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for Marine and
Atmospheric Research
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Annual Report for Fiscal Year 2020

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Front cover: JIMAR scientific divers using Structure-from-Motion technology to image the three-dimensional structure of the coral reef. (Photo credit: Ray Boland)

Wave image on pages 1, 3, 35, 43, 61, 71, 81, 87, 91, and 101 courtesy of freePNGimg.com.

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Introduction—Fundamentals of the Cooperative Institute

The Joint Institute for Marine and Atmospheric Research (JIMAR) manages the Cooperative Institute for the Pacific Islands Region (CIPIR), one of 15 NOAA cooperative institutes between NOAA facilities and academic research and training institutions nationwide. JIMAR’s mission is to support research that is necessary for understanding and predicting environmental change in the Pacific Islands Region, for conserving and managing coastal and marine resources in island environments, notably the Hawaiian Islands and the U.S.-affiliated Pacific Islands, and for supporting the region’s economic, social, and environmental needs. Included in this report are projects under award number NA16NMF4320058. JIMAR seeks to:

- facilitate innovative collaborative research between scientists at NOAA and the University of Hawaii;
- provide educational opportunities for basic and applied research in the Life and Earth Sciences at the undergraduate, graduate, and post-doctoral levels;
- advance interactions through the support of visiting scientists and post-doctoral scholars; and,
- promote the transition of research outcomes to operational products and services that benefit the Pacific Islands Region.



*Douglas S. Luther, PhD,
Director*

JIMAR is located at the University of Hawaii (UH), a research-intensive land-grant and Sea Grant institution that maintains a service mission to the State as well as to the Pacific Islands Region. JIMAR is a unit within the School of Ocean and Earth Science and Technology (SOEST), which has developed several centers of excellence in marine, atmospheric, and earth sciences that align well with the mission interests of NOAA. The University also provides capacity for social science research via several academic units. Adjacent to the UH campus is the independent, publicly funded East-West Center, which provides policy analysis and applied science across the Pacific Rim. JIMAR serves as a bridge to facilitate engagements between NOAA in the Pacific Region and these academic research units.



*Jeffrey Hare, PhD, Deputy
Director for PIFSC Projects*

The principal NOAA Line Office for JIMAR is the National Marine Fisheries Service (NMFS), and JIMAR staff are integrated closely with its Pacific Islands Fisheries Science Center (PIFSC) at the Daniel K. Inouye Regional Center (IRC) at Ford Island, Pearl Harbor, Oahu Island. The ~100 JIMAR scientists within PIFSC are oceanographers, marine biologists, zoologists, geographers, coastal and environmental scientists, economists, fisheries scientists, sociologists, computer scientists, and engineers. The work with PIFSC is undertaken across 22 JIMAR projects encompassing coral reef monitoring and research, marine mammal and turtle research, human dimensions investigations and economics of fisheries, fisheries bycatch mitigation research, oceanic and reef ecosystems modeling, insular and pelagic fisheries stock assessment research, fisheries database management, and more.

JIMAR-supported scientists also interact with the NOAA National Weather Service (NWS), National Environmental Satellite, Data, and Information Service (NESDIS), and Office of Oceanic and Atmospheric Research (OAR) Line Offices, which support a number of projects in the research themes of equatorial oceanography, climate research and impacts, tropical meteorology, and tsunamis and other long-period ocean waves. Significant JIMAR supported programs active in these areas include the University of Hawaii Sea Level Center (UHSLC), the Pacific El Niño Southern Oscillation (ENSO) Applications Climate (PEAC) Services, and a partnership with the Pacific Islands Ocean Observing System (PacIOOS).

Research Highlights

JIMAR research covers eight themes, all aligned with the NOAA strategic plan and the University’s Indo-Pacific mission. The themes are as follows: (1) ecosystem forecasting; (2) ecosystem monitoring; (3) ecosystem-based management; (4) protection and restoration of resources; (5) equatorial oceanography; (6) climate research and impacts; (7) tropical meteorology; and (8) tsunamis and other long-period waves.

JIMAR's collaboration with the NOAA PIFSC drives the primary research and educational activities within the Institute. Here are some highlights that demonstrate the scope of JIMAR/PIFSC research in the theme areas of ecosystem-based management, ecosystem monitoring and forecasting, and the protection and restoration of resources.

- *Atsuko Fukunaga, 3-D architecture of coral reefs.*

Quantifying the three-dimensional architecture of coral reefs is important since it affects the abundance and diversity of reef organisms. Three-dimensional models of coral reefs were used to investigate how different coral morphologies would contribute to the structural complexity of coral reefs and to identify specific habitat metrics that could capture changes in the abundances of corals with different morphologies (Fukunaga et al., 2020). Fractal dimension, which utilizes information on surface area obtained at various model resolutions and quantifies the irregularity of an object, and vector ruggedness measure (VRM) were correlated well with benthic cover, capturing the structural complexity of corals and crustose coralline algae. Depending on the model resolutions VRM captured different coral morphologies: branching forms for high-resolution reef models and mounding forms for low-resolution models. These results show that either fractal dimension or VRM measures obtained at different model resolutions can effectively capture the three-dimensional structural complexity provided by specific benthic organisms.



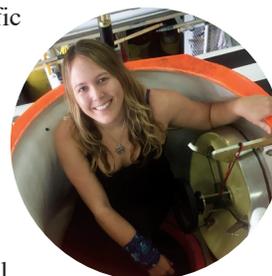
- *HingLing Chan, Exclusion zone impact on longline fisheries.*

On August 26, 2016, President Obama created the largest protected area on the planet by quadrupling the size of the Papahānaumokuākea Marine National Monument (PMNM) that was created in 2006, from 139,793 to 582,578 square miles of waters and submerged lands in the Northwestern Hawaiian Islands. Chan (2020) examined the economic impacts of the PMNM expansion on the Hawaii longline fishery using difference-in-differences models. They evaluated the impacts on catch per unit effort (CPUE) and fishing revenue for the group of vessels that had a high portion of their fishing effort inside the expanded area prior to the expansion. The results showed that the PMNM expansion caused the CPUE of this group of vessels to decrease by 7%. Revenue per trip decreased by 9%, \$3.5 million, during the first 16 months of post-expansion period. One likely reason for the negative impacts is that longline fishers who have been displaced from their traditional fishing grounds inside the PMNM are still in the process of becoming more efficient in finding areas with comparable productivity.



- *Meagan Putts, Deep-sea coral growth rates.*

A collaboration between researchers at the University of Hawai'i (UH) at Mānoa School of Ocean and Earth Science and Technology (SOEST), Hawai'i Pacific University (HPU), and the National Oceanic and Atmospheric Administration (NOAA) revealed for the first time growth rates of deep-sea coral communities and the pattern of colonization by various species (Putts et al., 2019). The scientific team used the UH Mānoa Hawai'i Undersea Research Laboratory's submersibles and NOAA's Deep Discoverer remotely operated vehicle to examine coral communities on submarine lava flows of various ages on the leeward flank of the island of Hawai'i. They observed that the deep-water coral community in Hawai'i appears to undergo a pattern of ecological succession over time scales of centuries to millennia. The pioneering taxa were the Coralliidae, pink coral, colonizing the lava flows first after they were deposited. With enough time, the deep-water coral community showed a shift toward supporting a more diverse array of tall, slower growing taxa: Isididae, bamboo coral, and Antipatharia, black coral. The last to colonize was Kulamanamana haumeaae, gold coral, which grows over mature bamboo corals and is the slowest growing taxa within the community. This work has important conservation and sustainability implications regarding deep-sea ecosystems that have never before been ecologically quantified, and provides insights about recovery rate of these ecosystems if disturbed by activities such as fishing and mining.



-
- *Marie Hill, Endangered Humpback Whale population.*

Humpback whales were known to occur in the Mariana Archipelago during winter months (December–April) from passive acoustic records, a sighting during a 2007 shipboard survey for whales and dolphins, and other anecdotal sightings; but it was not known whether these whales were just passing through on their way to the northern feeding grounds or using the area as a breeding ground. Research by the Pacific Islands Fisheries Science Center’s Cetacean Research Program (CRP) in 2015–2018 determined that the whales are using the shallow waters off Saipan, in the southern portion of the Archipelago, to mate and calve (Hill et al., 2020). By collaborating with international partners and using individual photo-identification and genetic data, the CRP was also able to determine that these whales are part of the endangered western North Pacific population, whose breeding range is unresolved. Knowledge of the breeding range of this endangered population is key to its conservation.



- *Bernardo Vargas-Angel, Catastrophic coral mortality.*

Widespread and catastrophic coral mortality was reported at Jarvis Island following the exceptionally strong 2015–2016 El Niño event. Hard coral cover declined from 17.8% in April 2015 (pre-bleaching) to 0.31% in May 2016 (post-bleaching), representing a catastrophic 98% decline. Reef building corals bleach when water temperatures are abnormally high. Between 2015 and 2016 corals at Jarvis experienced temperatures exceeding the bleaching threshold (28.7 °C) for 66 consecutive weeks. This resulted in widespread, mass coral bleaching as early as November 2015, followed by mass mortality across all coral taxa, depths, and island sectors. The bleaching event altered the entire coral reef ecosystem (Vargas-Angel, 2019). Coral cover had not recovered by 2018 and could be potentially delayed by fast-growing turf algae. As the frequency and intensity of these high-temperature events is projected to increase in coming years, it is essential to track how remote ecosystems normally undisturbed by human influence, such as Jarvis, respond to a climate change



Transitioning to Products and Services—Examples

A major focus for JIMAR researchers is to transition research outcomes to operational products and services and to build datasets that benefit the Pacific Islands Region, NOAA, and other partner operations across all oceans. Many JIMAR projects contribute directly to PIFSC databases, specimen collections, software, models, and outreach and educational endeavors. Because JIMAR staff inhabit all of the research and operational programs in PIFSC, JIMAR will have contributed to nearly every product developed by the PIFSC programs. These JIMAR contributions include not only peer-reviewed scientific output and project technical reports, but also: data administration from every relevant Pacific Island and State of Hawaii fishery; processed satellite data; stock assessment model improvements and outputs; coral reef benthic habitat and fish assemblage information; oceanographic data; Hawaiian monk seal population dynamics data; marine turtle nesting data; marine turtle biological and ecological information; fish life history data; collected marine debris data; socioeconomic indicators and survey data; cetacean counts and identification data, etc.

- *Sea level forecasts—weeks to months.* Regional and global sea level change studies by JIMAR researchers at the University of Hawaii Sea Level Center (UHSLC) have yielded assessments and forecast tools of high sea level events up to six months in advance in the Pacific Islands region. Using dynamical and statistical modeling techniques, the UHSLC has been able to provide notice of flooding threats weeks to months in advance and assisted the NWS with the issuance of public warnings. The seasonal sea level forecasting assessments established for the Pacific Islands are being extended to all U.S. coastlines under a NOAA-funded Modeling, Analysis, Predictions, and Projections (MAPP) project led by JIMAR researcher Matthew Widlansky. The coastal high water level forecasts are being conducted by a NOAA task team that also considers forecasts for marine living resources.
- *Ensuring sea level data quality and dissemination.* In addition to transitioning their research accomplishments, the UHSLC scientists continue to ensure that tide gauge data from nearly 500 stations maintained by 65 international agencies around the world, more than 80 of which are maintained by UHSLC, are collected, quality assessed, distributed, and archived for use in monitoring and research applications related to climate,

oceanography, ocean engineering, and geophysics. The UHSLC focuses on the stations that constitute the IOC/ UNESCO Global Sea Level Observing System (GLOSS) and the Global Climate Observing System (GCOS). The UHSLC is a primary data center in GLOSS, curating and distributing two sea level gauge datasets: the Fast Delivery dataset and the Research Quality dataset. In addition, as vertical land motion monitoring is recommended by GLOSS/GCOS for the proper attribution of local sea level changes, the UHSLC maintains continuous GPS receivers at 11 stations. Within JIMAR's tropical oceanography, meteorology and climate themes, UHSLC datasets were utilized in 60 peer-reviewed research articles, three books, six government agency reports, and four academic theses during FY 2020. UHSLC researchers were lead authors on the sea level section in the State of the Climate in 2019 report to be published in September, 2020, as a supplement to the Bulletin of the American Meteorological Society.

