line
- Temporary Operating Area (TOA)
- Hawaii Operating Area (OPAREA)
- Barking Sands Tactical Underwater Range (BARSTUR) Hydrophones
- Barking Sands Underwater Range Expansion (BSURE) Hydrophones
- Air Traffic Control Assigned Airspace (ATCAA)
- Special Use Airspace
- Special Use Airspace and ATCAA
- Shallow Water Training Range (SWTR)
- Papahānaumokuākea Marine National Monument
- Hawaii Range Complex (HRC)
- Land

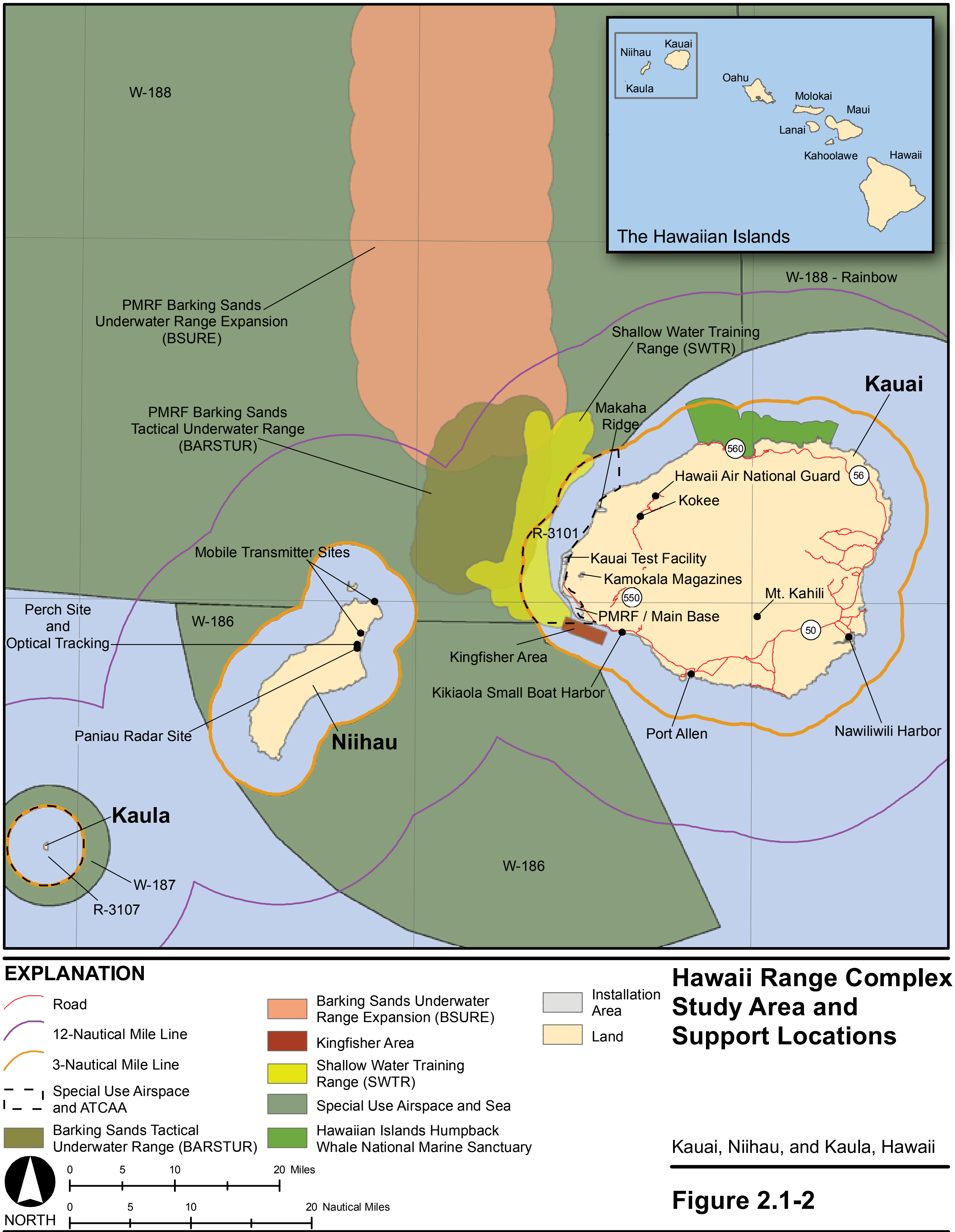
NORTH

0 50 100 200 Nautical Miles

EIS/OEIS Study Area: Hawaii Range Complex Including Temporary Operating Area

Hawaiian Islands

Figure 2.1-1



Hawaii Range Complex Study Area and Support Locations

Kauai, Niihau, and Kaula, Hawaii

Figure 2.1-2

EXPLANATION

- Road
- 12-Nautical Mile Line
- 3-Nautical Mile Line
- Pearl Harbor Naval Base Area
- Ewa Training Minefield
- Barbers Point Underwater Range
- Special Use Airspace and Sea
- Puuloa Underwater Range
- Fleet Operational Readiness Accuracy Check Site (FORACS) Range
- Shipboard Electronic Systems Evaluation Facility (SESEF) Hawaii Range
- Naval Defensive Sea Area
- Hawaiian Islands Humpback Whale National Marine Sanctuary
- Installation Area
- Land