- *Empowering ocean users and stakeholders.* JIMAR researchers and administrators make fundamental contributions to the success of the Pacific Islands Ocean Observing System (PacIOOS) that empowers ocean users and stakeholders throughout the Pacific Islands by providing accurate and reliable coastal and ocean information, tools, and services that are easy to access and use. PacIOOS continues to operate and maintain over 30 deployed buoys and other instrument systems throughout the U.S. Pacific Islands. During this reporting period, new collaborations were formed with the following agencies: the State of Hawai'i Department of Health Clean Water Branch (three nearshore water quality sensor systems in Maunaloa Bay, O'ahu); the Honolulu Harbor and Hawai'i Pilots Association (real-time weather observations at the Harbor entrance); and, an NGO in Palau PacIOOS as part of the PacIOOS Water Quality Sensor Partnership Program. A variety of forecasts are made available to the public, including coastal inundation, wave, ocean, and atmospheric forecasts. New wave forecast grids were created for the Manu'a Islands in American Samoa, and for the islands of Saipan, Tinian, Aguijan, and Rota in the Commonwealth of the Northern Mariana Islands.
- *Building ocean observation capacity and dissemination.* An ocean observing capacity building workshop was organized by PacIOOS in Pohnpei, Federated States of Micronesia. Plans to hold additional workshops throughout the year had to be postponed due to the ongoing COVID-19 pandemic shutdown. PacIOOS closely works with state and federal agencies, non-profit organizations, academic institutions, and other partners to make coastal and oceanographic data publicly available. Continuous improvements are being made to PacIOOS' website (<http://pacioos.org>) and data visualization platform, PacIOOS Voyager (<http://pacioos.org/voyager>), to provide free and easy access. PacIOOS supports local organizations to make citizen scientists data available on PacIOOS Voyager, such as the Hui O Ka Wai Ola water quality data. An online portal was developed for the Hawaiian Ko'a (coral) card, a citizen scientist project to help document the health and bleaching status of Hawaii's coral reefs. PacIOOS works with partners throughout the region to make large biological datasets widely accessible by aligning them to Darwin Core Standards and adding them to the Ocean Biogeographic Information System.
- *Water velocity profiles collected on all NOAA fleet vessels.* The NOAA research vessels carry acoustic Doppler current profilers (ADCPs) that aid a variety of NOAA programs and contribute to the global climatology of ocean current observations. JIMAR scientists at UH maintain and upgrade the ADCP data acquisition and processing software, called UHDAS, on NOAA vessels. The staff interface with a wide range of NOAA personnel, providing training and consulting on UHDAS usage and interpretation of acquired data, including immediate response to queries from at-sea ships, and are working with NOAA to establish a fully standardized "NOAA to NOAA" (N2N) data pipeline for getting all data submitted to the National Centers for Environmental Information (NCEI) so observations are available to researchers as quickly and correctly as possible.
- *Technical and data QC contributions to the international Argo Project.* At NOAA/PMEL, JIMAR staff are working with U.S. and International Argo Project partners to improve the already highly successful Argo profiling observational float platform by conducting: (i) testing, deployment, and data/engineering evaluation of conventional Argo floats; (ii) testing, deployment, and data/engineering evaluation of the newer Deep Argo float; and, (iii) delayed-mode quality control of conventional and Deep Argo float data for ocean climate change research. In addition to these products and services, Dr. John Lyman, in the JIMAR Argo team at NOAA's Pacific Marine Environmental Laboratory (PMEL), contributed analyses of ocean state variables using Argo and other data for the Global Oceans chapter of the State of the Climate in 2019 report.
- *Coral bleaching database.* Several databases are now available, including the American Samoa spatial data layers (hosted on the PacIOOS website) and the Hawaiian Islands 2019 Coral Bleaching database (hosted by NCEI). The Coral Bleaching database contains information on live coral cover and the percentage and average

bleaching severity, as well as taxa-specific metrics. The data are publicly accessible online via the NCEI Ocean Archive System at <https://accession.nodc.noaa.gov/0209239>.

- *Fishery stock assessment tools.* JIMAR researchers maintain, improve and disseminate the Automatic Differentiation Model Builder (ADMB), a free, open-source software package currently used by all NOAA Fishery Science Centers, as well as other U.S. and international institutions, to create fishery stock assessment tools. The project released a new version of “ADMB-12.0” binaries and sources in December, 2019, that has been downloaded 731 times as of May, 2020. To demonstrate updates and modifications to the software, there have been a total of 702 commits since July 2019 to May 2020. Since 2011, ADMB has been cited a total of 1609 times according to Google Scholar with 226 citations in 2019 and 86 citations as of June 2020.

Outreach and Education

JIMAR devotes personnel time and funding for educational opportunities for K-12 students through to postgraduate research training. The PIFSC Young Scientist Opportunity (PYSO) Summer Intern Program is a primary educational initiative sponsored by JIMAR. The PYSO is a collaborative program between PIFSC and JIMAR that offers 3-4 qualified undergraduate students from across the nation the opportunity to acquire professional research experience and training on summer science projects under the mentorship of selected PIFSC and JIMAR researchers at PIFSC. JIMAR projects also regularly hire University of Hawaii undergraduate students to work on projects as paid workers. Other UH undergraduates participate in projects as volunteers. PYSO successfully operated in the Summer of 2019 with four undergraduates working with staff in the divisions of PIFSC, but due to concerns about COVID-19, the program was cancelled for the Summer of 2020.

JIMAR projects supported 11 Graduate Assistant students during this reporting period, primarily at the University of Hawaii. All are pursuing Masters or PhD degrees in oceanography, marine sciences, and social sciences. JIMAR is also supporting UH graduate student Paige Okamura’s efforts to translate Hawaiian newspaper articles from the 1800’s that are of environmental and geophysical relevance. Progress of her work can be found in the tropical meteorology section of this report.

Given its remote locale, JIMAR has been funding a Visiting Scientist Program that provides an important mechanism to engage with experts from around the world. JIMAR also sponsors trips by JIMAR researchers to international conferences and workshops.

To educate and engage the general public, JIMAR staff continually participate in numerous outreach activities. JIMAR staff are active in UH and community events, such as the biennial SOEST Open House, the annual Waikiki Aquarium Family Night, Honolulu Seafood Festival, Hawaii Fish and Dive Expo, the weekly Hanauma Bay Education Lecture Series, and local fishing derbies. JIMAR staff also set up and manned information tables at events in the community, various expositions and conferences, events at local hotels to educate tourists on ocean concerns, and at fishermen forums and workshops, etc.

JIMAR staff participate in elementary, middle, and high school career and science day events, provide hands-on training for volunteers on observing and handling marine turtles and other protected species, facilitate and coordinate an annual NOAA Fisheries Teacher Workshop (cancelled for 2020), contribute to NOAA/NMFS/PIFSC blog postings and provide other web content, conduct and facilitate tours of the Inouye Regional Center facilities for VIPs and other visitors, and coordinate and conduct ‘newsroom’ sessions each month in the PIFSC to harmonize science communications, education, and outreach messaging for scientists in PIFSC.

JIMAR researchers regularly meet with fishermen and fisheries observers in the Pacific Islands Region to discuss and educate bycatch mitigation efforts for protected species. JIMAR staff also meet with local and U.S. territorial government officials to communicate scientific endeavors within their jurisdictions. For example, tours can be conducted on the NOAA ships while in port in American Samoa, Guam, or Saipan as part of reef monitoring activities, and JIMAR staff often escort local school children, government officials, and the general public to view the vessel and interact with the scientists.

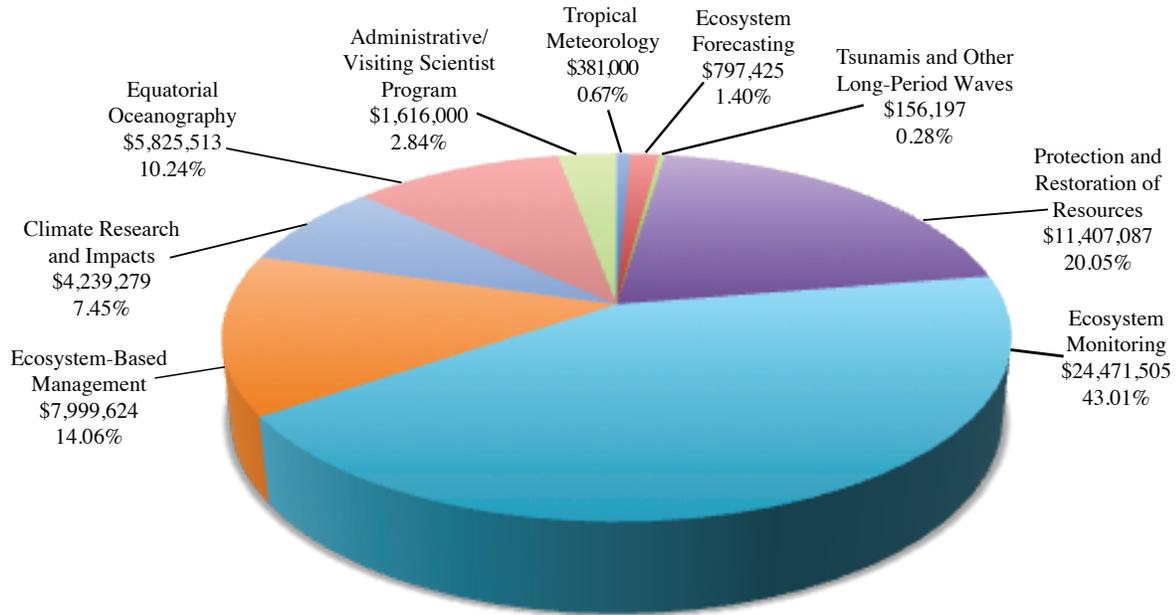
It has been a busy and productive year for JIMAR, despite COVID-19. The project descriptions on following pages will provide a better glimpse of the significant roles that JIMAR plays as a Cooperative Institute linking the academic opportunities available at the University of Hawaii to NOAA’s concept of resilient ecosystems, communities, and economies.

JIMAR Structure and Funding

The Director of JIMAR, Dr. Douglas S. Luther, is a regular member of the University of Hawaii faculty and is appointed through joint decisions by leaders of the University and NOAA. The Director reports to an Executive Board composed of University and NOAA officials. The Director manages JIMAR activities with the assistance of Dr. Jeffrey Hare, Deputy Director for PIFSC Projects, and Mr. Kevin K. Higaki, Assistant Director for Administrative Services, as well as Program Managers and faculty PI/Directors. Mr. Higaki manages day-to-day operations through the administrative staff who are fully-supported by the Cooperative Agreement and returned indirect cost funds. A Council of Fellows advises the Director on research opportunities and promotes cooperation and scientific collaboration. The Fellows are drawn from both NOAA and the University of Hawaii.

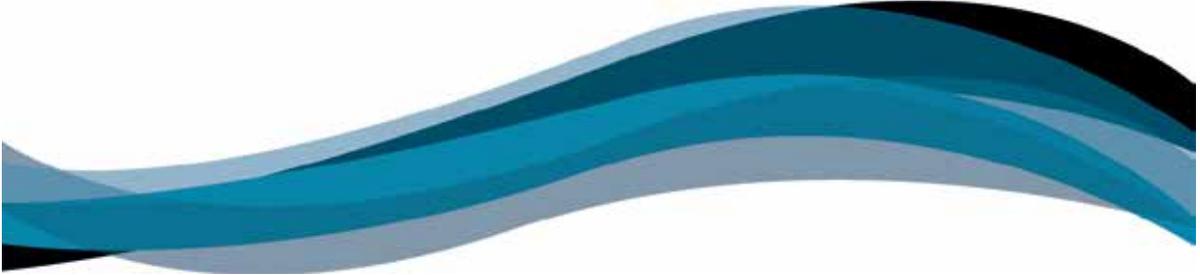
The following chart indicates how funds flowing through JIMAR are distributed according to the JIMAR research themes: (1) ecosystem forecasting; (2) ecosystem monitoring; (3) ecosystem-based management; (4) protection and restoration of resources; (5) equatorial oceanography; (6) climate research and impacts; (7) tropical meteorology; and (8) tsunamis and other long-period waves.

Distribution of NOAA Funding by Theme (FY 2017–2020)



Accomplishments for Fiscal Year 2020

Ecosystem Forecasting



Ecosystem Forecasting

Research under this theme leads to improved forecasting of the frequency and magnitude of ecosystem processes within the Pacific Islands region. JIMAR facilitates research in development of open source fisheries ecosystems modeling tools (Auto-Differentiation Model Builder) and marine population dynamics and fisheries stock assessment models.

Open Source ADMB Project

P.I.: Erik Franklin

**NOAA Office (of the primary technical contact): National Marine Fisheries Service/
Pacific Islands Fisheries Science Center**

NOAA Sponsor: Michael P. Seki

NOAA Goal(s)

- Resilient Coastal Communities and Economies
- NOAA Enterprise-wide Capabilities: Observing, Modeling, and Engaging for all Goals

Purpose of the Project

The general purpose of the Automatic Differentiation Model Builder (ADMB) Open Source Project is to maintain and improve the AD Model Builder software package as free, open-source software. ADMB is currently used by all NOAA Fishery Science Centers to create stock assessment tools. Specifically, the project aims to: 1) improve and maintain software installation and manuals for end users; 2) improve software quality and more fully apply the ADMB coding standard; 3) enhance the software with new features to improve run time efficiency and model development; 4) improve long-term maintainability of the source code; and 5) upgrade previous generation C++ coding standards to modern C++ coding standards. The project maintains a long term goal to support the ADMB software through an active and committed group of users and developers located in laboratories and universities around the USA and the world.