NORTH

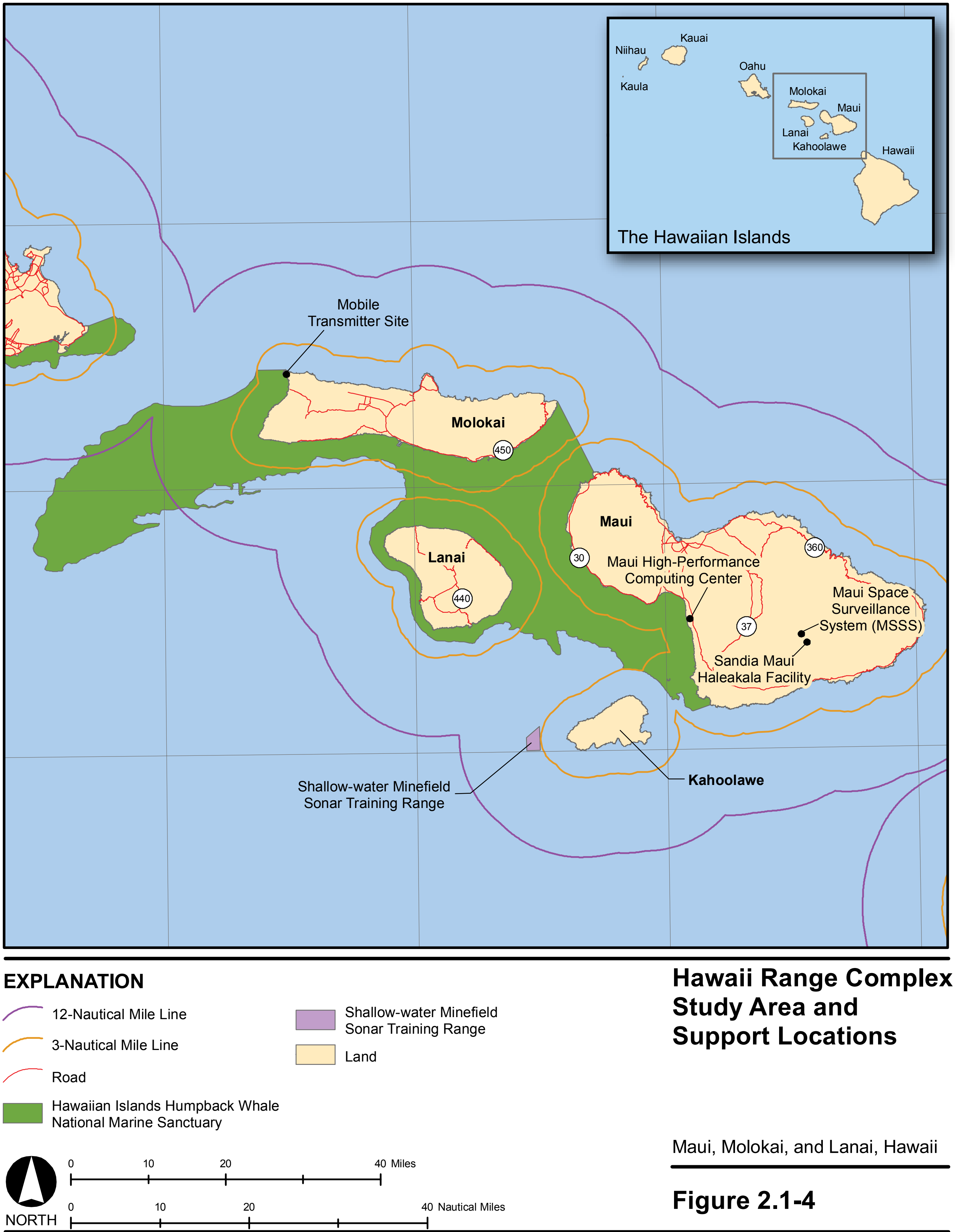
0 5 10 20 Miles

0 5 10 20 Nautical Miles

Hawaii Range Complex Study Area and Support Locations

Oahu, Hawaii

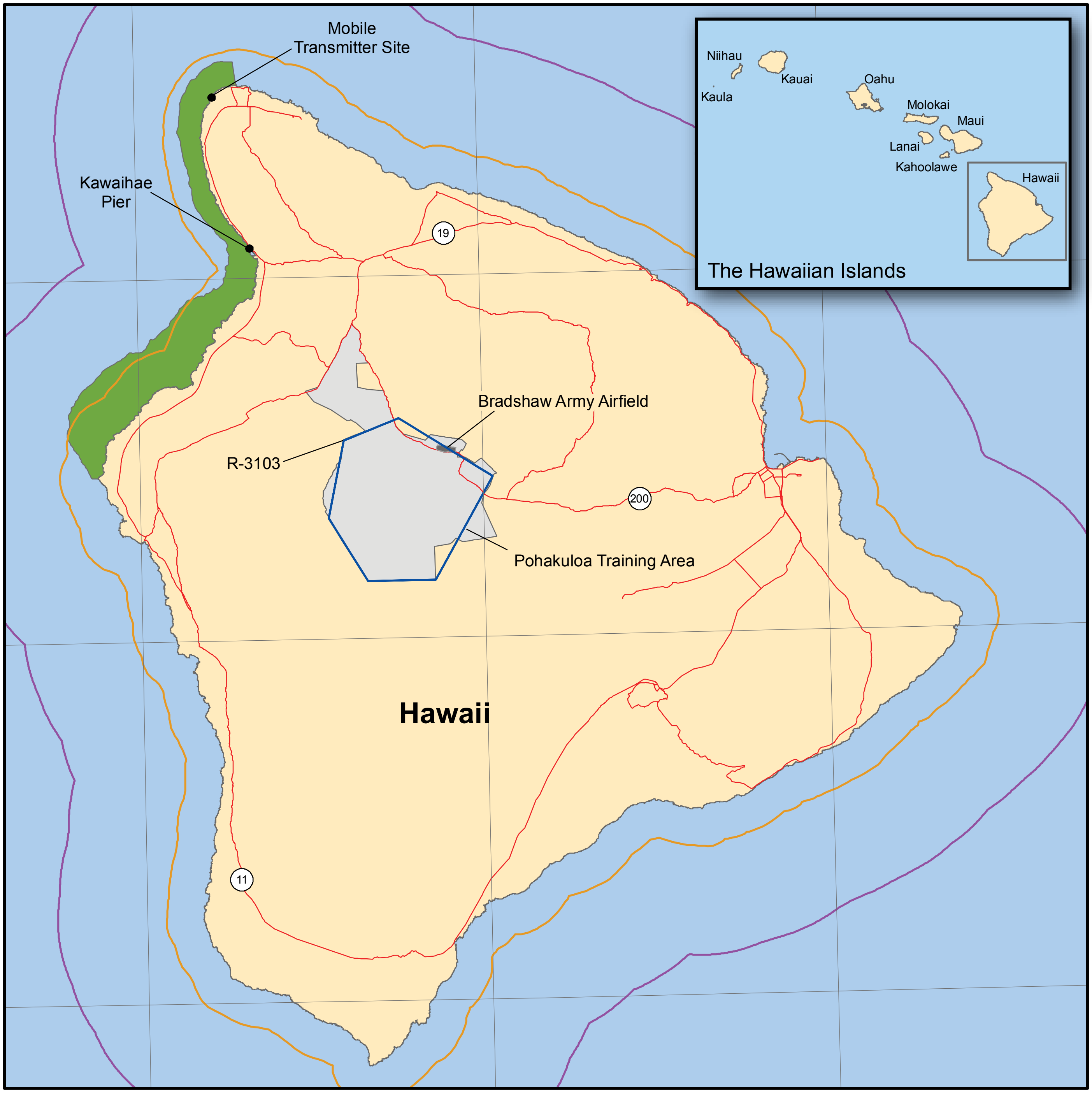
Figure 2.1-3



Hawaii Range Complex Study Area and Support Locations

Maui, Molokai, and Lanai, Hawaii

Figure 2.1-4



EXPLANATION

- 3-Nautical Mile Line
- 12-Nautical Mile Line
- Road
- Restricted Airspace (R-3103)
- Hawaiian Islands Humpback Whale National Marine Sanctuary
- Bradshaw Army Airfield
- Installation Area
- Land

NORTH

0 5 10 20 Miles

0 5 10 20 Nautical Miles

Hawaii Range Complex Study Area and Support Locations

Island of Hawaii

Figure 2.1-5

3 DATA INTEGRATION

This report will include a data integration chapter in subsequent years, as resources allow.

Attachment 1: Report to the Plan Team

Process Options for Designation of Habitat Areas of Particular Concern
April 11, 2016
Ala Moana Hotel

Background

In 2014 and 2015, the Western Pacific Regional Fishery Management Council (Council) underwent a five year review of its Fishery Ecosystem Plans (FEPs) and management process. Through this process, the Council, its staff, and stakeholders identified areas for change and update of its plans. Essential Fish Habitat (EFH) was an area identified for update and review. The EFH Final Rule[1] strongly encourages Councils to review the EFH information included in fishery management plans on a five year cycle[2]. This report considers the last component of EFH information identified in the EFH Final Rule: the EFH update and review procedure.

The Council recommended that new EFH information be reviewed, as necessary, during preparation of the annual reports by the Plan Teams. EFH designations may be changed under the FEP framework processes if information presented in an annual review indicates that modifications are justified[3]. Habitat Areas of Particular Concern (HAPC) are a subset of the EFH designations. The FEPs do not provide explicit direction in how the Council will designate HAPCs.

According to the EFH Final Rule, Councils may designate HAPCs based on one of the four following considerations:

(i) The importance of the **ecological function** provided by the habitat.
(ii) The extent to which the habitat is **sensitive** to human-induced environmental degradation.
(iii) Whether, and to what extent, development activities are, or will be, **stressing** the habitat type.
(iv) The **rarity** of the habitat type.[4]

While an HAPC designation process is not required, it may focus review efforts and increase consistency, transparency, and defensibility in the implementation of the EFH provisions of the Magnuson-Stevens Act in the Western Pacific Region. The 2015 Plan Team took up the question of how the Council should designate HAPC. They were presented with the following four process options:

1. Continue to address HAPC on a case-by-case basis as issues arise.
2. Consider clarifying the Coral Reef HAPC language only, which suggests designation of previously existing MPAs as HAPC.

[1] 67 FR 2376, Jan. 17, 2002
[2] 50 CFR §600.815(a)(10)
[3] Please see Chapter 6 of any FEP developed by the Western Pacific Fishery Management Council.
[4] 50 C.F.R. 600.815(a)(7)

3. Modify and adopt the process used in the Hawaiian Archipelago bottomfish EFH review.
4. Create a new process through which HAPC candidates areas can be identified and filtered.

The Plan Team formed a working group to explore the options for this process, which was performed through two webinars facilitated by Council staff. The members of the working group were Samuel Kahng (Hawai`i), Brent Tibbats (Guam), Mike Tenorio (CNMI), Mareike Sudek/Domingo Ochavillo (American Samoa), with support from Danielle Jayewardene, Mathew Dunlap, and Michael Parke (NMFS). The findings are reported below.

Working Group Sessions
On the first call on September 2, 2015, working group participants heard a background on the Western Pacific's EFH and HAPC designations, and reviewed the HAPC designation processes used by other Councils. Participants reviewed the options presented to the 2015 Plan Team, discussed if any options should be added, and selected options to address in further detail on the next call. The following three options were chosen for further development:

- No Action, i.e. address HAPC on a case-by-case basis
- Adopting the Hawaiian Archipelago bottomfish EFH review model
- Creating a New Process

The second option, modifying the coral reef language, was rejected from further development. Language in the FEPs is not prescriptive of how coral reef HAPCs will be designated in the future, and therefore does not speak to the HAPC designation process. Concerns were expressed that designating HAPCs based on existing protective status can create overly broad HAPC designations and does not necessarily effectively meet the intent of HAPC designation as per the EFH final rule. Additionally, the Council at its 163rd meeting directed staff to further explore and provide the Council with details in improving the ACL specification process through an omnibus amendment of the Fishery Ecosystem Plans to include, among other item, reclassification of appropriate management unit species into ecosystem components. As EFH does not need to be designated for species listed as ecosystem components, it would be most effective to address coral reef EFH once the ecosystem component species amendment is further developed.

Participants on the first call identified that a successful HAPC designation process would:

- be realistically implementable;
- effectively use the expertise in the region;
- be compatible with jurisdictional management;
- encourage the development of usable HAPC candidate area proposals; and
- occur within a reasonable amount of time.

Based on the first call, Council staff split the HAPC designation process into five separate components: the HAPC designation proposal development phase, the HAPC designation proposal review phase, development of a policy on weighting of HAPC considerations, standardizing the interpretation of the HAPC considerations, and timing for the HAPC designation process (Figure 4). A new process would involve some or all of these components; the bottomfish model for example included all components.

During a second call on November 23, 2015 , participants discussed the pros and cons of options for each of five components to evaluate each HAPC designation process.

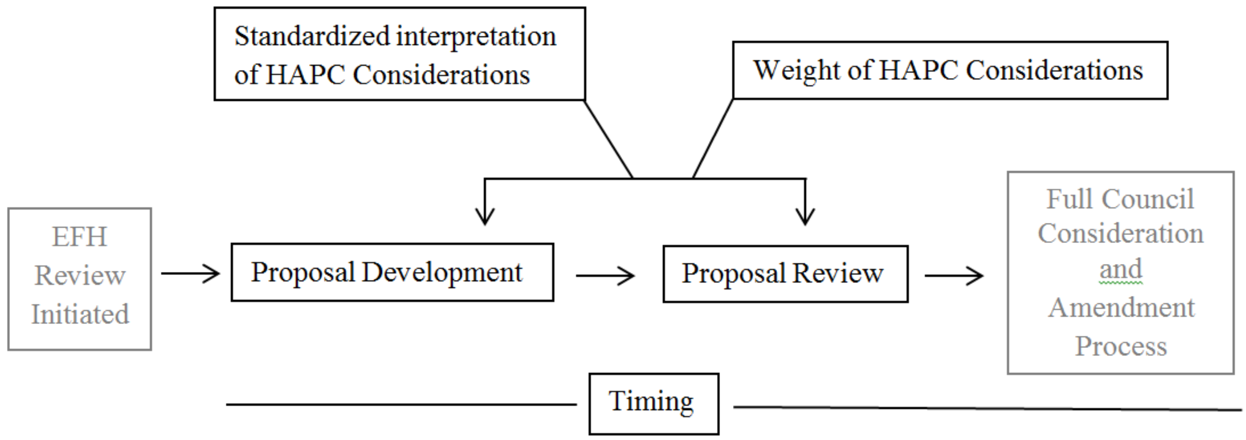


Figure 1. HAPC process components evaluated by the working group. The Council process is included for context.

Evaluation of HAPC Process Components

1. *Proposal Development Options*

During the proposal development phase**,** the participants agreed that it is key to identify a party who has the responsibility, dedication, expertise, and manpower to accomplish the task of submitting HAPC proposals. An option would be to develop and award service contracts, including for a graduate student, to develop proposals. Contractors would be dedicated to the effort, however acquiring funding for EFH review focused work is an ongoing challenge also requires management of the contract. Additionally, stakeholder involvement can be challenging when proposals are developed by contractors outside the Council process.   A second option discussed was for fishermen, who are a key stakeholder group with specialized knowledge of habitat, to develop proposals. However, fisherman constitute only one stakeholder group so may not provide a broad enough perspective. The third option for proposal developers could be the general public.as they would give access to more experts and have increased stakeholder involvement. However according to the experience of other Councils, this approach presents a real risk of an unmanageable number of HAPC proposals being developed that may be irrelevant or incongruent with the Council's management objectives[5]. A fourth option was to have the Council's plan team develop proposals as they have the responsibility for the EFH review already in place. The concern with this approach is that plan team membership may change, and there may not be enough time dedicated in the process to develop supporting rationale for candidate areas. Finally, other Council bodies had the same pros and cons with the exception that the Plan Team is specifically responsible for the EFH review.

Finding

Plan Team members or their staff, and/or contractors seem the most reasonable entities to develop HAPC proposals, i.e. identify candidate HAPC areas for the Council's consideration in

[5] Habitat Working Group of the Council Coordinating Committee , Group Discussion, October 3, 2014

updating FEPs. Use of contractors allows flexibility when additional funding opportunities are available. When candidate HAPCs areas are identified outside the Council process, which would be the case with a contractor, the contract must be carefully managed to ensure the proposal addressed Council priorities and objectives and stakeholders are involved.