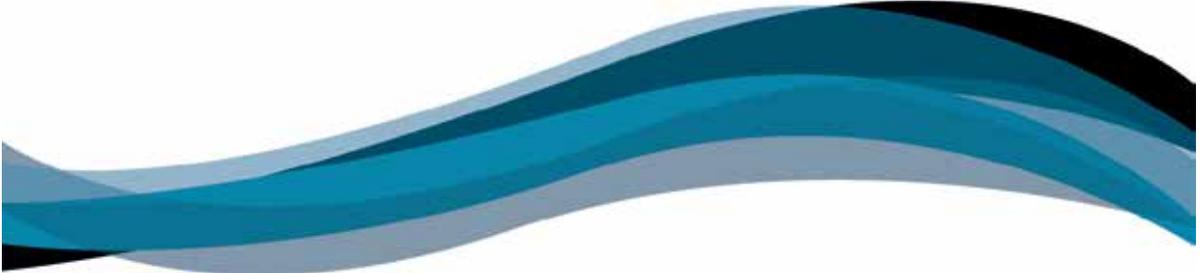
Progress during FY 2020

Proposed objectives for the project were met during the reporting period. The main project objective is to continually maintain and improve the AD Model Builder software. To address this objective, in December 2019 the project provided a new ADMB version with the release of “ADMB-12.0” binary and source distributions which had a total download count of 731 as of May 2020. The main changes in the ADMB-12.0 release included fixed memory leaks, corrected derivative computation, addition of missing data types, improved distribution installers and fixes to build files. Other changes included updated function documentation in the source code, unit testing of more functions, and a bug fix in the keyboard commands. To demonstrate updates and modifications to the software, there have been a total of 702 commits from July 2019 to May 2020.

A key ADMB objective is improving runtime performance speed by using multiple processors. The slower performance of ADMB compared to Template Model Builder (TMB) was reported to be an issue for most users at CAPAM 2019 in New Zealand. The plan is to reorganize the data structures which were originally coded for single processing for use in multi-processing computers, then use the threading feature in the C++11 standard. The reorganization of the code was completed but will still require testing and code review feedback from other developers to ensure correctness and model reproducibility. Developing the threading into ADMB is the next step in this process. The code review will occur during the next developer’s workshop tentatively planned for September 2020. If the workshop is not run due to the Covid-19 pandemic, then the project will attempt to coordinate a semi-virtual workshop in the interim to achieve code review and feedback. If there are no issues in the review, the changes in the branch will be merged into the main development files.

The ADMB software is used by NOAA scientists, academic researchers and fishery scientists from the USA and around the world. Since 2011, ADMB has been cited a total of 1609 times according to Google Scholar with 226 citations in 2019 and 86 citations as of June 2020.

Ecosystem Monitoring



Ecosystem Monitoring

Observing systems and data management are integral to this theme. Significant efforts are undertaken in JIMAR to monitor and assess reef ecosystems, fisheries habitat and stocks, endangered marine animals, and threats to marine ecosystems. JIMAR contributes to the NMFS effort to continually monitor catch data from the fisheries industry across the Pacific Islands.

Ecosystem Structure and Function

P.I.: Douglas S. Luther [JIMAR Project Lead: Jeffrey Hare]

**NOAA Office (of the primary technical contact): National Marine Fisheries Service/
Pacific Islands Fisheries Science Center**

NOAA Sponsor: Michael P. Seki, Phoebe Woodworth-Jefcoats

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

This project conducts research to further advance understanding of the structure and function of an important marine ecosystem, the subtropical gyre. This work includes a range of approaches to increase understanding of this ecosystem, particularly how trophic structure is impacted by climate variability and change. One component of the project consists of processing and analyzing a time-series of lancetfish stomach contents collected by observers in the Hawaii-based longline fishery to develop an index of the pelagic micronekton community. This index is then used to describe the spatial and temporal patterns of micronekton across the central North Pacific. Another component of the project examines fishery dependent data sets (observer, logbook, and dealer records from the Hawaii based longline fishery) in conjunction with oceanographic data to assess spatiotemporal trends in catch composition and to identify drivers of this change. Ecosystem modeling approaches are also used to evaluate changes in ecosystem structure and function as well as the vulnerability of species to climate change.

Progress during FY 2020

Longnose lancetfish (*Alepisaurus ferox*) are the most commonly caught by-catch species in Hawaii's longline fishery which mainly targets tuna and swordfish. Due to their slow digestion of prey, lancetfish act as biological samplers by providing a better idea of deep-living prey communities in the middle of the food web. During the report period, JIMAR Technician Emily Contreras dissected approximately 80



Figure 1. JIMAR Research Technician Emily Contreras at PIFSC lab looking into a microscope, holding forceps and petri dish.



Figure 2. Juvenile lancetfish on display on a white lab tray.



Figure 3. Squat lobster (*Pleuroncodes* sp.) pulled from a lancetfish stomach.

lancetfish to document stomach contents. She identified prey to species level, conserved rare or unknown samples, and worked with experts to identify cephalopods and fish. All prey items were entered into the lancetfish database and a data summary report will be provided in the coming months.

The JIMAR West Hawai'i Integrated Ecosystem Assessment project coordinated with this project to conduct plankton tows off West Hawai'i to assess ecosystem status through monitoring of indicators. Plankton samples caught off West Hawai'i from 1998-2018 were sorted by JIMAR project staff who identified larval fish (as small as 1mm) to species and worked with experts (or relied on DNA barcoding) to identify ecologically important species (flying fish, triggerfish, jacks, and goatfish). Plastics from samples were also photographed, weighed and analyzed using the processing program *ImageJ*. Project technicians also created a guide containing approximately 100 Hawaiian species which is used to aid new employees in confirming identifications. A manuscript is also being developed to highlight the habitat use of larval bigeye scad (*Selar crumenophthalmus*) and mackerel scad (*Decapterus macarellus*) from the West Hawai'i time series. Bigeye and mackerel scads represent the largest and arguably the most important inshore fisheries in Hawai'i for as long as the islands have been inhabited. The manuscript is focusing on time of collection which will be compared to known spawning times and spatial distribution thus providing the first record of these larval species found in these preferred habitats.



(above) Figure 4. A female paper nautilus with shell intact, found inside the stomach of a lancetfish.

(below) Figure 5. A larval frogfish pulled from a plankton tow displayed on the index finger of the laboratory technician.



Ecosystems Observations and Research Program: Research Support Project

P.I.: Douglas S. Luther [JIMAR Project Lead: Jeffrey Hare]

**NOAA Office (of the primary technical contact): National Marine Fisheries Service/
Pacific Islands Fisheries Science Center**

NOAA Sponsor: Michael P. Seki, Evan Howell

NOAA Goal(s)

- Healthy Oceans
- Resilient Coastal Communities and Economies

Purpose of the Project

The JIMAR Ecosystems Observations and Research Program (EORP) monitors and conducts research on ecosystems that involve marine species and resources of concern to NOAA in the Pacific Islands Region. The project activities enable scientists to provide advice to those charged with management of the resources as mandated by legislation (e.g., Reauthorized Magnuson Stevens Act, Marine Mammals Protection Act, Endangered Species Act, etc). Current project activities include: Aquaculture Systems Management, Outreach and Education, and Large Marine Ecosystem /Ecosystem-Based Fisheries Management Coordination.

Aquaculture Systems Management. The Aquaculture System Management project provides system management for the Seawater System (SWS) facility on Ford Island to support research of marine species of concern to the Pacific Island Region. This includes working closely with federal and University partners in coordinating, developing, modifying, and maintaining the captive care facility for research, culture, and rehabilitation for marine species.

Pacific Islands Region Fisheries Science Outreach and Education. The objectives of this JIMAR effort are to plan, develop and implement an effective outreach and education program via a partnership between JIMAR and the Pacific Islands Fisheries Science Center (PIFSC). JIMAR staff serve as resource, advisor, and point of contact for outreach and education activities for JIMAR, PIFSC, and Pacific Islands Regional Office (PIRO) outreach and communications staff, across all divisions and programs. This project directly supports the JIMAR aim of sustainable balances between the forces of coastal development and the goals of conservation/preservation through scientific and public outreach and education.

Large Marine Ecosystem/Ecosystem-Based Fisheries Management Coordination. In 2016, the NOAA National Marine Fisheries Service (NMFS) formally established a commitment to Ecosystem-based Fisheries Management (EBFM). EBFM requires a more holistic approach to looking at the ecosystem and aims to balance ecological well-being and human well-being through good governance across boundaries and encouraging collaboration and communication throughout the process. As the Pacific Islands Fisheries Science Center (PIFSC) begins investing more in moving toward EBFM, defining Large Marine Ecosystems (LMEs) for the Pacific Islands Region (PIR) will help lay the foundation for scientists, managers, and other stakeholders to effectively implement EBFM.

LMEs are defined as highly productive, extensive open ocean areas of 200,000 km² or more with distinct ecological characteristics relative to bathymetry, hydrography, biological productivity, and trophically-linked populations. Ecologically significant, LMEs are some of the world's most productive areas of the ocean. A large portion of the world's fish catch is caught in LMEs thus contributing goods and services to the global economy. LMEs harbor high levels of biodiversity and provide important ecosystem services as global centers for fisheries, marine tourism, shipping, energy production, and other sectors, but the majority of ocean pollution and coastal habitat alteration also occur in LMEs. In turn, they provide ecologically defined areas for stakeholder engagement in understanding root causes of impacts and initiating sectoral changes. LMEs can be used in an ecosystem approach toward assessment, management, recovery, and sustainability of marine resources.

The U.S. Pacific Exclusive Economic Zone has an area over 5.8M km², but the Insular Pacific Hawaiian area is the only LME officially defined in the central and western Pacific Ocean. To spatially define discrete LMEs of the PIR, in 2019 JIMAR and PIFSC collaborated to characterize the Izu-Bonin Mariana Arc System as a "Marianas LME". Staff provided baseline information on the key components for assessment: oceanography



Figure 1. Turtle in newly designed tank at the IRC seawater facility on Ford Island.

and productivity; ecology and fisheries; ecosystem health; threats and impacts; governance; and socioeconomics. This vast ecosystem has clear intrinsic connections and physically defining features, as well as a large amount of existing scientific data. The designation of the Marianas as an LME should provide an enhanced ecosystem wide perspective to assist managers and stakeholders in making informed decisions.

Progress during FY 2020

Aquaculture System Management. Led by Aaron Moriwake, the JIMAR staff implemented a weekly exercise program and a year-round maintenance schedule to ensure system readiness for incoming animals in the four (monk seal, turtle, fish, and multi-purpose) distinct units. JIMAR staff trained turtle, monk seal, and SWS staff on system operations and coordinated daily activities within the SWS yard. Other support included troubleshooting and resolving maintenance issues, designing and making improvements to the facility, updating protocols, and conducting monthly safety assessments for the SWS facility. Records on the repair, maintenance, and replacement of equipment were also archived in a shared Google document.

During the reporting period, JIMAR staff provided support for rehabilitation and/or housing of twelve turtles, five monk seals, juvenile mullet (food for seals), and “live rock” (i.e., dead coral skeleton with bio-eroding mussels embedded). Staff also provided support for several tests of equipment (e.g., cameras, water chemistry sensors) for PIFSC researchers. When animals were housed at the SWS facility, JIMAR staff provided 24/7 emergency support through email/text alarm alerts, and remote access control of cameras and the Supervisory Control and Data Acquisition (SCADA) system.

Pacific Islands Region Fisheries Science Outreach and Education. Led by Ali Bayless, the project produced printed and online scientific outreach and education products, programs, and services including community events, educational opportunities, career fairs, Science Camp, and PIFSC Young Scientist Opportunity (PYSO). FY 2020 was drastically impacted by a change in operations due to the COVID-19 pandemic shutdown so project efforts shifted to a completely online platform with virtual outreach and education products.

Outreach and educational activities. Staff participated in community and educational events to communicate information about JIMAR and NOAA missions, programs, and policies and encourage the public to learn about and support healthy ocean ecosystems and marine science research. Outreach events included opportunities to provide career guidance for students and inspire the next generation of marine scientists. In the past year, the project participated in the following in-person events: Summer Youth Fishing Clinic; Kapiolani Community College Career Presentation; Kapiolani Community College Marine Option Program visit to IRC; Hawaii Preparatory Academy Sea Turtle Program; Radford High School Career Day; UH Manoa SOEST Open House; Waiiau Elementary School class visit; Kailua High School Career Fair; Kahala Elementary class visit; Le Jardin kindergarten class visit to IRC; NOAA Teacher Whale Watch Workshop; Honolulu Community College Career Presentation; Waipahu Elementary class visit; Fishers Forum; and Kahala Elementary Career Day.