2. *Proposal Review Options*

In the proposal review phase, participants discussed the importance for the Pacific Island Fisheries Science Center (PIFSC) stock assessment authors to weigh in on the review of proposals for their stocks. Time management was the leading concern for Council staff and Advisory Panel review of the proposals. In the North Pacific region, Council staff review HAPC proposals to ensure consistency with Council priorities.[6] Advisory Panel review, however, would increase stakeholder participation in the HAPC designation process in the fishing community. This was considered an essential lesson learned from the Hawaiian Archipelago bottomfish EFH review. The Scientific and Statistical Committee (SSC) was recognized as the responsible body for review of all scientific information, and therefore HAPC proposals. The SSC is familiar with the fisheries, giving it an advantage over Center for Independent Expert (CIE) reviews. CIE reviews are managed at PIFSC.

Western Pacific Stock Assessment Review (WPSAR) is an existing peer review procedure for the scientific information that may be used as a basis for federal fisheries management in the region. A WPSAR review would occur as supplemental to the SSC's review, but may slow down the process. The WPSAR Coordinating Committee anticipates what WPSAR reviews may be needed for the region and advises the Steering Committee. The Steering Committee prioritizes and schedules regional science products for review based on its potential influence, available resources, and other factors as appropriate. Due to the implications stock assessments have on setting Annual Catch Limits, the assessments usually get higher priority than other scientific information like EFH or HAPC reviews. An HAPC proposal may be considered by the Steering Committee for the WPSAR schedule through two avenues: recommendation of the Coordinating Committee, or recommendation of the SSC.

Overall, interim checkpoints and the review methodology are important to ensure enough stakeholder involvement without prolonging the process. More levels of review mitigates the risk of rejection by various stakeholders, which may prolong the timeline of the review substantially.

Finding

Flexibility in the process is again important, so that as many reviewers may be exposed to the draft HAPC proposal without unnecessarily prolonging the process. Because the level of review is anticipated to be different for different managed fisheries, a concurrent initial review by Council staff, the PIRO regional EFH Coordinator, and Plan Team Habitat team members as well as the relevant PIFSC stock assessment authors will help to focus further review of the HAPC proposals through the Council process. These desktop reviewers will review the draft for scientific quality and consistency with Council objectives. The reviewers may make recommendations for additional stakeholder meetings if necessary. Comments should be

[6] HAPC Process Document, North Pacific Fishery Management Council and National Marine Fisheries Service, Alaska Region. September 2010.

provided within 45 days to prevent delays in the review process. A flow chart depicting how the review process is integrated with the Council process is shown in Figure 5.

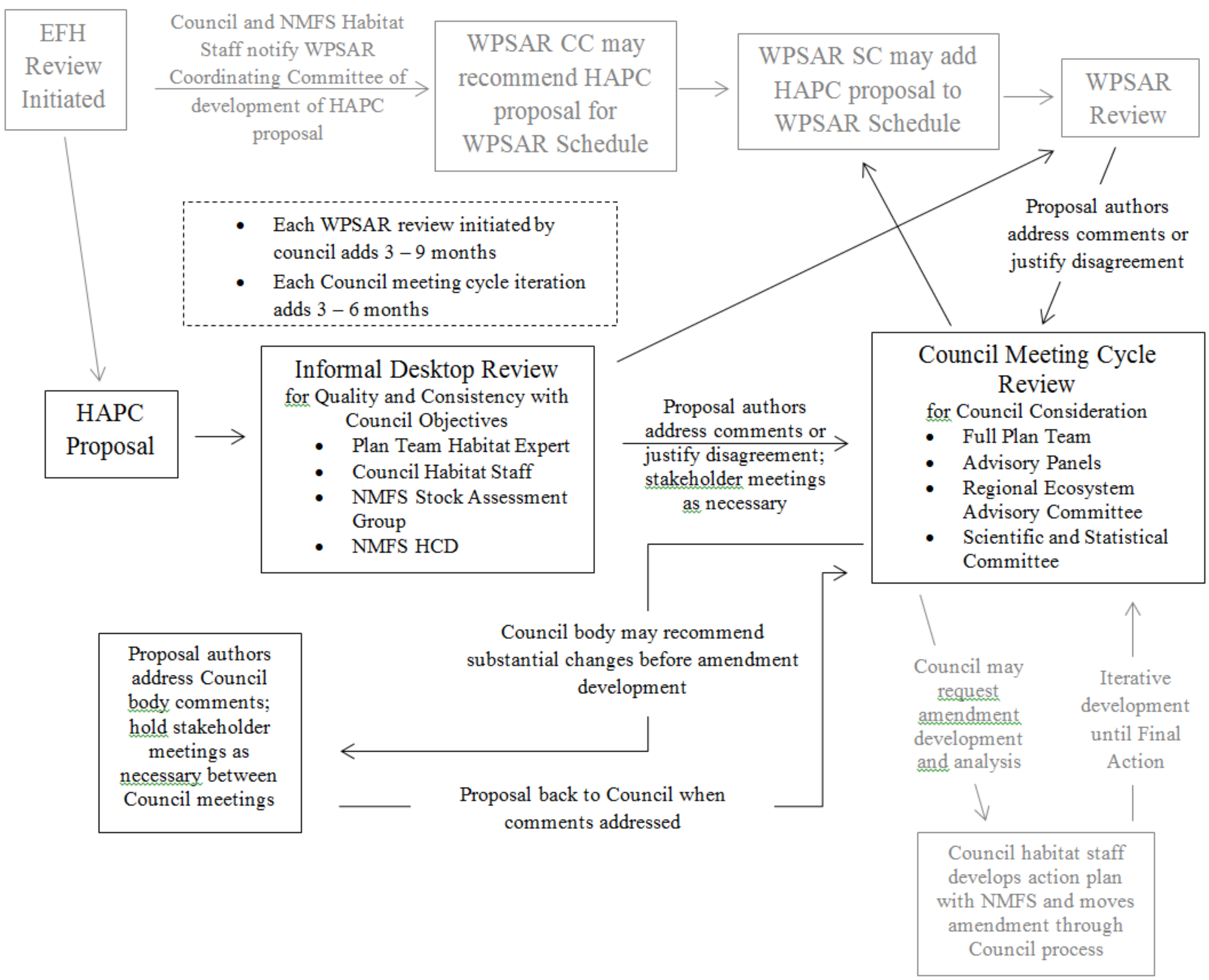


Figure 2. Integration of HAPC Proposal Review with the Council process. HAPC-specific phases are in black while established Council processes are in gray.

3. *Weighting of HAPC Considerations*

The working group discussed the weighting of considerations. In the WPSAR review of the bottomfish candidate areas, the panel determined that all candidate HAPCs must be ecologically important and meet one additional consideration in order to become an HAPC. The working group recognized that if the weighting is left up to the proposal writers or reviewers, the result could be subjective. Without any consideration of weighting, there are fewer restrictions on the proposal process and less quality control built into the process. However, the working group did not feel that recommending particular weights for the considerations was appropriate at this time, as some of the concerns with having no weighting for the considerations could be alleviated through developing terms of reference for candidate HAPC proposals.

4. *Interpretation of Considerations*

Further interpreting the considerations for the region had similar pros and cons as weighting the considerations. Interpreting them for the region may result in a more objective process, but runs the danger of producing overly restrictive proposals. Other Councils have interpreted the HAPC considerations further than in the EFH Final Rule, such as the North Pacific. This may be more appropriate in other regions that do authorize fishing gears with substantial adverse effects on EFH, where HAPC has been associated with gear closures. However, the Western Pacific Council does not authorize these gear types.

The working group did discuss the interpretation of the third consideration: "Whether, and to what extent, development activities are, or will be, stressing the habitat type." Participants agreed that local or regional actions/ threats should be given more consideration than global threats when the stressor/s associated with the global threats are not identifiable at a habitat and/or site specific scale.

Findings

The primary purpose of further interpreting and weighting the HAPC considerations is to increase the quality and refine the HAPC candidate areas received in a proposal. Terms of reference for the development of HAPC proposals could address these goals, while involving members of other Council bodies that are more appropriate for policy, not FEP, development.

Proposed HAPC Process and Recommendations

The working group recommends to the Plan Team that Council staff develop an HAPC policy from the working group discussions. The policy should include terms of reference for proposals from the HAPC guidance documents, working group discussions, and additional input from other relevant sources including Council bodies. If contractors are used to identify candidate areas, a term of the contract must be to gather information from the Council's advisory bodies and NMFS before submitting a final proposal for review to the Plan Team, Scientific and Statistical Committee, Advisory Panels, and Council. In addition to the regular Council process and WPSAR process, the HAPC process will include an initial desktop review of the HAPC proposal by Council habitat staff and Plan Team member, stock assessment scientists from the PIFSC Stock Assessment group, and NMFS Habitat Conservation Division. Producing a policy, instead of amending the FEPs with an HAPC update procedure, will facilitate flexibility in the process by not requiring a new amendment for revision of the process.

ATTACHMENT 2: DRAFT Precious Corals Species Descriptions Update

1 PRECIOUS CORALS SPECIES

1.1 General Distribution of Precious Corals

This document is an update of the 2015 "Essential Fish Habitat Source Document for Western Pacific Archipelagic, Remote Island Areas, and Pelagic Fishery Ecosystem Plan Management Unit Species" for precious corals. Important new references and data points have been added to the original documentation. Many older observations continue to be cited because no newer studies have been completed, with a few notable exceptions. While the original sources are still relevant, new research has revealed important distribution, life history, growth rate, age, and abundance information that is relevant to precious coral management. Some progress has also been made toward clarifying some of the vexing taxonomic challenges presented by these organisms. First, the name of the most important species of gold coral, *Gerardia* sp., has been updated to *Kulamanamana haumeaae* by Sinniger, *et al.* (2013). Second, two of the most important species in the family Coralliidae, *Corallium secundum* (pink coral) and *Corallium regale* (red coral) have been placed into separate genera, the latter also becoming a different species (Figueroa & Baco, 2014). Their new names are now *Pleurocorallium secundum* and *Hemicorallium laauense*, respectively. Third, two changes have taken place in the black corals. *Antipathes dichotoma* is now *Antipathes griggi* and *Antipathes ulex* has been moved to a different genus and is now *Myriopathes ulex* (Opresko, 2009). These changes are shown in Table 1.

Most research related to precious corals has been limited to the Hawaiian archipelago, and the majority of the more recent efforts have been directed at taxonomy or simply documenting species distributions, with a few works on growth and life history (*Parrish et al.*, 2015). However, significant new insights have been gained into the genetics (Baco and Cairns, 2012; Sinniger, *et al.*, 2013; Figueroa and Baco, 2014), reproductive biology (Waller and Baco, 2007; Wagner, *et al.*, 2011; Wagner *et al.*, 2012; Wagner *et al.*, 2015), growth and age (Parrish and Roark 2009; Roark *et al.*, 2009), and community structure (Kahng *et al*., 2010; Long and Baco, 2014; Parrish, 2015; Wagner, *et al*., 2015) of precious coral and black coral species.

The U.S. Pacific Islands Region under jurisdiction of the Western Pacific Regional Fisheries Management Council consists of more than 50 oceanic islands, including the Hawaiian and Marianas archipelagos, American Samoa, Johnston, Wake, Palmyra, Kingman, Jarvis, Baker and Howland, and numerous seamounts in proximity to each of these groups. These islands fall under a variety of political jurisdictions, and include the State of Hawaii, the Commonwealth of the Northern Mariana Islands (CNMI), and the territories of Guam and American Samoa, as well as nine sovereign Federal territories—Midway Atoll, Johnston Atoll, Kingman Reef, Palmyra Atoll, Jarvis Island, Howland Island, Baker Island, Rose Atoll, and Wake Island. Precious corals (with currently accepted species names) are known to exist in American Samoa, Guam, Hawaii and the Northern Mariana Islands, as well as throughout the other US islands in the Pacific (Tables 1 and 2), but the only detailed assessments of precious corals have been in Hawaii (Parrish and Baco, 2007, Parrish *et al*., 2015; Wagner, *et al*., 2015). Over the last 10 years, we have begun to better understand the distribution and abundance of these corals, but many areas remain unexplored, and conditions which lead to their settlement, growth and distribution are still uncertain. Modelling efforts have provided some insight into the global distribution and habitat requirements of deep-water corals (Rogers *et al.*, 2007; Tittensor *et al.*, 2009, Clark *et al.*, 2011, Yesson *et al.*, 2012, Schlacher *et al.*, 2013), but have provided little certainty regarding localized distribution or the specific conditions required for growth of precious corals. Antipatharians, commonly known as black corals, have been exploited for years, but are still among the taxonomic groups containing precious corals that have been inadequately surveyed, as evidenced by the high rates of species discoveries from deep-water surveys around the Hawaiian Islands (Opresko 2003b; Opresko 2005a; Baco 2007; Parrish & Baco 2007; Parrish *et al.*, 2015; Roark, 2009; Wagner *et al.*, 2011, 2015; Wagner, 2011, 2013). Despite this ongoing research, only a few places are known to have dense agglomerations of precious corals. A summary of the known distribution and abundance of precious corals in the central and western Pacific Islands region follows.

Table 1: Precious corals covered under the FMP

Species	Common name
Pleurocorallium secundum (prev. *Corallium secundum*)	Pink coral
Hemicorallium laauense (prev. *C. regale*)	Red coral
Kulamanamana haumeaae (prev. *Gerardia* sp.)	Gold coral
Narella sp.	Gold coral
Calyptrophora sp.	Gold coral
Callogorgia gilberti	Gold coral
Lepidisis olapa	Bamboo coral
Acanella sp.	Bamboo coral
Antipathes griggi (prev. *A. dichotoma)*	Black coral
Antipathes grandis	Black coral
*Myriopathes ulex (*prev. *Antipathes ulex*)	Black coral

American Samoa

There is little information available for the deepwater species of precious corals in American

Samoa. Much of the information available comes from the personal accounts of fishermen. In the South Pacific there are no known commercial beds of pink coral (Carleton and Philipson 1987). Survey work begun in 1975 by the Committee for Co-ordination of Joint Prospecting for Mineral Resources in South Pacific Offshore Areas (CCOP/SOPAC) identified three areas of *Corralium* off Western Samoa: off eastern Upolu, off Falealupo and at Tupuola Bank (Carleton and Philipson 1987). Pink coral has been reported off Cape Taputapu, but no information concerning the quality or quantity of these corals or the depths where they occur is available. Unidentified precious corals have also been reported in the past off Fanuatapu at depths of around 90 m. Precious corals are known to occur at an uncharted seamount, about three-fourths of a mile off the northwest tip of Falealupo Bank at depths of around 300 m.

Commercial quantities of one or more species of black coral are known to exist at depths of 40 m and deeper. However, these are found in the territorial waters of American Samoa and, therefore, are not subject to the Council’s authority. Wagner (personal communication, 2015) has tentatively identified as many as 12 species (not previously catalogued in Am. Samoa) of black corals in depths between 50m and 90m, with 6 of these potential new species exhibiting growth forms that could lead to harvestable sizes. However, Wagner did not see find any locations with the types of densities and sizes that would support any commercial harvest of these corals.

<u>Guam and the Commonwealth of the Northern Marianas</u>

There are no known commercial quantities of precious corals in the Northern Mariana Islands archipelago (Grigg and Eldredge 1975). In the past, Japanese fishermen claimed to have taken some *Corralium* north of Pagan Island and off Rota and Saipan. Surveys are planned for the Marianas Islands in 2016 that may provide more information regarding abundance and distribution of certain precious corals found in waters deeper than 250 m.

<u>U.S. Pacific Island Remote Areas</u>

There are no known commercial quantities of precious corals in the remote Pacific Island areas, though individual colonies of precious corals have been seen at Jarvis, Palmyra, Kingman (Parrish and Baco, 2007) and Johnston Atoll, and planned surveys in 2017 may provide more information about abundance and distribution of precious corals found in waters deeper than 250 meters in these areas.

<u>Hawaii</u>

In the Hawaiian Archipelago there are seven legally-defined beds of pink, gold and bamboo corals, which are shown in Table 2. It is difficult to determine from the publication record exactly why these particular areas were singled out for legal recognition, other than the fact that they contain some unspecified densities of precious corals within their geographic boundaries. In the MHI, the Makapuu bed is located off Makapuu, Oahu, at depths of between 250 and 575 meters. Discovered in 1966, it the precious coral bed that has been most extensively surveyed in the Hawaiian chain. Its total area is about 4.5 km^2. Its substrate consists largely of hard limestone (Grigg, 1988). Careful examination during numerous dives with a submersible has determined that about 20% of the total area of the Makapuu bed is comprised of irregular lenses of thin sand, sediments and barren patches (WPRFMC, 1979). These sediment deposits are found primarily in low lying areas and depressions (Grigg, 1988). Thus, the total area used for extrapolating coral density is 3.6 km^2, or 80% of 4.5 km^2 (WPRFMC, 1979).

Precious coral beds have also been found in the deep inter-island channels such as Auau, Alalakeiki, and Kolohi channels off of Maui, around the edges of Penguin Banks, off promontories such as Keahole Point, on older lava flows south from Keahole to Ka Lae, and off of Hilo Harbor, and off of Cape Kumukahi on the Big Island of Hawaii (Oishi, 1990; Grigg, 2001, 2002). On Oahu, there is a bed off Kaena Point, and multiple precious coral observations have been made from offshore Barber’s Point extending to offshore Pearl Harbor, Oahu. On Kauai, a bed of black corals has been identified offshore of Poipu (WPRFMC, 1979).

A dense bed has been located on the summit of Cross Seamount, southwest of the island of Hawaii. This bed covers a pinnacle feature on the top of the summit, but does not contain numbers of corals large enough to sustain commercial harvests (Kelley, pers. comm., 2015).

Table 2: Location of legally-defined precious coral beds. Source: WPRFMC 1979

Area Name	Description
Makapu'u (Oahu)	includes the area within a radius of 2.0 nm of a point at 21°18.0′ N. lat., 157°32.5′ W. long.
Auau Channel, Maui	includes the area west and south of a point at 21°10′ N. lat., 156°40′ W. long., and east of a point at 21° N. lat., 157° W. long., and west and north of a point at 20°45′ N. lat., 156°40′ W. long.
Keahole Point, Hawaii	includes the area within a radius of 0.5 nm of a point at 19°46.0′ N. lat., 156°06.0′ W. long.
Kaena Point, Oahu	includes the area within a radius of 0.5 nm of a point at 21°35.4′ N. lat., 158°22.9′ W. long.
Brooks Banks	includes the area within a radius of 2.0 nm of a point at 24°06.0′ N. lat., 166°48.0′ W. long.
180 Fathom Bank, north of Kure Island	N.W. of Kure Atoll, includes the area within a radius of 2.0 nm of a point at 28°50.2′ N. lat., 178°53.4′ W. long.
WesPac Bed, between Nihoa and Necker Islands	includes the area within a radius of 2.0 nm of a point at 23°18′ N. lat., 162°35′ W. long. *

* This area falls within the boundaries of the Papahanaumokuakea National Marine so

precious corals here are no longer subject to harvest or removal.
In the NWHI, a small bed of deepwater precious corals have been found on WestPac bed, between Nihoa and Necker Islands and east of French Frigate Shoals. This bed is not large enough to sustain commercial harvests. Precious coral beds have also been discovered at Brooks Banks, Pioneer Bank, Bank 8, Seamount 11, Laysan, and French Frigate shoals (Parrish and Baco, 2007; Parrish *et al*., 2015). ROV surveys conducted throughout the NWHI by the Okeanos Explorer during 2015 discovered multiple places that had dense colonies of deep-sea corals. Few of these colonies were precious corals, but these dives were mostly conducted in waters deeper than normal distributions of precious corals (>1500 meters). However, large areas of potential habitat exist in the NWHI on seamounts and banks near 400 m depth. Based on the abundance of potential habitat, it is thought that stocks of precious corals may be more abundant in the northwestern end of the island chain. All precious coral stocks within the boundaries of the Paphanaumokuakea National Marine Monument are protected from harvest, and most habitat suitable for precious corals growth falls within the boundaries of the monument.

Precious corals have also been discovered at the 180 Fathom Bank, north of Kure Island. The extent of this bed is not known. Precious corals have been observed during submersible and ROV dives throughout the Northwestern Hawaiian Islands, and in EEZ waters surrounding Johnston, Jarvis, Palmyra, and Kingman atolls, but little can be definitively said about the overall distribution and abundance of precious corals in the central Pacific region.

In addition to these legally defined areas of precious corals, many other sites have been discovered that sustain populations of precious corals (Parrish and Baco, 2007; Parrish *et al*., 2015; Wagner *et al*., 2015). The map below (Figure 1) provides a color-coded illustration of some of these 8600 observations (Kelley and Drysdale, 2012, *unpublished data*). Given the number of observations and the wide distribution of precious corals in the main Hawaiian Islands, it is almost certain that undiscovered beds of precious corals exist in the EEZ waters of the region managed by the WPRFMC. Whether these beds would contain organisms at sufficient densities and size distributions to support commercial harvests is yet to be determined.