Once COVID-19 pandemic shutdown restrictions occurred, communication efforts were primarily conducted online via hosted virtual events for school groups and the community at large including: Ask-A-Meteorologist with Waialae Elementary School; Monk Seal Behavior: Crittercam with Waialua Elementary School; Learn to Speak Whale with Kamehameha Schools and Red Hill Elementary School; Turtle Talk with Jefferson Elementary School; Hurricanes at Home with Red Hill Elementary; Following O'io: The life of Hawaiian Bonefishes (nationwide broadcast); Tsunamis: Nature's Warning Signs (nationwide); Learn to Speak Whale (Hawaii wide); Hurricanes at Home (Hawaii wide); and, Corals: Too hot to Handle (Hawaii wide). JIMAR also assisted with hosting a virtual World Ocean's Day with a talk on sea turtles and a public service announcement on eating U.S.-caught sustainable seafood.

2020 NOAA Fisheries Teacher Workshop. The 2020 NOAA Fisheries Teacher Workshop was unfortunately cancelled due to the COVID-19 pandemic shutdown. Prior to cancellation, twenty local middle school science teachers from both public and private schools around Oahu were registered to participate. The planned workshop included a full day at the NOAA facility with hands-on learning activities using NOAA data. The intent was for these teachers to incorporate NOAA data and research into their classroom lesson plans. The project hopes to host this event next year.

PIFSC Young Scientist Opportunity (PYSO). Due to a change in operations as a result of the COVID-19 pandemic shutdown, project staff were unable to facilitate the 2020 PIFSC Young Scientist Opportunity (PYSO) program through to completion. Projects were solicited, applications accepted and finalists were chosen, at which point the program was cancelled for the summer of 2020.

Outreach and Science Communications. Newsroom sessions were established to develop and coordinate science communications, education, and outreach opportunities for research expeditions, scientific publications, and projects with staff from all PIFSC and JIMAR programs, PIRO, and external project partners.

Web Content. During the project year, the staff produced web content including feature stories, science blogs, story maps, photographs and videos. This year, PIFSC added a new content type with a podcast series and JIMAR consistently contributed to this series. The JIMAR EORP staff helped to produce the following blogs, podcasts and story maps.

- Staying Calm in the Face of Trauma: Reflections of a Student Assistant
- Punahele: A Green Sea Turtle's Journey to "Destination Unknown"
- The Human Dimensions of Wildlife Disease
- An Integrated Compliance Approach could improve Fisheries Management in NOAA's Largest Region
- Four Generations of Hawaiian Monk Seals
- Studying and Conserving Western Pacific Leatherback Turtles in the Solomon Islands
- Hawaiian Monk Seal Population Saw Signs of Recovery in 2019
- Hope for Coral Reef Recovery in American Samoa?
- Beaked Whale Strandings in the Mariana Archipelago May Be Associated with Sonar
- International Whales of Mystery: Uncovering the Identity of Humpback Whales Breeding in the Mariana Archipelago
- Coral Reef Monitoring Mission: Investigating Land-Based Pollution in American Samoa
- Photo Journal: Whales and Dolphins around Hawai'i during Winter
- The "Why" of WHICEAS, the Winter Hawaiian Islands Cetacean and Ecosystem Assessment Survey
- Little Relief in the Deep for Heat-Stressed Corals
- New Approach to Identifying False Killer Whale Populations Proves Challenging
- Lava Flow Time Portals: Understanding the Development of Deep-water Coral Communities
- A Long-Term Partnership Continues Prosperity for Sea Turtles, Students, and Scientists

- Coral Bleaching in 2019: Survey Update from Leeward Maui
- Taking a Deep Dive into a Land-based Threat to Hawaiian Monk Seals
- Coral Bleaching in 2019: Survey Update from O‘ahu
- Prey-Size Plastics are Invading Larval Fish Nurseries
- Composition and Distribution Patterns of Deep Water Fish Communities in Hawai‘i
- Endangered Hawaiian Monk Seals Cry Foul Over Selfies
- I Found a Message in a Bottle
- Learning from Stakeholders in the Marianas: How Do Sharks Affect Fishers and What Can Be Done?
- Rare Olive Ridley Sea Turtle Nest Discovered on O‘ahu
- Surveys to Assess the 2019 Hawai‘i Coral Bleaching Event
- Podcast, Pohaku Chronicles (Parts 1–4)
- Story map, One Program’s Quest to Save an Endangered Turtle Population
- Story map, Winter Hawaiian Islands Cetacean and Ecosystem Assessment Survey 2020
- Story map, Modeling a Coral Reef Ecosystem

Large Marine Ecosystem/Ecosystem-Based Fisheries Management Coordination. Led by JIMAR Lead Megan Asher and spearheaded by JIMAR LME Research Technician, Taylor Souza, JIMAR and PIFSC staff continued drafting the Marianas LME document. JIMAR project staff reached out to PIFSC experts in a range of disciplines for comprehensive review, input, and contribution to the document. This included the addition of socioeconomic and governance modules, and revisions of a manuscript ready publication. Presentations, a poster, relevant figures, and an informational document were also generated to gain inputs and to publicize this effort with partners and scientists through: August 2019 Scientific Steering Committee meeting in Hawaii; August 2019 Western Pacific Regional Fishery Management Council (WPRFMC) meeting in Guam; Ecosystem Sciences Division Quarterly Coordination Meeting in November 2019; and other venues such as the November 2019 JIMAR Symposium.

Ecosystems Observations and Research Program: Science Operations Project

P.I.: Douglas S. Luther [JIMAR Project Lead: Kyle Koyanagi]

**NOAA Office (of the primary technical contact): National Marine Fisheries Service/
Pacific Islands Fisheries Science Center**

NOAA Sponsor: Michael P. Seki, Noriko Shoji

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

This Project’s mission is to provide high quality effective logistical, operational, and technical project support and lead the standard in safety and training for the Pacific Islands Fisheries Science Center’s (PIFSC) research activities in the Pacific Islands Region (PIR). Six project elements are described below.

Analysis and Evaluation of Fishery Independent Data and Collection Methods for Insular Fish Stocks in the Pacific Islands Region. In the Pacific Islands Region, commercial fish stocks are made up of reef fish, bottomfish, and pelagic species. The use of sampling technologies can greatly aid in the study of these commercially-exploited species as each set of gear can be customized to survey species-specific depths, habitat types, and spatial scales. As effective management of fisheries resources becomes more critical, advancements in data collection methodologies expands knowledge of target fish assemblage dynamics and supplement current fisheries data sets. Currently, photo and video recordings from camera systems make up the bulk of the incoming fishery-independent survey data. These recordings require processing of fish counts, fish lengths, and habitat data for use in fisheries studies. The JIMAR Analysis and Evaluation Team generate the fish assemblage data products from optical data streams through annotation of photo and/or video. And as camera survey technologies continue to be developed, there will be a continuing need for evaluation of new technology and standardization of fisheries data products across survey platforms from photo and/or video analysis.

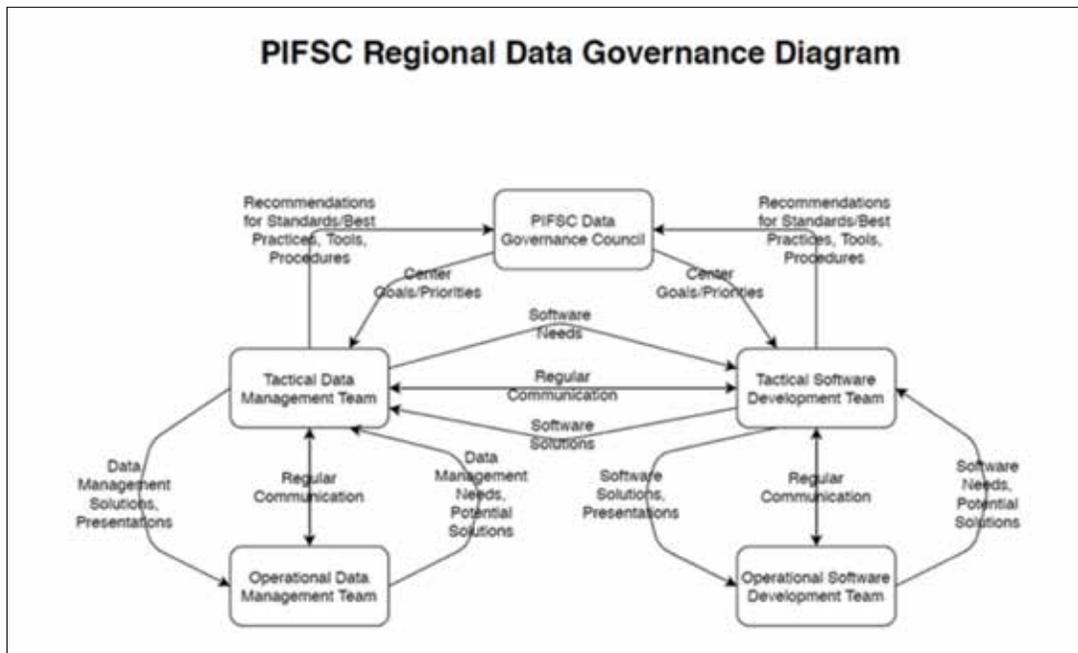


Figure 1. Diagram of PIFSC Regional Data Governance that shows the interactions between the different functional data groups and the Data Governance Council.

Operations and Logistics Services to Support Pacific Islands Fisheries Science Center Research Missions and Projects. As scientific field campaigns become more complex with multi-faceted, multi-platform, multi-disciplinary, and technologically advanced endeavors, the responsibilities of PIFSC scientists have grown such that dedicated trained JIMAR staff is necessary to support planning and execution of desired science endeavors. Science operational staff directs research by collaborating with JIMAR investigators to plan the effective use of equipment and resources and to ensure operations are conducted safely and according to established policy. This model allows the scientists to focus on their research objectives, while expert staff helps plan, coordinate, and execute safe and effective science operations.

Advanced Survey and Sampling Technology Development. Keeping abreast of emerging new technology and maintaining current survey and sampling technological assets are vital to staying on the cutting edge of fisheries research. Coordination between dedicated JIMAR staff and researchers of different disciplines provide a broader perspective in ascertaining survey and sampling technology needs and priorities. This centralized model allows technology to be assessed for availability and effectiveness for multiple users. The need for survey and sampling technology development on a broader scale at PIFSC is essential to fostering collaboration and maximizing utilization of technology assets. It provides opportunities for cost sharing and cross training to gain a wider range of expertise. This allows scientists to focus on their research while still integrating the newest most cost effective way of data collection.

Environmental Data Management to Support Fisheries and Ecosystem Research. This JIMAR effort provides continuous support to fishery and ecosystem research and data management within the Western and Central Pacific Ocean (WCPO) region. The overall objective of this project is to provide JIMAR database development, data management, and data application development support and services to scientist and resource managers at the Pacific Islands Fisheries Science Center (PIFSC) to facilitate quality science research and resource management.

Geospatial Products. The need for improved access to collected data is an ongoing concern for data users both internal and external to PIFSC. The need to access, create and compile geospatial data is critical for planning research programs and publishing results. Unfortunately, access to the data and associated tools is not universally available. While some PIFSC programs have well-developed Geographic Information System (GIS) capabilities and databases, others have staff with limited skills and resources yet must still meet all requests related to accessing, processing and displaying spatial data. The JIMAR Geospatial Products Team (GPT) is a centralized resource providing access to high-quality data, tools and resources that would not otherwise be available.



Figure 2. Screenshot from a Modular Optical Underwater Survey System (MOUSS) video (video # 20190920_200547) showing *Seriola dumerili* (kahala) swimming with two Deep 7 species, *Pristipomoides filamentosus* (opaka'paka) and *Pristipomoides sieboldii* (kalekale), near a wreck site (probable military vehicle) at a depth of 156 meters.

Marine National Monuments of the Pacific. This project addresses the need to expand centralized resources for continued development of products and tools that create effective ways to access, compile, and package Marine National Monuments of the Pacific data streams. These data streams are essential for planning research programs, publishing results, and supporting outreach and education activities and materials. The project helps facilitate collaboration with federal, state, local, and academic partners and coordinate NOAA scientific research within the Marianas Trench, Pacific Remote Islands, and Rose Atoll Marine National Monuments. To encourage collaboration, the project is working on a variety of ways to make data and products more readily available. By providing easy access to its repository of photos, The Monuments Photo Library Project aims to engage and inspire researchers and the general public. This project collaborates with different programs within the NOAA Fisheries to provide assistance with collecting archived photos, selecting the best images, cataloging, and updating metadata records for photos in preparation for data entry into Monuments Photo Library Interface.