1.2 Systematics of the Deepwater Coral Species

Published records of deep corals from the Hawaiian Archipelago include more than 137 species of gorgonian octocorals and 63 species of azooxanthellate scleractinians (Parrish and Baco, 2007). A total of 6 new genera and 20 new species of octocorals, antipatharians, and zoanthids have been discovered in Hawaii since the 2007 report (Parrish *et al.*, 2015). These are either new to science, or new records for the Hawaiian Archipelago (Cairns & Bayer 2008, Cairns 2009, Opresko 2009, Cairns 2010, Wagner *et al.*, 2011a, Opresko *et al.*, 2012, Sinniger *et al.*, 2013). Taxonomic revisions currently underway for several groups of corals, e.g., isidids, coralliids, plexaurids and paragorgiids, are also likely to yield additional species new to science and new records for Hawaii (Parrish *et al.*, 2015). Only a handful of these deep coral species are considered economically *precious* and have any history of exploitation.

Recent molecular phylogenetic and morphologic studies of the family Coralliidae, including Hawaiian precious corals, have illuminated taxonomic relationships. These studies synonymized

Paracorallium into the genus Corallium, and resurrected the genera Hemicorallium (Ardila *et al*., 2012; Figueroa & Baco, 2014; Tu *et al*., 2015) and Pleurocorallium (Figueroa & Baco, 2014; Tu *et al*.,2015) for several species, including several species in the precious coral trade. A molecular and morphological analysis of octocoral-associated zoanthids collected from the deep slopes in the Hawaiian Archipelago revealed the presence of at least five different genera including the gold coral (Sinniger *et al*.,2013). This study describes the five new genera and species and proposes a new genus and species for the Hawaiian gold coral, *Kulamanamana haumeaae*, an historically important species harvested for the jewelry trade and the only Hawaiian zoanthid that appears to create its own skeleton.

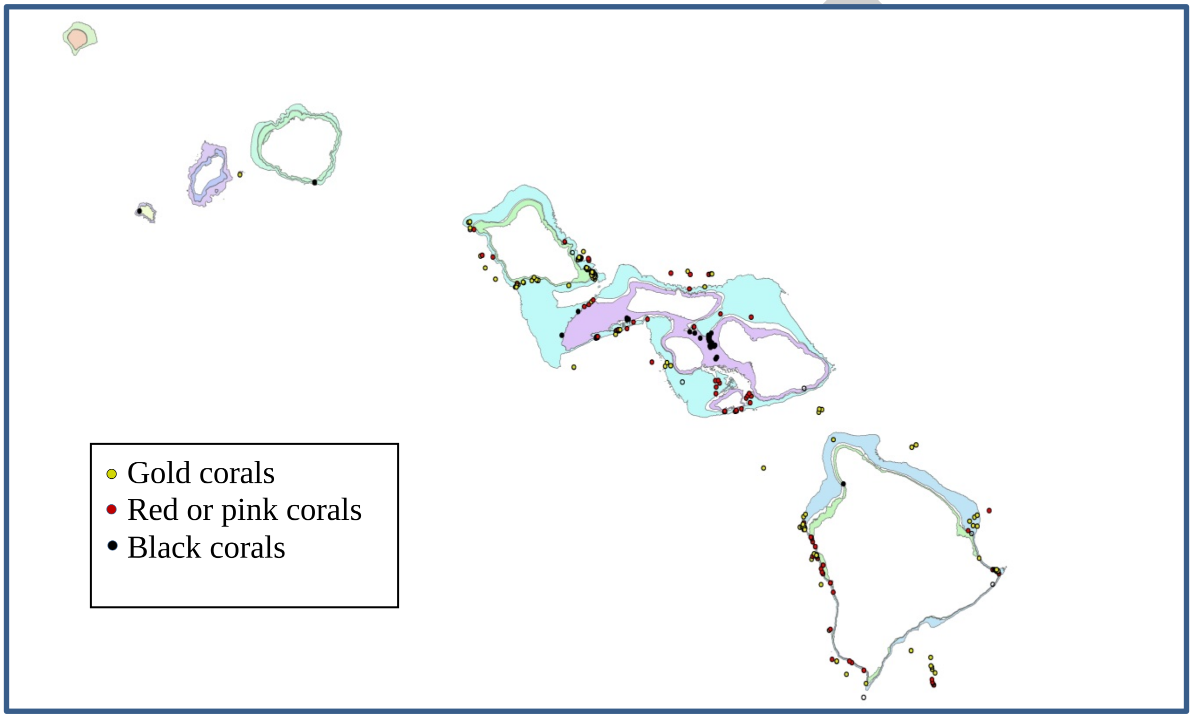


Figure 1. Observations of precious corals in the main Hawaiian Islands

Precious corals are found principally in three orders of the class Anthozoa: Gorgonacea, Antipatharia, and Zoanthiae (Grigg, 1984). In the western Pacific region, pink coral (*Pleurocorallium secundum*), red coral (*Hemicorallium laauense*), gold coral (*Kulamanamana haumeaae*), black coral (*Antipathes* sp.) and bamboo coral (*Lepidisis olapa*) are the primary species/genera of commercial importance. Of these, the most valuable precious corals are species of the genera *Pleurorallium* and *Hemicorallium*, the pink and red corals (Grigg, 1984). Pink coral (*P. secundum*) and Midway deep-sea coral (*Corallium* sp. nov,) are two of the principal species of commercial importance in the Hawaiian and Emperor Seamount chain (Grigg, 1984). *P. secundum*, is found in the Hawaiian archipelago from Milwaukee Banks in the Emperor Seamounts (36^{o}N) to the Island of Hawaii (18^{o}N); *Corallium* sp. nov. is found between 28^{o}–36^{o}N, from Midway to the Emperor Seamounts (Grigg, 1984). In addition to the pink corals, the bamboo corals, *Lepidistis olapa* and *Acanella* sp., are commercially important precious corals in the western Pacific region (Grigg, 1984). Pink coral and bamboo coral are found in the order

Gorgonacea in the subclass Octocorallia of the class Anthozoa, in the Phylum Coelenterata (Grigg, 1984).

The final two major groups of commercially important precious corals, gold coral and black coral, are found in separate orders, Zoanthidea and Antipatharia, in the subclass Hexacorallia, in the class Anthozoa and the phylum Coelenterata. The gold coral, *Kulamanamana haumeaae* (prev. *Gerardia* sp.) (Sinneger, *et.al.*, 2013), is endemic to the Hawaiian and Emperor Seamount chain (Grigg 1984). It inhabits depths ranging from 300–400 m (Grigg 1974, 1984). In Hawaii, gold coral, *Kulamanamana haumeaae,* grows mostly on bamboo hosts (e.g. *Acanella, Keratoisis*) as a parasitic overgrowth (Brown, 1976; Grigg, 1984; Parrish, 2015). Gold coral is, therefore, only found growing in areas that were previously inhabited by colonies of *Acanella* (Grigg, 1993) and possibly other bamboo corals (Parrish, 2015). Despite its ecological significance and long history of exploitation, the Hawaiian gold coral has never been subject to taxonomic studies or a formal species description. As a result of this, the nomenclature concerning the Hawaiian gold coral has been relatively confused. Symptomatic of the order, a suite of other zoanthids, besides the Hawaiian gold coral, have been observed and collected in Hawaii, but far less is known of their biology and ecology and they have not been described taxonomically.(Sinnegar *et al.,* 2013).

Grigg (1984) classified black corals in the order *Antipatharia,* and identified fourteen genera of black corals reported from the Hawaii-Pacific region with species found in both shallow and deep habitats Grigg, 1965). Wagner (2015) noted that there are over 235 known species of black coral that occur in the oceans of the world, and of this total, only about 10 species are of commercial importance (Grigg, 1984). Wagner (2011) confirmed 8 species of black corals in Hawaii, including (1) *Antipathes griggi* Opresko, 2009, (2) *Antipathes grandis* Verrill, 1928, (3) *Stichopathes echinulata* Brook, 1889, (4) an undescribed *Stichopathes* sp., (5) *Cirrhipathes* cf. *anguina* Dana, 1846, (6) *Aphanipathes verticillata* Brook, 1889, (7) *Acanthopathes undulata* (Van Pesch, 1914), and (8) *Myriopathes* cf. *ulex* Ellis & Solander, 1786. A new name for the Hawaiian species of antipatharian coral previously identified as *Antipathes dichotoma* (Grigg and Opresko, 1977) is described as *Antipathes griggi* (Opresko, 2009).

Many species of gorgonian corals are known to occur within the habitat of pink, gold and bamboo corals in the Hawaiian Islands. At least 37 species of precious corals in the order Gorgonacea have been identified from the Makapuu bed (Grigg and Bayer, 1976). In addition, 18 species of black coral (order Antipatharia) have been reported to occur in Hawaiian waters (Grigg and Opresko, 1977; Oishi, 1990; Wagner, 2011.), but only 3 of these species have been subject to commercial harvest (Oishi, 1990; Wagner *et al.,* 2015).

1.3 Biology and Life History

The management and conservation of deep-sea coral communities is challenged by their commercial harvest for the jewelry trade and damage caused by deep-water fishing practices. In light of their unusual longevity, a better understanding of deep-sea coral ecology and their interrelationships with associated benthic communities is needed to inform coherent international conservation strategies for these important deep-sea habitat-forming species (Bruckner, 2013).

Most of the interior of the global ocean remains unobserved. This leaves questions of trophic connectivity, longevity, and population dynamics of many deep-sea communities unanswered. Deep-sea megafauna provide a complex, rich, and varied habitat that promotes high biodiversity and provides congregation points for juvenile and adult fish (Freiwald *et al.*, 2004; Husebo *et al.*, 2002; Smith *et al.*, 2008).

Precious corals may be divided primarily into two groups of species based on their depth ranges: the deepwater species (200-600m) and the shallow water species (20-120m). Other precious corals can be found in depths down to 2000 m, but these species are not exploited in the U.S. for commercial purposes. Deep-sea corals are found on hard substrates on seamounts and continental margins worldwide at depths of 300 to 3,000 m.

Deep Corals

The Pacific Islands deepwater precious coral species include pink coral, *Pleurocorallium secundum* (prev. *Corallium secundum*), red coral, *Hemicorallium laauense* (prev. *C. regale or C. laauense*), gold coral, *Kulamanamana haumeaae (*prev. *Gerardia sp*.) and bamboo coral, *Lepidistis olapa*. As previously discussed, the most valuable precious corals are gorgonian octocorals (Grigg, 1984). There are seven varieties of pink and red precious corals in the western Pacific region, six of which used to be recognized as distinct species of *Corallium* (Grigg, 1981), but have been reclassified (Parrish *et al.*, 2015). The two species of commercial importance in the EEZ around the Hawaiian Islands are the pink coral *Pleurocorallium secundum* (prev. *Corallium secundum*), and the red coral, *Hemicorallium laauense* (prev. *C. laauense*). The Gorgonian octocorals are by far the most abundant and diverse corals in the Hawaiian Archipelago. Two species, *Pleurocorallium secundum* and *Hemicorallium laauense* are known to occur at depths of 300-600 m on islands and seamounts throughout the Hawaiian Archipelago (Grigg 1974, 1993; Parrish *et al.*, 2015; Parrish and Baco, 2007). Parrish (2007) surveyed *Pleurocorallium secundum* and *Hemicorallium laauense* at 6 precious coral beds in the lower Hawaiian chain, from Brooks Bank to Keahole Point, Hawaii, in depths ranging from 350m to 500m. He found corals on summits, flanks, and shallow banks, with bottom substrate and relief at these sites ranging from a homogenous continuum of one type to a combination of many types at a single site. The survey results show that all three coral taxa colonize both carbonate and basalt/manganese substrates, and the corals favor areas where bottom relief enhances or modifies flow characteristics that may improve the colony's feeding success.