Progress during FY 2020

Analysis and Evaluation of Fishery Independent Data and Collection Methods for Insular Fish Stocks in the Pacific Islands Region. During the reporting period, JIMAR staff on the Analysis and Evaluation Team supported the Modular Underwater Survey System (MOUSS), a stereo-video survey tool that provides non-extractive size-structured relative abundance estimates for fish species in their natural habitat. MOUSS surveys were conducted aboard NOAA Ship *Oscar Elton Sette* and additional Pacific Islands Fisheries Group (PIFG) contract fishing vessels *F/V Ao Shibi IV* and *F/V Ao Shibi Too*. Video analysis for the 2019 Hawaiian bottomfish fishery-independent survey was completed (424 videos) and size-structured species abundance data was delivered to the Fisheries Research and Monitoring Division's (FRMD) Stock Assessment Program in February 2020. The video data set was monitored for dropped frame (gap) and camera recording issues, with only 9.7% of the total videos experiencing issues (versus 17% in 2018). Dropped frame errors were typically around three minutes in length and most often affected the master cameras, as opposed to the typical nine minutes of dropped frames seen exclusively on the slave cameras in 2018. These shorter camera errors did not affect the bottomfish data output (e.g., fish abundance estimates and length measurements) and the MOUSS Camera Error Report was updated for



Figure 3. Screenshot from the Wide Area Motion Imagery (WAMI) software viewer, showing annotation bounding boxes (rectangles) generated by interpolation and fish track lines (white lines) for Deep 7 bottomfish and other fish species, to be used for Video and Image Analytics for Marine Environment (VIAME) software model training.

2019. The Science Operations Division (SOD) Advanced Tech Team is currently conducting MOUSS camera testing and refurbishing to ensure that the bottomfish data will not be impacted by camera errors in 2020.

The ability to precisely determine the effective sampling area (ESA) of the MOUSS camera system remains the most significant impediment in improving the precision of fishery-independent survey data being used in the Main Hawaiian Islands (MHI) Deep 7 Stock Assessment. ESA is primarily determined by two factors: 1) the distance from which fish targets are able to enter the sampling frame over the time period in which sampling is conducted; and 2) the proportion of the 360-degree environment covered by the sampling frame. As the MOUSS camera is limited to an 82-degree field of view, a 360-degree camera system may be helpful in estimating this second factor. The Team's ongoing MOUSS-360 comparison study includes videos from three research surveys: SE-18-06 (55 paired videos); SE-19-04 (51 paired videos); and SE-19-06 (79 paired videos) for a total of 185 paired MOUSS-360 videos. Paired videos from additional surveys in 2019 were necessary to ensure a sufficient number of annotatable videos with fish present for pairwise comparisons were obtained. Video analysis for this study is currently ongoing with annotation of approximately 80% of 360 videos and 85% of MOUSS videos completed to date. Preliminary results suggest that more fish may be detected using the omnidirectional 360-degree camera versus the directional MOUSS cameras, especially when larger schools of fish surround the MOUSS on multiple sides or when fish pass by outside the MOUSS's field-of-view. However, analysis of the complete MOUSS-360 comparison dataset is required to determine whether such instances are statistically significant and should thus be considered when estimating bottomfish population abundances from MOUSS data.

The MOUSS camera system used as part of the Bottomfish Fishery-Independent Survey in Hawaii (BFISH) generates large amounts of imagery which requires processing and annotation by analysts. As technology continues to evolve, machine learning and computer vision has resulted in algorithms capable of detecting, tracking, and classifying targets of interest within optical data streams. The Team was engaged in the preliminary testing of the Video and Image Analytics for a Marine Environment (VIAME) open-source automated image analysis toolkit to determine if this application could be used to streamline and improve BFISH video data analysis workflow. Initial training used the Wide Area Motion Imagery (WAMI) viewer software to interpolate and create new Deep 7 bottomfish annotations from videos which were previously annotated manually. Rapid Model Generation (VIAME based iterative query refinement) results found that four species of fish were correctly identified in only 2,040 frames out of the 25,388 frames previously identified by the analysts. These results indicated that significantly more iterative machine learning is required to determine if VIAME can be a viable alternative to current analysis workflows.



Figure 4. Screengrab from a 360-degree video (video # 20190621_185351 V0100046) showing a high abundance of fish (>300), including the Deep 7 species, *opaka'paka*. The 360 camera was deployed paired with the Modular Optical Underwater Survey System (MOUSS) cameras at Penguin Banks at a depth of 107 meters in June, 2019, from the NOAA Ship Oscar Elton Sette during the SE1904 Life History mission.

Operations and Logistics Services to Support Pacific Islands Fisheries Science Center Research Missions and Projects. During the reporting period, JIMAR staff supported a large portion of PIFSC missions and projects by providing logistical, operational, small boat, laboratory, and dive research support to all PIFSC Divisions. On the NOAA ship-based BFISH project SE-19-06, JIMAR Field Operations team members played pivotal project leadership roles and made significant contributions to the successful completion of mission objectives. During this mission, JIMAR staff held the Operations Lead role and provided leadership, expertise, and support for executing MOUSS deployment/recovery operations in the Main Hawaiian Islands (MHI). JIMAR staff also conducted additional MOUSS operations and gear trials aboard the commercial fishing vessels *Ao Shibi IV* and *Ao Shibi Too* as part of a PIFSC/PIFG collaboration. As a result, the PIFSC Stock Assessment Program's (SAP) 2019 Bottomfish Fishery Independent Survey-Hawaii (BFISH) received valuable MOUSS video-data collected by JIMAR staff during SE-19-06 and the PIFSC/PIFG collaboration. These data contributed significantly to the stock assessment and correlative policies and regulations of the Hawaii 'Deep 7' commercially viable bottomfish species. Because of the success of the PIFSC/PIFG collaborative effort, expansion of the fleet of commercial fishing boats capable of performing MOUSS operations continues, thus advancing the goal of completing all fishery-independent data collection (Cooperative Research Fishing and MOUSS video) with commercial fishing vessels.

Science Operations Division (SOD) JIMAR staff also supported the FK19102 Expedition, "Listening for Cryptic Whales Species", aboard the Schmidt Ocean Institute's *R/V Falkor*, that conducted cetacean surveys around the MHI. During the mission, JIMAR staff assisted with visual surveys, deployment and recovery of Drifting Acoustic Spar Buoy Recorders (DASBR), and utilized new techniques like eDNA water sampling to better assess the status of the elusive beaked and false killer whales.

In addition to project field support, SOD JIMAR staff provided technical operational support by developing and reviewing project instructions and mission plans. JIMAR staff played pivotal roles by assisting PIFSC researchers with outlining safe and effective research activities that met or exceeded JIMAR and NOAA safety standards. This calendar year, SOD JIMAR Staff supported the Big Eye Tuna Oceanography project SE-20-06 (canceled due to COVID-19) and MHI Coral Reef Bleaching Assessment Surveys MP-20-01 (Oahu), MP-20-02 (Maui), and MP-200-03 (Hawaii Island).

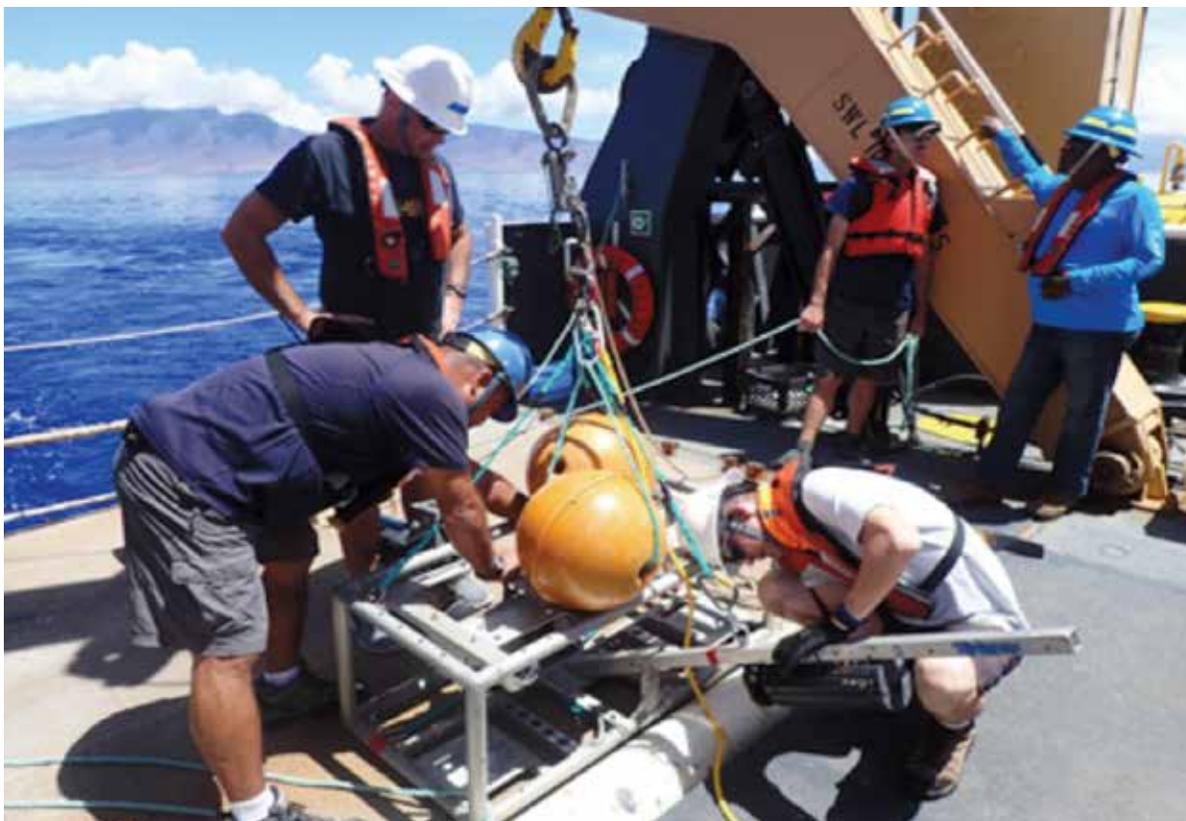


Figure 5. DropCam Instrument Package (DCIP) being assembled for deployment during the Bottom Fishery-Independent Survey-Hawaii (BFISH) 2019.

SOD JIMAR staff also worked as small boat Vessel Operations Coordinators (VOCs) and managed small boat operations and assets for two PIFSC Divisions. Staff managed small boat maintenance and repairs to ensure that PIFSC small boat assets met or exceeded NOAA Small Boat Program safety standards to minimize safety risks and the loss of project operational days due to mechanical breakdowns. The third regionally coordinated Annual Small Boat Evaluation (ASBE) effort was held December 2019 and SOD JIMAR staff played a leading role in small boat and safety equipment inventory and inspections. SOD JIMAR Staff supported other PIFSC operations by assisting the Protected Species Division's (PSD) Hawaiian Monk Seal Research Program (HMSRP) and Marine Turtle Biology and Assessment Program (MTBAP) with preparation for their 2020 field camps in the Northwestern Hawaiian Islands. Support provided by project staff included small boat improvements, maintenance and repairs, and virtual training courses in inflatable boat repair/maintenance and basic marine electrical concepts.

The SOD JIMAR Dive and Laboratory Research Manager provided expertise and support in overseeing day-to-day operations and training of the Inouye Regional Center (IRC) Dive Center and Laboratories. Duties included assisting with review and assessment of research dive plans as well as providing equipment support. During the past year the manager played a critical role in the Hawaiian Archipelago Reef Assessment and Monitoring (HARAMP) project RA-19-03 and Marianas Archipelago Reef Assessment and Monitoring Program (MARAMP) RA-20-01 (cancelled due to COVID-19) missions by assisting with planning and coordination for diving activities and hyperbaric chamber equipment, operationalizing a new Nitrox compressor system essential to dive operations aboard NOAA Ship *Rainier* (which is new to Hawaiian waters), and supporting large scale diving operations. The SOD JIMAR Dive Research Manager provided training support for NOAA Diver certifications, NOAA Diver Annual Watermanship, Divers Alert Network Cardiopulmonary Resuscitation (CPR), Emergency Oxygen Provider, and Diving First Aid (FA) for Professional Divers courses. The manager also assisted in training five new JIMAR/NOAA divers and held nine CPR/FA/O₂ courses. The JIMAR IRC Dive and Laboratory Research Manager was additionally responsible for leading quarterly laboratory users meetings, ensuring users

were up to date with Annual Laboratory Safety Refresher training modules, and maintaining the IRC Laboratory Chemical Hygiene Plan which greatly improved user competence and compliance with laboratory safety best practices. In March 2020, the responsibilities of the Dive and Laboratory Research Manager were transferred to federal oversight.

Advanced Survey and Sampling Technology Development. During the reporting period, JIMAR staff engaged in Advanced Survey and Sampling Technology Development in a variety of field and laboratory capacities to support the work of PIFSC researchers who required development, evaluation, fabrication, and maintenance of in-situ instrumentation and monitoring systems in the Pacific Islands Region (PIR). JIMAR Survey and Sampling Technology Program (SSTP) staff served as technical leads for science operations and collaborated with participating researchers to fulfill their projects' technical requirements. JIMAR SSTP staff served as lead author on an important manuscript detailing the Modular Optical Underwater Survey System (MOUSS). The "NOAA Technical Memorandum MOUSS Protocol for the Pacific Islands Fisheries Science Center" provides the fisheries optical stereo-video data community with detailed descriptions of equipment, Standard Operating Procedures for camera deployment

and recovery, data processing, and annotation of in situ stereo-video data. Other SSTP major efforts included maintenance of aging MOUSS equipment and trouble shooting of a gap error detected on the 2019 fall Bottomfish Fishery Independent Survey-Hawaii (BFISH) SE-19-06. JIMAR staff are currently collaborating with MOUSS developers to troubleshoot gap issues in order to have fully operational working field units and maximize data collection. Concurrently, SSTP is developing new stereo camera system software based on forward-looking infrared (FLIR) camera operating systems. The goal is to use in-house software and off the shelf FLIR cameras to make stereo camera systems modular, customizable, affordable (with a lower per unit cost), and easier to use. This will facilitate an increase in the survey effort and allow for a broader user spectrum.