These corals can grow to more than 30 cm in height, and are often found in large beds with other octocorals, zoanthids, and sometimes scleractinians (Parrish *et al.*, 2015; Parrish and Baco, 2007). These species are relatively long lived, with some of the oldest colonies observed within Makapuu Bed about 0.7 m in height and at least 80 years old (Grigg, 1988b, Roark, 2006). Populations of *P. secundum* appear to be recruitment limited, although in favorable environments (e.g., Makapuu Bed) populations are relatively stable, suggesting that recruitment and mortality are in a steady state (Grigg, 1993). A study by Roark *et al.* (2006) showed that the radial growth rate for specimens of *P. secundum* in the Hawaiian Islands is ~170 μm yr^{-1} and average age is 67 to 71 years, o;der than previously calculated. Individual colonies have been measured as tall as 28 cm. Bruckner (2009) suggested that the minimum allowable size for genus Corallium for harvest should be increased, and supported a potential listing for Corallium within the Appendices of the Convention on International Trade in Endangered Species (CITES). The current size restriction in the 2010 Code of Federal Regulations for Pacific Islands Region is 10 in (25.4 cm).

In Cairn's reviews (2008; 2009; 2010), he summarized the research conducted on Hawaiian Octocorallia taxa, including three gold coral PCMUS genuses, *Narella*, *Calyptrophora* and *Callogorgia*. Octocorallia are distributed over all ocean basins, found in depths ranging from shallow (~ 50m) to deep (~ 4,600) in Alaska. All gold PCMUS in Hawaii were collected in deep water (> 270m), throughout the Hawaiian archipelago and adjacent seamounts. Although these octocorals are managed as PCMUS, the only commercially exploited gold coral is the zoantharian, *Kulamanamana haumeaae* (prev. *Gerardia* sp.). It is probably the most common and largest of the zoanthids in Hawaii, and is widely distributed throughout the Hawaiian Archipelago and into the Emperor Seamount Chain at depths of 350–600 meters (Parrish *et al.*, 2015; Parrish and Baco, 2007). While subject to commercial exploitation from the 1970's until 2001 with an interruption between 1979 and 1999 (Grigg, 2001), the gold coral is not currently exploited in Hawaii due to a moratorium on the fishery. The Hawaiian gold coral is one of the largest and numerically dominant benthic macro-invertebrates in its depth range on hard substrate habitats of the Hawaiian Archipelago, and plays an important ecological role in Hawaiian seamount benthic assemblage (Parrish, 2006; Parrish and Baco, 2007; Parrish, *et al.*, 2015). The Hawaiian gold coral has also been found to be one of the longest-lived species on earth. Earlier ageing attempts on the gold coral focused on ring counts (Grigg, 1974; Grigg, 2002) and led to a maximal estimated age of 70 years and a radial growth rate (increase in branch diameter) of 1 mm/year. Recent studies using radiometric data suggest colonies of Hawaiian gold coral are as old as 2740 year with a radial growth rate of only 15 to 45 µm/year (Roark *et al.*, 2006; Roark *et.al.*, 2009; Parrish and Roark, 2009).

Parrish (2015) has found the host of the parasitic *Kulamanamana haumeaae* to be primarily the bamboo corals (e.g. Acanella, Keratoisis). *K. haumeaae* secretes a protein skeleton that over millennia can grow and more than double the original mean size of the host colony. It is relatively common and even dominant at geologically older sample sites, but recruitment is probably infrequent (Parrish, 2015). Although it can be relatively common compared to some other deep corals, it grows very slowly. Parrish and Roark (2009) determined that the Hawaiian gold coral *Kulamanamana haumeaae* has a mean life span of 950 yrs with an overall radial growth of ~41 µm yr^{-1}, and a gross radiocarbon linear growth rate of 2.2 ± 0.2 mm yr^{-1}. This is a much slower growth rate and longer life span than given in previous studies. Grigg (2002) reported a 1 mm yr^{-1} radial growth rate, equivalent to a 6.6 cm yr^{-1} linear growth for a maximum life span of roughly 70 yrs. This means these corals are growing much slower than previously thought, and have much longer life spans if undisturbed. Newly applied radiocarbon age dates from the deep water proteinaceous corals *Gerardia* and *Leiopathes* show that radial growth rates are as low as 4 to 35 micometers per year and that individual colony longevities are on the order of thousands of years (Roark *et al.*, 2009, 2006). The longest-lived *Gerardia* sp. and *Leiopathes* specimens were estimated to be 2,742 years old and 4,265 years old, respectively. *Gerardia* sp. is a colonial zoanthid with a hard skeleton of hard proteinaceous matter that forms tree-like structures with heights of several meters and basal diameters up to 10s of a centimeter. Black corals of *Leiopathes sp*. also has a hard proteinaceous skeleton and grows to heights in excess of 2 m. In Hawai'ian waters, these corals are found at depths of 300 to 500 m on hard substrates, such as seamounts and ledges.

The two bamboo coral PCMUS in the Pacific Islands Region are classified under two genera, Acanella and Lepidisis. Not much work has been done specifically on these genera, but Parrish (2015) identified branched bamboo colonies such as Acanella as a preferred host for *Kulamanamana haumeaae*. Because of the long colony life span of >3000 yrs and the bony hard bodied calcareous internodes of bamboo corals (family Isididae), geochemists are interested in using them to analyze paleo-oceanographic events and long-term climate change (Hill *et al*. 2011), while biologists use them to size and age deep-sea coral populations. Recent studies show that the subfamily Keratoisidinae (family Isididae) consists of four genera (*Acanella*, *Isidella*, *Lepidisis*, and *Keratoisis*), with two genera (*Tenuisis* and *Australisis*) perhaps belonging elsewhere in the Isididae family (Etnoyer 2008; France 2007). Bamboo corals commonly colonize intermediate to deep water depths (400m to >3000m) of continental slopes and seamounts in the Pacific Ocean.

Shallow Corals

The second group of precious coral species is found in shallow water between 20 and 120 m (Grigg, 1993 and Drysdale, *unpublished data*, 2012; Wagner *et al.*, 2015). The shallow water fishery is comprised of three species of black coral, *Antipathes griggi*, *A. grandis* and *Myriopathes ulex*, which have historically been harvested in Hawaii (Oishi 1990), but over 90% of the coral harvested by the fishery consists of *A. griggi* (Oishi 1990; Parrish *et al.*, 2015; Wagner *et al.*, 2015). Other black coral species are found in the NWHI in a wider depth range (20m to 1,400m), but with lower colony density (Wagner *et al*., 2011). Surveys performed in depths of 40-110 meters in the Au‘au Channel in 1975 and 1998, suggested stability in both recruitment and growth of commercially valuable black coral populations, and thus indicated that the fishery had been sustainable over this time period (Grigg, 2001). Subsequent surveys performed in the channel in 2001 indicated a substantial decline in the abundance of black coral colonies, with likely causes including increases in harvesting pressure and overgrowth of black coral colonies by the invasive octocoral *Carijoa sp.* and the red alga, *Acanthophora spicifera*, especially on reproductively mature colonies at mesophotic depths (Grigg 2003; Grigg 2004; Kahng & Grigg 2005; Kahng, 2006). Together, these factors renewed scrutiny on the black coral fishery and raised questions about whether regulations need to be redefined in order to maintain a sustainable harvest (Grigg, 2004). In addition to these challenges, Wagner has suggested that taxonomic misidentification has led to the mistaken belief that there is a depth refuge that exists for certain harvested species (Wagner *et al.,* 2012; Wagner, 2011). All of these uncertainties and lack of basic life history information regarding black corals complicates effective management of the resource (Grigg, 2004).

In Hawaii, *A. griggi* accounts for around 90% of the commercial harvest of black coral (Oishi 1990). *A. grandis* accounts for 9% and *M. ulex* 1% of the total black corals harvested. In Hawaii, roughly 85% of all black coral harvested are taken from within state waters. Black corals are managed jointly by the State of Hawaii and the Council. Within state waters (0–3 nmi), black corals are managed by the State of Hawaii (Grigg, 1993).

A new name for the Hawaiian species of antipatharian coral previously identified as *Antipathes dichotoma* (Grigg and Opresko, 1977) is described as *Antipathes griggi* Opresko, n. sp. (Opresko, 2009). The shallow water black coral *A. dichotoma* (*A. griggi)* collected at 50m exhibited growth rates of 6.42 cm yr^{-1} over a 3.5 yrs study.

1.4 Growth and Reproduction

There is very limited published literature regarding coral spawning of the PCMUS in the Pacific Islands Region. However, studies by Gleason, *et al*. (2006) and Waller and Baco (2007) indicate that the gold coral *Kulamanamana haumaae* may have seasonal reproduction, and that two pink coral species have a periodic or quasi-continuous reproductive periodicity. Although limited studies about growth rates and life spans of adult PCMUS in the Pacific Islands Region are available, early life history data on larvae, polyps, and juvenile colonies of the PCMUS are unavailable. Many other questions related to genetic connectivity and spatial distribution across the Pacific also remain unanswered. Recent mesophotic coral reef ecosystem studies provide an outline of essential knowledge for the limited deep water coral ecosystem (Kahng, *et al*. 2010). Slow-growing deep-water coral ecosystems are sensitive to many disturbances, such as temperature change, invasive species and destructive fishing techniques.