The SOD JIMAR fabrication team staff supported the Cetaceans Research Program (CRP) with the fabrication of two additional Drifting Acoustic Spar Buoy Recorders (DASBR) housings and arrays for the CRP mission aboard NOAA Ship *Oscar Elton Sette* in April (SE-20-01). DASBRs are free-floating acoustic recorders designed to mitigate background noises that are associated with towed array systems and to detect species that tend to shy away from ships and other activities that create a noisy environment. SSTP also redesigned and fabricated a more rugged DASBR+ prototype equipped with a battery bank, solar charger, power management system, Automatic Identification System (AIS) tracking, and a low light LED flasher avoidance system. The first generation prototype was damaged during recovery on SE-19-01. The second generation DASBR+ prototype was successfully deployed and recovered on SE-20-01. All the data obtained from the DASBR+ was high quality, confirming a successful design and construction of the enhanced unit. The Fabrication team staff additionally



Figure 6. DropCam Instrument package (DCIP) with a timed Niskin bottle release to collect eDNA samples being deployed by NOAA Ship Oscar Elton Sette during the 2019 Bottomfish Fishery-Independent Survey-Hawaii (BFISH).



Figure 7. Drifting Acoustic Spar Buoy Recorder (DASBR) being deployed on aboard the Schmidt Ocean Institute's R/V Falkor (FK19102) for cetacean surveys around the Main Hawaiian Islands (MHI).

designed a custom Lotek LAT1400 Temperature Depth Recorder (TDR) holder to be used on the 2020 Pacific Islands Fisheries Group (PIFG) Fall Bottomfish Fishery Independent Survey-Hawaii (BFISH). The TDR brackets were designed small and strong enough to be used in-line with existing bottom fishing gear rigging. A short run of the TDR brackets is currently being produced at a vendor.

SSSTP JIMAR staff also continued its collaboration with the Northwest Fisheries Science Center (NWFS) by providing technical expertise for Autonomous Underwater Vehicle (AUV) operations aboard NOAA Ship *Reuben Lasker* (RL-19-05) in support of the West Coast Initiative on Deep Sea Coral and Sponges. This survey focused on Essential Fish Habitat conservation areas proposed for modification under the Pacific Fishery Management Council's draft Amendment 28, surveying potential areas for offshore wind energy generation and exploring areas that had been not been previously surveyed.

Environmental Data Management to Support Fisheries and Ecosystem Research. During the reporting period, JIMAR staff supported PIFSC with data management and processing, database development, application development, server administration, troubleshooting, consultations, and developing Standard Operating Procedures (SOPs).

The project worked closely with PIFSC administrative and research staff to assemble an additional functional data group named the Tactical Data Management Team (DMT) that will meet on a regular basis to discuss PIFSC data management priorities. The Environmental Data Management to Support Fisheries and Ecosystem Research Project will contribute to the team. JIMAR staff documented how the different functional data groups will interact with each other and with the PIFSC Data Governance Council (DGC) to ensure it is consistent with the National Marine Fisheries Service (NMFS) data governance guidance (Figure 1).

One of the project's goals was identifying collaborative opportunities between PIFSC divisions and programs. JIMAR staff collaborated with the Operations, Management and Information Division (OMI) to migrate PIFSC version control repositories to a new server, provide database and Application Express (APEX) administration services, and provide a new database server and APEX server. Staff additionally collaborated with FRMD, ESD, and NMFS Office of Science and Technology to document and deploy an APEX reporting application, integrate web services, generate data packages for data archiving, develop data management training modules, and develop specifications for a custom data management application.

The Environmental Data Management to Support Fisheries and Ecosystem Research project also identified data sets that were feasible for direct integration. The project continued to develop the PIFSC Centralized



Figure 8. Modular Optical Underwater Survey System (MOUSS) gear trials with local fisherman on the F/V Ao Shibi Too for the Pacific Island Fisheries Group (PIFG), Main Hawaiian Islands (MHI) Bottomfish Fishery-Independent Survey (BFISH) operations.

Cruise Database (CCD) and implemented the Cruise Data Management Application (CRDMA) to manage cruise information. Formal application testing is currently underway for the CRDMA in preparation for deploying the CCD to the PIFSC production enterprise database to make it available for integration with other production databases. In the future, plans will be developed to integrate the CCD with the existing Modular Optical Underwater Survey System video application database.

To continue improving the quality of PIFSC data management, the project developed and documented additional standards and best practices throughout the report period in the areas of version control, database development, and application development. One standard and two best practices for software development were reviewed and approved by the Software Development Team (SDT); these were then submitted to the DGC for organization-wide implementation to help ensure the integrity of the enterprise database. The project selected an additional six software development standards and best practices that are planned for submission to the SDT.

The project developed data tools and procedures to address a formal phase of the data life cycle. Extensive updates were made to an existing File Operations Module to ensure integrity of the data files and fulfill a PIFSC milestone. The module can be used before or during the processing phase of the data life cycle depending on the data management workflow for a given data set. JIMAR staff compiled a comprehensive Convert Spreadsheet to Oracle Data Model SOP to convert a given spreadsheet to an Oracle relational data model to facilitate the different phases of the data life cycle using standard database tools. The project developed the CRDMA to facilitate the capture and assurance phases of the data life cycle for the CCD. Project staff are currently developing substantial upgrades to an existing Data Validation Module (DVM) framework to formally address the assurance phase of the data life cycle for a given Oracle scientific database; this is scheduled for completion within the project year. Following the DVM upgrades, JIMAR staff will publish the module on GitHub to allow for community use and development as requested by the PIFSC Director's Office. The project upgraded an existing Authorization Application Module (AAM) to satisfy an updated NOAA security requirement and completed a formal System Change Request (SCR) to make it available for all PIFSC applications. JIMAR staff developed a database and APEX administration project to provide standardized tools to streamline common administration tasks. Staff developed a Database Module Package project to streamline the installation of multiple complementary custom PIFSC modules to facilitate the software development process. Project staff developed a Template Application in APEX to streamline the process of developing secure applications that integrate custom PIFSC modules as well as standards and best practices established by the SOD Data Management Team. The project created or updated sixteen SOPs during the project year to provide guidance for common software development and data management activities.

In order to streamline getting started with PIFSC data systems and scientific data management, the project compiled guidance for installing standard software and using the version control, database, and APEX application servers. The guidance includes links to all related PIFSC tools, SOPs, and resources for each server type. Throughout the reporting period, the project updated the PIFSC Data Enterprise Google Site to provide access to the various data tools, SOPs, standards, best practices, software support contact list, and standard documentation examples maintained by the JIMAR project. The Convert Spreadsheet to Oracle Data Model SOP the project developed is the first of four planned training modules to provide PIFSC staff comprehensive guidance for developing a data model, developing a data management application, implementing formal data validation criteria, and deploying the data system to the production PIFSC servers. The project implemented the Data Model SOP on a specific Life History Program example and provided the resultant project repository that includes standard documentation and all code files used.

In addition to this year's project priorities the JIMAR staff worked with SOD leadership, contributed to the formation of a PIFSC Cloud working group, submitted initiative ideas to the PIFSC Science Council, and cataloged the PIFSC intranet's data section. To maintain proficiency with the latest in data management developments, JIMAR staff attended the 2019 NOAA Environmental Data Management (EDM) Workshop and Ocean Observation 2019 conference and learned about efforts by other organizations to address data management challenges. JIMAR project staff was also designated as a co-chair for a 90 minute session in the upcoming 2020 EDM Workshop scheduled within the project year.

Geospatial Products and Marine National Monuments of the Pacific. Due to staff vacancies, progress on these projects is on hold pending new recruitment action.

Main Hawaiian Islands Commercial Fisheries Fast Track Data Project

P.I.: Douglas S. Luther [JIMAR Project Lead: Frances Tong]

**NOAA Office (of the primary technical contact): National Marine Fisheries Service/
Pacific Islands Fisheries Science Center**

NOAA Sponsor: Michael P. Seki, Beth Lumsden

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

The Main Hawaiian Islands (MHI) Commercial Fisheries Fast Track Data Project is an ongoing JIMAR project that began in September 2007. The primary objective of the project is to improve the accuracy of data collection, timely reporting, and improve processing methods for the State of Hawaii's commercial fisheries and fish dealer data, including the Deep-7 bottomfish fishery that is managed by a federal Annual Catch Limit (ACL).

The ACL is set by the Western Pacific Regional Fishery Management Council (WPRFMC) in the State of Hawai'i to manage sustainable harvest of the deep-7 bottomfish species caught in the main Hawaiian Islands. Near real-time monitoring is needed to close the fishery before the ACL is reached, without exceeding this limit, so data collection and processing must be fast-tracked to provide timely and accurate landings information to assist in the monitoring and management of this fishery. The Deep-7 complex is comprised of six eteline snappers and an endemic grouper, known locally as onaga (*Etelis coruscans*), ehu (*Etelis carbunculus*), opakapaka (*Pristipomoides filamentosus*), kalekale (*Pristipomoides sieboldii*), gindai (*Pristipomoides zonatus*), lehi (*Aphareus rutilans*), and hapu'upu'u (*Hyporthodus quernus*).

Hawai'i Revised Statutes require commercial fishers to submit their monthly fishing reports within ten days following the month in which marine life was taken. The Department of Land and Natural Resources (DLNR) Hawaii Division of Aquatic Resources (HDAR) implemented a new Administrative Rule on September 1, 2011, requiring commercial fishermen who catch Deep-7 species to submit trip reports within five days of their trip end date. JIMAR staff work in collaboration with DLNR-HDAR to fast-track deep-7 bottomfish fishing and dealer data in order to successfully monitor the fishery. The fishing year for the deep-7 bottomfish fishery opens annually on September 1st and closes either when the total landings are predicted to reach the ACL or on August 31st (whichever occurs first).

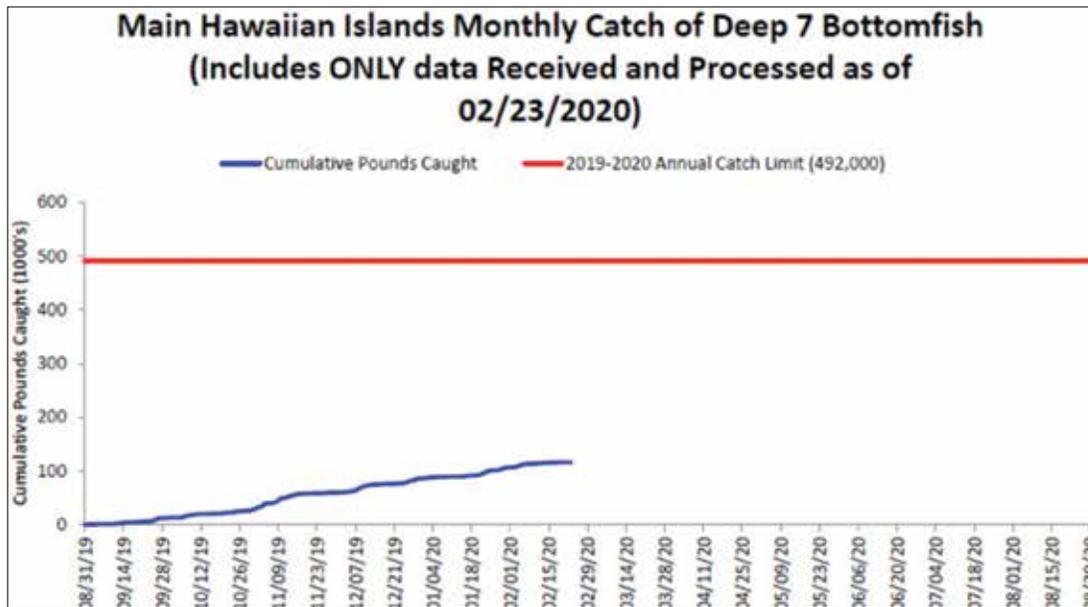


Figure 1. Accumulated pounds for the MHI Deep-7 bottomfish fishery during for the 2019–2020 federal fishing year (115,849 lbs or 23.5% of the ACL of 492,000 lbs).

Progress during FY 2020

JIMAR staff successfully fast-tracked data processing of the Main Hawaiian Islands commercial catch and dealer reports, including the Deep-7 bottomfish fishery that is managed by a federal ACL for the 2019-2020 fishing year ending August 31, 2020. As of February 23, 2020 (the most recent report), commercial fishers landed 115,849 pounds of Deep-7 bottomfish, or 23.5% of the ACL at 492,000 pounds.

DLNR-HDAR launched the new Online Commercial Marine Dealer Reporting System (ODR) in July 2017 which was in a testing phase until October 2019 when it went live as a public-facing web application. The website allows commercial marine dealers to report their commercial marine purchase reports online instead of submitting paper or emailed reports. The Online Fishers Reporting System (OFR), launched in 2010, continues to operate as the means for fishers to report their catch. JIMAR staff continued to provide technical support and maintenance for both OFR and ODR websites.

The full conversion of the obsolete Visual FoxPro-based database to a MySQL database for the HDAR Fisher Reporting and Dealer System will be completed by the end of 2020. After a long break work was restarted in July 2019 to redesign the database that houses State of Hawaii commercial fisheries data at PIFSC. These are some of the last datasets to be converted from Visual FoxPro to MySQL. All work was developed and implemented by Western Pacific Fisheries Information Network (WPacFIN).

By the end of July 2019, JIMAR had only one staff person at the HDAR office due to staff attrition and upon completion of commitments, the project ended.

National Ocean Acidification Observing Network—Oahu NCRMP Class III

P.I.: Christopher Sabine

NOAA Office (of the primary technical contact): Ocean Acidification Program

NOAA Sponsor: Dwight Gledhill

NOAA Goal(s)

- Healthy Oceans
- Resilient Coastal Communities and Economies
- NOAA Enterprise-wide Capabilities: Observing, Modeling, and Engaging for all Goals

Purpose of the Project

This project uses an autonomous buoy in Kaneohe Bay, Oahu, HI to measure carbon dioxide (CO₂) in the atmosphere and dissolved in seawater as well as a variety of other environmental parameters necessary to understand the biogeochemistry of the ocean carbon cycle and ocean acidification. One of the project's objectives is to resolve local from basin-scale drivers of the inorganic carbon system in coastal waters. This study will also logistically support reef studies conducted by colleagues at other institutions and be part of larger national and international efforts under the auspices of NOAA and the Global Ocean Acidification Observing Network (GOA-ON). Nearly ten years of high-temporal resolution data from these buoys around Oahu are now beginning to reveal trends of increased CO₂ in coastal waters that will continue and could further exacerbate the impact of ocean acidification on valuable reef systems. Ocean acidification could significantly affect the fishing industry and tourism (through degradation of beaches and reefs), both major components of Hawaii's economy. This research work can help resource managers understand how the chemistry of Hawaiian coastal waters is changing over time and the implications for coastal services.

Progress during FY 2020

This past year marked the official transition of mooring operations from E. De Carlo to C. Sabine. Sabine oversaw the mooring maintenance and validation sample collection and analysis. The activities remain largely the same as described in the prior annual reports. His team will continue to support the broader agency (NOAA/PMEL, NOAA/OAP) based efforts to develop technologies to monitor coastal processes, with emphasis on the inorganic carbon system (CO₂-carbonic acid system) and ocean acidification (OA). The Coral reef instrumented platform-2 buoy (CRIMP-2) is a National Coral Reef Monitoring Program (NCRMP) Class III (climate level) observing station, one of two in the Pacific, and is an important asset supporting the goals of the national and global OA observing efforts. The project continued to collect and analyze bottle samples for the subsequent laboratory determination of dissolved inorganic carbon (DIC) and total alkalinity (TA) at two week intervals (weather and sea conditions permitting). They also conducted short term high intensity sampling experiments in conjunction with projects undertaken by academic and agency colleagues whose objectives are to: 1) derive a better understanding of processes driving coral reef metabolism near the project's fixed moored autonomous partial pressure of CO₂ (MAPCO₂) buoy sites; 2) develop and test new technology permitting precise and accurate automated measurement of two of the four CO₂-carbonic acid system (with PMEL and SIO colleagues); and 3) continue the long standing high frequency time-series pCO₂ (11th year) observations on a coral reef environment.

NCRMP Pacific Reef Assessment and Monitoring Program (RAMP)

P.I.: Douglas S. Luther [JIMAR Project Lead: Brittany Huntington]

**NOAA Office (of the primary technical contact): National Marine Fisheries Service/
Pacific Islands Fisheries Science Center**

NOAA Sponsor: Michael P. Seki, Russell Brainard

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

The JIMAR National Coral Reef Monitoring Program (NCRMP) Pacific Reef Assessment and Monitoring Program (RAMP) project is a multi-disciplinary research endeavor to monitor and assess the condition of coral reef ecosystems in the main Hawaiian Islands (MHI), the Northwestern Hawaiian Islands (NWHI), the Pacific Remote Island Areas (PRIA), the Commonwealth of Northern Mariana Islands (CNMI), American Samoa, and Guam. JIMAR NCRMP Project supports the NOAA Pacific RAMP project which in turn supports the National Coral Reef Monitoring Program (NCRMP). The overall project goal is to inform effective management by providing high-quality scientific data on the health and vitality of coral reefs in the U.S. Pacific Islands. This interdisciplinary, integrated approach to ecosystem monitoring requires coordinated research from the JIMAR staff in the NOAA NMFS Pacific Islands Fisheries Science Center (PIFSC) Ecosystem Sciences Division (ESD)

across three research focuses: fish ecology and monitoring; benthic ecology and monitoring; and, ocean and climate change. NOAA continues to rely on the expertise of JIMAR personnel who are instrumental in completing the Pacific RAMP efforts in support of the larger national NCRMP program.

Progress during FY 2020

Field Mission. The Hawaiian Islands RAMP (HARAMP) cruise was completed in mid-September 2019 and included fish, benthic, and ocean and climate monitoring surveys of the MHI and the NWHI. JIMAR benthic scientists executed a pilot study to evaluate the potential of Structure-from-Motion photogrammetry techniques to yield efficient collection and extraction of benthic coral community data. Due to the COVID-19 pandemic shutdown, the Marianas Archipelago RAMP cruise (scheduled to start in April 2020) is delayed until 2021.

Data archive for FY 2019. Data collected during this reporting cycle are in various stages of the data lifecycle progress. Datasets submitted to the NOAA archive from the FY19 NCRMP mission include diver-based observations from reef fish and coral demographic surveys, water temperature data from subsurface temperature recorders, benthic images, and benthic cover derived from the images. Additionally, diver-based observations, images, and benthic cover from the 2019 coral bleaching surveys and from the 2020 American Samoa benthic mission were submitted to the archive. The remaining datasets collected in 2019 are in progress, and not anticipated to be ready for submission to the NOAA archive by the end of this reporting cycle for the following reasons:

- Processing of the Calcification Accretion Units for calcification rate data is on hold due to access restraints to lab facilities during COVID-19 pandemic shutdown.
- Carbonate chemistry and diel suite datasets are delayed due to a database migration.
- Structure from motion imagery has been postponed due to large data transfer challenges with the NOAA archive.

To address data integrity issues with the OCC data streams, the Data Services Team is migrating the data from a Microsoft Access database to Oracle and developing an Oracle Application Express tool to channelize the entry of this data with appropriate validations. This resulted in improved data accuracy and integrity of existing OCC data streams, and the project resubmitted these data streams to the data archive.



(above) Figure 1. Deploying the small boat Malolo from the NOAA Ship Oscar Elton Sette off the coast of Ni'ihau.



(right) Figure 2. JIMAR scientific divers using Structure-from-Motion technology to image the three-dimensional structure of the coral reef.

Ocean Remote Sensing

P.I.: Douglas S. Luther [JIMAR Project Lead: Jeffrey Hare]

**NOAA Office (of the primary technical contact): National Marine Fisheries Service/
Pacific Islands Fisheries Science Center**

NOAA Sponsor: Michael P. Seki, Evan Howell

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

This JIMAR project distributes a suite of reprocessed, delayed and near real-time satellite oceanographic data products to the scientific community, management and conservation agencies, and the general public through web-based services. These datasets include sea surface temperature, dynamic sea surface topography and geostrophic currents, surface winds, and ocean color products, such as chlorophyll-a concentration, photosynthetically available radiation (PAR), diffuse attenuation coefficient at 490 nm (Kd490). These products are served at various temporal (daily, weekly, monthly) and spatial scales (regional or global). The project also works with local, regional, and international users to explore and foster new partnership opportunities and develop a suite of climate indicators for research purposes.

Progress during FY 2020

In addition to maintaining databases and servers and servicing data to OceanWatch-Central Pacific (OWCP) users, the project continued its collaboration with the Pacific Islands Ocean Observing System (PacIOOS) and OWCP data was regularly updated on the PacIOOS Voyager site.

Datasets that were added to the OWCP online portals include: Global Seascapes dataset; NOAA Coral Reef Watch product suite for coral bleaching; NOAA Sea Level Anomaly and Geostrophic Currents; Cross-Calibration Multi-Platform (CCMP) v2.0 Wind product, available in near-real time; Soil Moisture Ocean Salinity (SMOS); Soil Moisture Active Passive (SMAP) salinity product; and European Space Agency (ESA) Climate Change Initiative (CCI) Ocean Color (OC) v4.2 products.

All datasets available online via Environmental Research Division Data Access Program (ERDDAP) or Thematic Realtime Environmental Distributed Data Services (THREDDS) by OWCP were modified to be centered on the Pacific to simplify downloading procedures for users in the Pacific Region.

The tutorials section of training materials for a three-day satellite course were adapted to Python and all training materials (lectures, R scripts, Python scripts, tutorials) were converted to a Gitbook and made available online. Gitbook also allows integration with Github for version control which will simplify subsequent updates. The training course was scheduled to be organized at PIFSC but had to be canceled due to the COVID-19 pandemic shutdown.

The JIMAR OceanWatch Researcher/Manager, Dr. Melanie Abecassis, assisted the regional fishing council and PIRO in investigating recent increases in loggerhead interactions in the shallow-set longline fishery and provided the TurtleWatch product to longline fishermen. TurtleWatch provides daily maps of sea surface temperatures with a range of temperatures identified as the zone to avoid in attempt to reduce turtle interactions. She also participated on the steering committee of a new Ecosystem-Based Fisheries Management project aimed at estimating risk contours of interactions in the longline fishery. In February 2020, Dr. Abecassis presented a poster about OceanWatch and gave a talk at the NOAA booth at the American Geophysics Union meeting in San Diego CA.

Dr. Abecassis also contributed graphics and analyses for various chapters of the 2020 Stock Assessment and Fishery Evaluation (SAFE) reports developed by the Western Pacific Regional Fishery Management Council, generated data for a project on land-based source pollution in American Samoa (which will be hosted online by PacIOOS), and contributed figures for the NOAA/NOS Papahānaumokuākea Marine National Monument Five-Year State of the Monument Report.

Finally, the project produced an outreach brochure on CoastWatch/OWCP for distribution at scientific conferences.

On-site Support for OA Mooring Test-beds: Evaluating and Expanding New Carbon Technologies to Subsurface Habitats

P.I.: Christopher Sabine

NOAA Office (of the primary technical contact): Ocean Acidification Program

NOAA Sponsor: Dwight Gledhill

NOAA Goal(s)

- Healthy Oceans
- Resilient Coastal Communities and Economies
- NOAA Enterprise-wide Capabilities: Observing, Modeling, and Engaging for all Goals

Purpose of the Project

The NOAA/PMEL Carbon Group has been augmenting and expanding high-frequency observations on moorings to provide valuable information for better understanding natural variability in inorganic carbon chemistry over daily to inter-annual cycles. The current NOAA ocean acidification (OA) mooring network consists of 21 moorings in coral, coastal, and open ocean environments which host a standardized suite of surface sensors measuring air and seawater partial pressure of CO₂ (pCO₂), pH, temperature (T), salinity (S), dissolved oxygen (DO), fluorescence, and turbidity at all sites. Although OA is primarily driven by uptake of CO₂ from the atmosphere, many coastal and estuarine processes that affect water chemistry and the interpretation of coastal OA are manifested in subsurface waters. Furthermore, many of the most sensitive organisms (e.g., corals, shellfish) are benthic and respond primarily to subsurface water chemistry. The objectives of this project are to: provide on-site support at existing Hawaii MAPCO₂ buoy sites to evaluate the best carbon system technologies to deploy in the subsurface; demonstrate the utility of these enhanced observations on the moorings; and to make recommendations on how advanced technologies can be incorporated into the overall OA program. In addition to the deployment and servicing of benthic instruments, other on-site support includes conducting analyses of water samples in the project's laboratory at the UH Manoa campus.

Progress during FY 2020

Multiple sensor deployments were conducted at the CRIMP2 site. Dr. E. Briggs and Dr. T. Martz tested a novel combined pH and Total Alkalinity (TA) sensor twice over the past year. The results of the first deployment were recently published in Briggs et al. (2020). The second deployment was in conjunction with a new Submersible Autonomous Moored Instrument for alkalinity system (SAMI-alk) provided by NOAA/PMEL. Unfortunately, both systems failed within the first two days so no useful data were collected. The manufacturers have since fixed the problem, but because of the COVID-19 pandemic shutdown, the project was unable to redeploy the systems for the next round of tests.