While different species of precious corals inhabit distinct depth zones, their habitat requirements are strikingly similar. Grigg (1984) noted that these corals are non-reef building and inhabit depth zones below the euphotic zone. In an earlier study, Grigg (1974) determined that precious corals are found in deep water on solid substrate in areas that are swept relatively clean by moderate to strong bottom currents (>25 cm/sec). Strong currents help prevent the accumulation of sediments, which would smother young coral colonies and prevent settlement of new larvae. Grigg (1984) notes that, in Hawaii, large stands of *Corralium* are only found in areas where

Table 3: Depth zonation of precious corals in the Western Pacific. (Source: Grigg 1993, Baco-Taylor, 2007, HURL and Drysdale, 2012)

Species and Common Name	Depth Range (m)
Paracorallium secundum Angle skin coral	250–575
Hemicorallium laauense Red coral	250–575
Corallium sp nov. Midway deepsea coral	1,000–1,500
Kulamanamana haumeaae (prev. *Gerardia* sp.) Hawaiian gold coral	350–575
Lepidisis olapa, *Acanella* spp. bamboo coral	250–1800
Antipathes griggi (prev. *A. dichotoma*), black coral	20–120
Antipathes grandis, pine black coral	20–120
Cirrhipathes cf. *anguina* (prev. *Antipathes anguina*), wire black coral	20–120
Myriopathes ulex (prev. *Antipathes ulex*),	20–220

Species and Common Name	Depth Range (m)
fern black coral	

sediments almost never accumulate, and *P. secundum* appears in large numbers in areas of high flow over carbonate pavement (Parrish *et al.,* 2015; Parrish and Baco, 2007). *Hemicorallium laauense* grows in an intermediate relief of outcrops; and *Kulamanamana haumaae* is most commonly seen growing in high relief areas on pinnacles, walls, and cliffs. These habitat differences may reflect preferred flow regimes for the different corals (e.g., laminar flow for *P. secundum*, alternating flow for *Kulamanamana haumaae*) (Parrish *et al.*, 2015).

Surveys of all potential sites for precious corals in the MHI conducted using a manned submersible show that most shelf areas in the MHI near 400 m are periodically covered with a thin layer of silt and sand (Grigg, 1984). Precious corals are known to grow on a variety of bottom substrate types. Precious coral yields, however, tend to be higher in areas of shell sandstone, limestone and basaltic or metamorphic rock with a limestone veneer. Grigg (1988) concludes that the concurrence of oceanographic features (strong currents, hard substrate, low sediments) necessary to create suitable precious coral habitat are rare in the MHI. Depth clearly influences the distribution of different coral taxa and certainly there is patchiness associated with the presence of premium substrate and environmental conditions (flow, particulate load, etc.). The environmental suitability for colonization and growth is likely to differ among coral taxa.

The habitat sustaining precious corals is generally in pristine condition. There are no known areas that have sustained damage due to resource exploitation, notwithstanding the alleged heavy foreign fishing for corals in the Hancock Seamounts area. Although unlikely, if future development projects are planned in the proximity of precious coral beds, care should be taken to prevent damage to the beds. Projects of particular concern would be those that suspend sediments or modify water-movement patterns, such as deep-sea mining or energy-related operations.

There has been very little research conducted concerning the food habits of precious corals. Precious corals are filter feeders (Grigg, 1984; 1993). The sparse research available suggests that particulate organic matter and microzooplankton are important in the diets of pink and bamboo coral (Grigg, 1970). Many species of pink coral, gold coral (*Kulamanamana haumeaae (*prev. *Gerardia* sp.*)* and black coral (*Antipathes*) form fan shaped colonies (Grigg, 1984; 1993). This type of morphological adaption maximizes the total area of water that is filtered by the polyps (Grigg, 1984; 1993). Bamboo coral (*Lepidisis olapa*), unlike other species of precious corals, is unbranched (Grigg, 1984). Long coils that trail in the prevailing currents maximize the total amount of seawater that is filtered by the polyps (Grigg, 1984). While clearly, the presence of strong currents is a vital factor determining habitat suitability for precious coral colonies, their role to date is not fully understood.

Light is one of the most important determining factors of the upper depth limit of many species of precious corals (Grigg, 1984).The larvae of two species of black coral, *Antipathes grandis* and *A. griggi*, are negatively phototaxic**.**

Grigg (1984) states that temperature does not appear to be a significant factor in delimiting suitable habitat for precious corals. In the Pacific Ocean, species of *Corallium* are found in temperature ranges of 8° to 20°C, he observes. Temperature may determine the lower depth limits of some species of precious coral, including two species of black corals in the MHI. In the MHI, the lower depth range of two species of black corals (*A.griggi* and *A. grandis*) coincides with the top of the thermocline (about 100 m). Although, *A. griggi* can be found to depths of 100 m, it is rare below the 75 m depth limit at which commercial harvest occurs in Hawai‘i. Thus, the supposed depth refuge from harvest does not really exist, and was probably based on taxonomic misidentification, thereby calling into question population models used for the management of the Hawaiian black coral fishery (Wagner *et al.*, 2012; Wagner, 2011).

In pink coral (*P. secundum*), the sexes are separate (Grigg, 1993). Based on the best available data, it is believed that *P. secundum* becomes sexually mature at a height of approximately 12 cm (13 years) (Grigg, 1976). Pink coral reproduce annually, with spawning occurring during the summer, during the months of June and July. Coral polyps produce eggs and sperm. Fertilization of the oocytes is completed externally in the water column (Grigg, 1976; 1993). The resulting larvae, called planulae, drift with the prevailing currents until finding a suitable site for settlement.

Pink, bamboo and gold corals all have planktonic larval stages and sessile adult stages. Larvae settle on solid substrate where they form colonial branching colonies. Grigg (1993) notes that the lengths of the larval stage of all deepwater species of precious corals is unknown. Clean swept areas exposed to strong currents provide important sites for settlement of the larvae, Grigg adds. The larvae of several species of black coral (*Antipathes*) are negatively photoactic, he notes. They are most abundant in dimly lit areas, such as beneath overhangs in waters deeper than 30 m. In an earlier study, Grigg (1976) found that “within their depth ranges, both species are highly aggregated and are most frequently found under vertical dropoffs. Such features are commonly associated with terraces and undercut notches relict of ancient sea level still stands. Such features are common off Kauai and Maui in the MHI. Both species are particularly abundant off of Maui and Kauai, suggesting that their abundance is related to suitable habitat.” Off of Oahu, many submarine terraces that otherwise would be suitable habitat for black corals are covered with sediments (Grigg, 1976).

A variety of invertebrates and fish are known to utilize the same habitat as precious corals. These species of fish include onaga (*Etelis coruscans*), kahala (*Seriola dumerallii*) and the shrimp (*Heterocarpus ensifer*). These species do not seem to depend on the coral for shelter or food.

Densities of pink, gold and bamboo coral have been estimated for an unexploited section of the Makapuu bed (Grigg, 1976). As noted in the FMP for precious corals, the average density of pink coral in the Makapuu bed is 0.022 colonies/m^2. This figure was extrapolated to the entire bed (3.6 million m^2), giving an estimated standing crop of 79,200 colonies. At the 95% confidence limit, the standing crop is 47,500 to 111,700 colonies. The standing crop of colonies was converted to biomass ($3N_iW_i$), resulting in an estimate of 43,500 kg of pink coral in the Makapuu bed. These estimates need to be revised with more rigorous statistical enumeration methodologies.

In addition to coral densities, Grigg (1976) determined the age-frequency distribution of pink coral colonies in Makapuu bed. He applied annual growth rates to the size frequency to calculate the age structure of pink coral at Makapuu Bed (Table 4). More recent work by Roark *et al.* (2006) suggests that annual growth ring dating may underestimate the ages of many species of deep water corals, and that most of the colonies that have been dated using the ring method are probably older and slower growing than first estimated.

Estimates of density were also made for bamboo (*Lepidisis olapa*) and gold coral (*Kulamanamana haumeaae (*prev. *Gerardia* sp.*)* for Makapuu bed. The distributions of both these species are patchy. As noted in the FMP, the area where they occur comprises only half of that occupied by pink coral (1.8 km^2). Estimates of the unexploited abundance of bamboo and gold coral were 18,000 and 5,400 colonies, respectively. Estimates of density for the unexploited bamboo coral and gold coral in the Makapuu bed are 0.01 colonies/m^2 and 0.003 colonies/m^2. Using a rough estimate for the mean weights of gold and bamboo coral colonies (2.2 kg and 0.6 kg), a standing crop of about 11,880 kg of gold coral and 10,800 kg for bamboo for Makapuu bed was obtained. These estimates need to be revised with more rigorous statistical enumeration methodologies.

Growth rates for several species of precious corals found in the western Pacific region have been calculated. Grigg (1976) determines that the height of pink coral (*P. secundum*) colonies increases about 0.9 cm/yr up to about 30 years of age. These growth rates are probably overestimated, and should be revisited using modern methodologies. As noted in the FMP for precious corals, the height of the largest colonies of *Pleurocorallium secundum* at Makapuu bed rarely exceed 60 cm. Colonies of gold coral are known to grow up to 250 cm tall while bamboo corals may reach 300 cm. The natural mortality rate of pink coral at Makapuu bed is believed to be 0.066, equivalent to an annual survival rate of about 93%.

Table 4: Age-Frequency Distribution of *Pleurocorallium secundum* (Source: Grigg, 1973)

Age Group (years)	Number of Colonies
0–10	44
10–20	73
0–30	22
30–40	12
40–50	7
50–60	0

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Attachment 3: Species list table for the Hawaii FEP

1. MHI Deep 7 Bottomfish Multi-species Stock Complex (FSSI)

HDAR Species Code	**Species Name**	**Scientific Name**
19	Opakapaka	*Pristipomoides filamentosus*
22	Onaga	*Etelis coruscans*
21/36	Ehu	*Etelis carbunculus*
15	Hapuupuu	*Epinephelus quernus*
97	Gindai	*Pristipomoides zonatus*
17	Kalekale	*Pristipomoides seiboldii*
58	Lehi	*Aphareus rutilans*

2. MHI Non-Deep 7 Bottomfish Multi-species Stock Complex (non-FSSI)

HDAR Species Code	**Species Name**	**Scientific Name**
208	yellowtail snapper (kalekale)	*Pristipomoides auricilla*
20	gray jobfish (uku)	*Aprion virescens*
205	giant trevally (white ulua)	*Caranx ignoblis*
202	black trevally (black ulua)	*Caranx lugubris*
114	taape	*Lutjanis kasmira*
16	greater amberjack (kahala)	*Seriola dumerili*
200	pig lipped trevally (butaguchi)	*Pseudocaranx dentex*

NOTE: Taape (*Lutjanis kasmira*) is listed in the Hawaii CREMUS group, Lutjanidae (Snapper)

Kahala (*Seriola rivoliana*) is listed in the Hawaii CREMUS group, Carangidae (Jacks)

MHI Deep 7 bottomfish not inlcuded in the 2012 ACL tracking exercise

Seamount groundfish not included in the 2012 ACL tracking exercise

3. Crustacean deep-water shrimp complex (non-FSSI)

HDAR Species Code	Species Name	Scientific Name
708	deepwater shrimp	*Heterocarpus* spp.
709	deepwater shrimp (ensifer)	*Heterocarpus* spp.

4. Crustacean spiny lobster complex (non-FSSI)

HDAR Species Code	Species Name	Scientific Name
716	spiny lobster	*Panulirus marginatus*
717	spiny lobster	*Panulirus penicillatus*

5. Crustacean slipper lobster complex (non-FSSI)

HDAR Species Code	Species Name	Scientific Name
718	Slipper lobster	Scyllaridae

6. Crustacean Kona crab complex (non-FSSI)

HDAR Species Code	Species Name	Scientific Name
701	Kona crab	*Ranina ranina*

7. Auau Channel Black coral complex (non-FSSI)

HDAR Species Code	Species Name	Scientific Name
860	Black Coral	*Antipathes griggi*
860	Black Coral	*Antipathes dichotoma*
860	Black Coral	*Antipathes grandis*
860	Black Coral	*Antipathes ulex*

8. Precious corals on identified beds and exploratory beds (non-FSSI)

HDAR Species Code	Species Name	Scientific Name
871	Pink coral	*Corallium secundum*
872	Pink coral	*Corallium regale*
873	Pink coral	*Corallium laauense*
891	Bamboo coral	*Lepidisis olapa*
892	Bamboo coral	*Acanella* spp.
880/881	Gold Coral	*Gerardia* spp.
882	Gold Coral	*Callogorgia gilberti*
883	Gold Coral	*Narella* spp.

884	Gold Coral	*Calyptrophora* spp.

9. Coral reef ecosystem (non-FSSI)

HDAR Species Code	Species Name	Scientific Name	Grouping
28	Bigeye Scad (Adult)	*Selar crumenophthalmus*	Akule
37	Bigeye Scad (Juvenile)	*Selar crumenophthalmus*	Akule
81	OPELU	*Decapterus* spp.	Opelu
16	BARRED JACK	*Carangoides ferdau*	Carangidae
18	DOBE	*Caranx (Urapsis) helvolus*	Carangidae
23	KAGAMI	*Alectis ciliaris*	Carangidae
48	KAHALA	*Seriola rivoliana*	Carangidae
56	KAMANU	*Elagatis bipinnulata*	Carangidae
79	LAE	*Scomberoides lysan,*	Carangidae
79	LAE	*Scomberoides sancti-petri*	Carangidae
89	NO-BITE	*Caranx equula*	Carangidae
104	OMAKA	*Atule mata*	Carangidae
112	OMILU	*Caranx melampygus*	Carangidae
203	PAOPAO	*Gnathanodon speciosus*	Carangidae
204	PAPA	*Carangoides orthogramus*	Carangidae
220	PAPIO, ULUA (MISC.)	*Carangidae*	Carangidae
221	SASA	*Caranx sexafaciatus*	Carangidae
52	KUMU	*Parupeneus porphyeus*	Mullidae
110	MALU	*Parupeneus pleurostigma*	Mullidae

68	MOANA	*Parupeneus spp.*	Mullidae
206	MOANO KALE	*Parupeneus cyclostomus*	Mullidae
70	MOELUA; GOAT FISH (RED)	*Mulloidichthys sp.*	Mullidae
121	MUNU	*Parupeneus bifasciatus*	Mullidae
103	WEKE (MISC.)	*Mullidae*	Mullidae
128	WEKE A'A	*Mulloidichthys flavolineatus*	Mullidae
24	WEKE NONO	*Mulloidichthys pflugeri*	Mullidae
122	WEKE PUEO	*Upeneus arge*	Mullidae
127	WEKE-ULA	*Mulloidichthys vanicolensis*	Mullidae
47	KALA	*Naso annulatus*	Acanthuridae
47	KALA	*Naso brevirostris*	Acanthuridae
47	KALA	*Naso Unicornus*	Acanthuridae
125	KALALEI	*Naso lituratus*	Acanthuridae
51	KOLE	*Ctenochaetus strigosus*	Acanthuridae
59	MAIII	*Acanthurus nigrofuscus*	Acanthuridae
60	MAIKO	*Acanthurus nigroris*	Acanthuridae
61	MAIKOIKO	*Acanthurus leucopareius*	Acanthuridae
64	MANINI	*Acanthurus triostegus*	Acanthuridae
72	NAENAE	*Acanthurus olivaceus*	Acanthuridae
124	OPELU KALA	*Naso hexacanthus*	Acanthuridae
85	PAKUIKUI	*Acanthurus achilles*	Acanthuridae
86	PALANI	*Acanthurus dussumieri*	Acanthuridae
92	PUALU	*Acanthurus blochii,*	Acanthuridae

92	PUALU	*A. xanthopterus*	Acanthuridae
83	YELLOW TANG	*Zebrasoma flavescens*	Acanthuridae
126	API	*Acanturus guttus*	Acanthuridae
129	BLACK KOLE	*Ctenochaetus hawaiiensis*	Acanthuridae
209	GOLDEN KALI	*Erythrocles schegelii*	Lutjanidae
123	GURUTSU, GOROTSUKI	*Aphareus furca*	Lutjanidae
207	RANDALL'S SNAPPER	*Randallichthys filamentosus*	Lutjanidae
	TAAPE	*Lutjanus kasmira*	Lutjanidae
115	TOAU	*Lutjanus fulvus*	Lutjanidae
38	WAHANUI	*Aphareus furcatus*	Lutjanidae
29	ALAIHI	Squirrelfish	Holocentridae
101	ALAIHI MAMA	Squirrelfish	Holocentridae
100	MENPACHI	Squirrelfish	Holocentridae
90	PAUU	Squirrelfish	Holocentridae
30	AMAAMA	*Mugil cephalus*	Mugilidae
32	SUMMER MULLET	*Mugil sp.*	Mugilidae
726	HE'E (DAY TAKO)	*Octopus cyanea*	Mollusk
727	HE'E PU LOA	*Octopus ornatus*	Mollusk
720	OLEPE	*Albula glossodonta*	Mollusk
721	OCTOPUS	*Octopus* spp.	Mollusk
87	PANUHUNUHU	*Scarus* spp.	Scaridae
88	PANUNU	*Scarus* spp.	Scaridae
96	UHU (MISC.)	*Catalomus* spp.	Scaridae
710	A'AMA	*Graspus tenuicrustatus*	CRE-crustaceans

711	BLUE PINCHER CRAB	*Callinectes sapidus*	CRE-crustaceans
700	CRAB (MISC.)	n/a	CRE-crustaceans
703	HAWAIIAN CRAB	*Podophthalmus vigil*	CRE-crustaceans
702	KUAHONU CRAB	*Portunus sanguinolentus*	CRE-crustaceans
713	METABETAEUS LOHENA	*Metabetaeus lohena*	CRE-crustaceans
705	MISC. SHRIMP/PRAWN	n/a	CRE-crustaceans
712	OPAE ULA	*Halocaridina rubra*	CRE-crustaceans
704	SAMOAN CRAB	*Scylla serrata*	CRE-crustaceans
65	SHARK (MISC.) MANO, SPINY DOGFISH, GREY REEF	Carcharhinidae	Carcharhinidae
66	HAMMERHEAD SHARK	Spheyrnidae	Carcharhinidae
753	HA'UKE'UKE	*Colobocentrotus atratus*	Other Invertebrates
754	HAWAE	*Tripneustes gratilla*	Other Invertebrates
751	WANA	*Diadema* sp.	Other Invertebrates
751	WANA	*Echinothrix* sp.	Other Invertebrates
752	NAMAKO	Holothuroidea	Other Invertebrates
755	SLATE PENCIL URCHINS	*Heterocentrotus mammillatus*	Other Invertebrates
27	AHOLEHOLE	*Kuhlia sandvicensis*	Other CRE Finfish
31	AWA	*Chanos chanos*	Other CRE Finfish
33	AWAAWA	*Elops hawaiensis*	Other CRE Finfish
34	AWEOWEO	*Heteropriacanthus cruentatus*	Other CRE Finfish
133	GOLD SPOT HERRING	*Herklotsichthys quadrimaculatus*	Other CRE Finfish
39	HAULIULI	*Gempylus serpens*	Other CRE Finfish

300	HOGO	*Pontinus macrocephalus*	Other CRE Finfish
43	HUMUHUMU	Balistidae	Other CRE Finfish
44	IAO	*Pranesus insularum*	Other CRE Finfish
45	IHEIHE	Hemiramphidae	Other CRE Finfish
46	KAKU	*Sphyraena barracuda*	Other CRE Finfish
49	KAWALEA	*Sphyraena helleri*	Other CRE Finfish
53	KUPIPI	*Abudefduf sordidus*	Other CRE Finfish
57	LAUWILIWILI	*Chaetodon auriga*	Other CRE Finfish
77	LOULU	Monacanthidae	Other CRE Finfish
67	MAKAIWA	*Etrumeus micropus*	Other CRE Finfish
62	MALOLO	Exocoetidae	Other CRE Finfish
63	MA'O MA'O	*Abudefduf abdominalis*	Other CRE Finfish
69	MOI	*Polydactylus sexfilis*	Other CRE Finfish
109	MOLA MOLA	Mola mola	Other CRE Finfish
73	NEHU	*Stolephorus purpureus*	Other CRE Finfish
75	NOHU	*Scorpaenopsis* spp.	Other CRE Finfish
76	NUNU	*Aulostomus chinensis*	Other CRE Finfish
78	OIO	*Gracilaria parvispora*	Other CRE Finfish
80	OOPU HUE	*Diodon* spp.	Other CRE Finfish
84	PAKII	*Bothus* spp.	Other CRE Finfish
91	PIHA	*Spratelloides delicatulus*	Other CRE Finfish
119	POO PAA	*Cirrhitus* spp.	Other CRE Finfish
93	PUHI (MISC.)	*Gymnothorax* spp.	Other CRE Finfish
95	PUHI (WHITE)	Muraenidae	Other CRE Finfish

725	PUPU	Congridae spp.	Other CRE Finfish
111	SABA	*Scomber japonicus*	Other CRE Finfish
113	TILAPIA	*Tilapia* sp.	Other CRE Finfish
99	UPAPALU	*Apogon kallopterus*	Other CRE Finfish
800	LIMU (MISC.)	*Gracilaria* spp.	Algae
801	LIMU KOHU	*Asparagopsis taxiformis*	Algae
802	MANAUEA	*Gracilaria coronopifolia*	Algae
803	OGO	*Aulostromus chinensis*	Algae
804	WAWAEIOLE	*Ulva fasciata*	Algae
74	NENUE	*Kyphosus bigibbus,*	Rudderfish
74	NENUE	*Kyphosus cinerescens*	Wrasse
25	A'AWA	*Bodianus bilunulatus*	Wrasse
35	WRASSE (MISC.)	Labridae	Wrasse
41	HILU	*Coris flavovittata*	Wrasse
42	HINALEA	*Thalassoma* spp.	Wrasse
54	KUPOUPOU	*Cheilio inermis*	Wrasse
55	LAENIHI	*Xyichthys pavo*	Wrasse
82	OPULE	*Anampses cuvier*	Wrasse
105	MALLATEA	Labridae	Wrasse
120	POOU	*Cheilinus unifasciatus*	Wrasse
	MU	*Monotaxis grandoculis*	Emperor
	ROI	*Cephalopholus arugs*	Grouper