Pacific Fisheries Monitoring Program

P.I.: Douglas S. Luther [JIMAR Project Lead: Frances Tong]

**NOAA Office (of the primary technical contact): National Marine Fisheries Service/
Pacific Islands Fisheries Science Center**

NOAA Sponsor: Michael P. Seki, Keith Bigelow

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

This JIMAR project works to provide the Pacific Islands Fisheries Science Center (PIFSC) with timely and accurate Fishery Ecosystem Plan (FEP) logbook data and other fishery information for use in research

and management towards the goal of maintaining a healthy ocean, which provides for a resilient and economically sound community. The main focus of the work is the daily monitoring of the Hawaii and American Samoa pelagic longline fleets, along with four California vessels, which are presently and increasingly subject to international management at a species level. The project provides PIFSC and the fishing industry a contact point for feedback and information exchange with fishery scientists and managers.

Progress during FY 2020

The JIMAR staff continued to provide timely high-level support to fishery monitoring activities by providing high quality fisheries data to NMFS, PIFSC, and other JIMAR projects. Staff collected federal logbooks and Pacific tuna fishery purse seine fleet data forms. Data was run through a quality control process, entered into the system via data entry applications, processed and loaded into databases.

The general Hawaii-permitted longline fleet-wide quarterly reports were completed forty-five days after the end of the quarter. As of June 2020, staff collected and processed 9,427 logbook set forms from Hawaii, 994 set forms from American Samoa and 165 set forms from California. The COVID-19 pandemic shutdown negatively impacted paper logbook data entry.

The Electronic Reporting (ER) team, comprised of JIMAR and PIFSC staff, deployed tablets installed with ELog-It software on 23 vessels. Elog-It is an Android application that enables longline captains to securely record and submit their logbook data electronically in real time. A total of 62 vessels (43% of the fleet) are currently using Elog-It. During FY 2020, 460 e-log trips with approximately 5,910 fishing set and haul forms were successfully transmitted by fishing captains and received at PIFSC. Further deployment of the ER systems was delayed because of the COVID-19 pandemic.

Captains expressed satisfaction with the ER application's simple and user-friendly interface and discovered that using the application to complete electronic logs was faster than filling out paper logsheets. Feedback and suggestions are continually compiled and will be considered for future application updates.



Figure 1. JIMAR Electronic Monitoring Team, Jennifer Stahl and Matthew Carnes, installing a new camera for a cooperative research project.



Figure 2. Walter Machado, JIMAR Data Team, checking newly collected logsheets before heading into the office.

Further adoption of ER will significantly improve the timeliness of data availability for Regional Fishery Management Organization (RFMO) reporting, scientists and researchers, and forecasting fishing area closures. Implementing ER has reduced the time and labor required to manually enter or keypunch the fisheries data by JIMAR staff. Staff can now allocate more resources to performing quality control on ER data, processing ER data and providing technical support to captains and vessel owners.

The Fast-Track program for selected species also continued into FY 2020 for the bigeye tuna and striped marlin. Fast-track information is used to forecast landings, predict possible closure dates of the Hawaii-permitted longline bigeye tuna fishery, and anticipate when the Western and Central Pacific Fisheries Commission (WCPFC) and Inter-American Tropical Tuna Commission (IATTC) annual quota are expected to be reached. Striped marlin landings are fast-tracked due to stock concerns.

Tallies were compiled weekly or as necessary as the quota was met. Additional quality control procedures and cross checks of relevant databases were implemented as needed to continually validate and improve the quality of results and timeliness of the product. Cross-checks involved a matching program that compared the longline logbook tuna counts to sales records from dealer data. The fisheries observer data were reconciled with Hawaii longline logbook data.

Electronic monitoring (EM) continued to be managed entirely by JIMAR staff. In FY 2020, a technical memo was published summarizing results from data comparisons drawn between fisheries data collected using EM and data collected by at-sea observers. The memo avers that EM can detect fish and protected species reliably and at a cheaper cost than current monitoring methods. Also during the reporting period, many technical issues were encountered as systems aged. While JIMAR staff fixed many of the systems, ultimately they needed to research procurement of new replacement platforms. From January to June 2020, the EM systems were used for the first time in cooperative research to investigate how bird interaction mitigation devices, called tori lines, can be used to minimize bird catches during longline setting operations. This project was the first of its kind where Pacific Island Region (PIR) staff outside of PIFSC used EM systems in novel research. In February 2020, JIMAR project staff attended the third EM workshop in Renton, Washington, and presented on the successful training of AI technology to identify fishing events. After curating a training set that included over 250,000 images and training a YOLOv3 convolutional neural net, fishing events were successfully detected 88% of the time with no human intervention.

The paper logbook scanning and archiving project is ongoing.

Pacific Islands Territorial Science Initiative

P.I.: Douglas S. Luther [JIMAR Project Lead: Frances Tong]

**NOAA Office (of the primary technical contact): National Marine Fisheries Service/
Pacific Islands Fisheries Science Center**

NOAA Sponsor: Michael P. Seki, Beth Lumsden

NOAA Goal(s)

- Healthy Oceans
- Resilient Coastal Communities and Economies

Purpose of the Project

The overarching objective of the JIMAR Pacific Islands Territorial Science Initiative (TSI) project is to improve the volume and quality control of catch data from the fisheries of the U.S. Pacific territories of Guam, American Samoa, and the Commonwealth of the Northern Mariana Islands (CNMI). Insufficient data collection and quality control in the territories has resulted in a paucity of fisheries information to guide management actions mandated by the Magnuson-Stevens Act and other federal law. The small size and modest budgets of territorial governments, relatively low commercial value of the diverse and small-scale fisheries, and limited physical presence of National Marine Fisheries Service (NMFS) staff in these islands all detract from the efficacy of data collection programs. Thus, there is a need to improve the amount and detail of fisheries monitoring data collected from the territories along with improving quality control, in order to enable fisheries scientists to conduct more accurate stock assessments. The TSI project collaborates with several other JIMAR projects and Pacific Islands

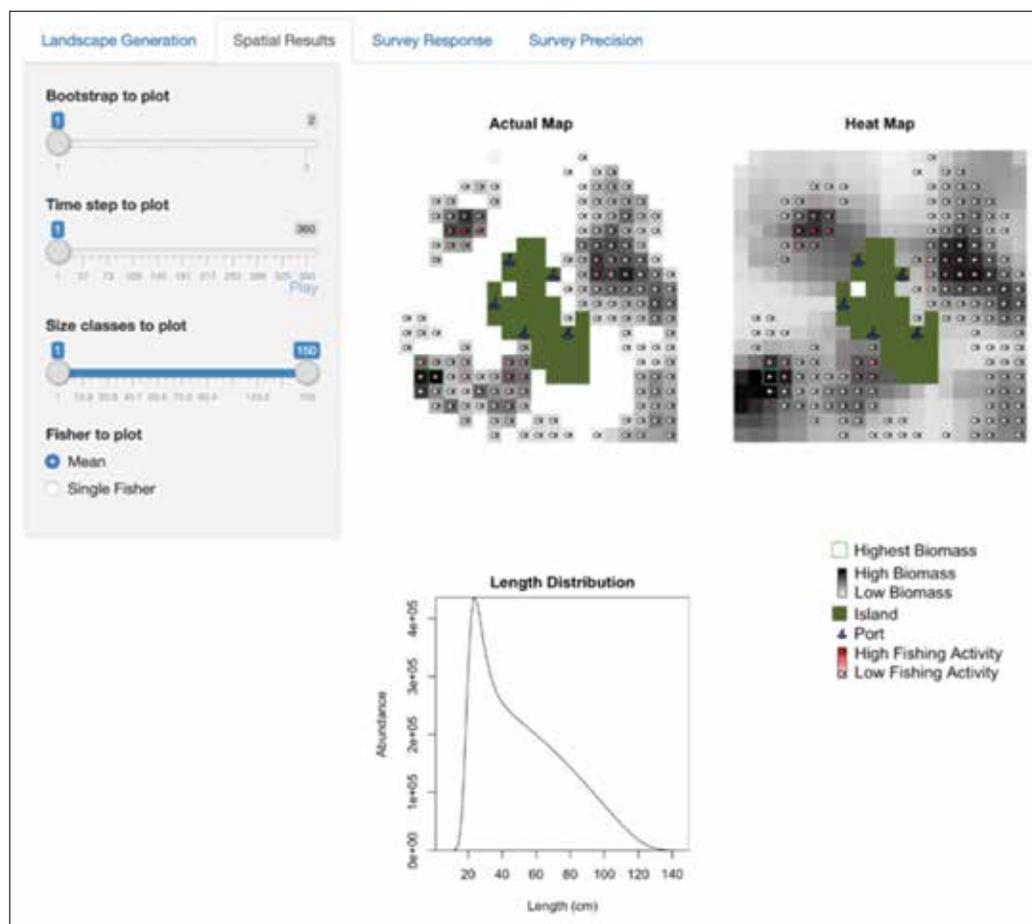


Figure 1. Simulation output from the single-species neutral landscape model, showing for a single time step: 1) actual distribution of fish and fishing effort; 2) fishers' heat map of believed fish distribution based on previous trips; and 3) length distribution of fish.

Fisheries Science Center (PIFSC) programs to promote better communication with management agencies in the territories, establish and improve protocols for fisheries monitoring and sampling, and develop tools for data expansion and summary analyses.

Progress during FY 2020

During the reporting period, a JIMAR Fisheries Database Assistant keypunched boat-based and shore-based creel survey data, boat log and commercial receipt book data; scanned in creel survey sheets to a document management system; and performed quality checks of the entered data. As part of the quality control process for entered data, JIMAR staff worked with the federal territory liaison during each of the liaison's trips to Guam to cross-check data identified by automated error checking programs and make corrections as needed.

JIMAR project staff also worked with the Guam Division of Aquatic and Wildlife Resources (DAWR) Education Program Manager to conduct outreach at schools and assist at DAWR events, such as the Spring Economic Outlook Forum.

As of February 2020, the responsibility to enter the boat-based and shore-based creel survey data, boat log data, and log sheet scanning transitioned to the Guam DAWR office. Data activities for the commercial receipt books transitioned to a contractor through the Western Pacific Regional Fishery Management Council.

The project's Territorial Fisheries Data Specialist completed a single-species neutral landscape model which generates random landscapes consisting of an island and surrounding reef habitat populated with fish and fishers. Fish are represented both in abundance and length distribution, and fishers are modeled using an agent-based approach. Together these allow survey data for a number of fishery and ecosystem surveys to be simulated under

a variety of fishing scenarios and fish life histories. Initial analysis that compared the statistical performance of these surveys was completed and a manuscript is currently in progress. Progress was also made on a second model that integrates data from multiple survey types through a Bayesian framework to provide more power to multi-survey monitoring programs.

JIMAR project staff also worked with other JIMAR and federal staff at PIFSC and began preparing code and documentation for an external review of the creel survey expansion algorithms used in the U.S. Pacific territories. Full versions of the code for each survey expansion were proposed and an outline of the accompanying documentation was completed.

Pacific Tuna Fishery Data Management

P.I.: Douglas S. Luther [JIMAR Project Lead: Frances Tong]

**NOAA Office (of the primary technical contact): National Marine Fisheries Service/
Pacific Islands Fisheries Science Center**

NOAA Sponsor: Michael P. Seki, Keith Bigelow

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

The objective of this project is to develop improved data management tools to preserve and provide scientific and management access to purse seine tuna fishery data obtained by U.S. flagged vessels licensed under the South Pacific Tuna Treaty (SPTT). This important data set is of high value to tuna stock assessment scientists, tuna fisheries monitoring, fisheries managers and policy makers. JIMAR develops contemporary tools to enable access to these data and a system for sustained data management. The project coordinates with several NOAA National Marine Fisheries Service (NMFS) offices to effect the development of the data management system and also collaborates with several Pacific Islands Fisheries Science Center (PIFSC) programs and the Pacific Islands Regional Office (PIRO) divisions for subsequent access and analysis functions and to meet monitoring and reporting requirements.

Progress during FY 2020

The project continued with ongoing data management activities to ensure data quality, accuracy, and completeness. JIMAR staff entered the regional purse seine log sheets (RPL), unloading and trans-shipment log sheets (UL), final out turn receipts (FOT), and sampling forms received into the enterprise database using the existing data management applications and maintained the various reference lists used in the SPTT database throughout the year. The project evaluated the defined data quality control checks on a regular basis for the RPL, UL, FOT, and sampling data streams and resolved data issues to help ensure the quality of the data used for reports and data analysis.

Sustaining Healthy Coastal Ecosystems

P.I.: Douglas S. Luther [JIMAR Project Lead: Brittany Huntington]

**NOAA Office (of the primary technical contact): National Marine Fisheries Service/
Pacific Islands Fisheries Science Center**

NOAA Sponsor: Michael P. Seki, Russell Brainard

NOAA Goal(s)

- Healthy Oceans
- Resilient Coastal Communities and Economies

Purpose of the Project

The JIMAR Sustaining Healthy Coastal Ecosystems (SCHE) project is a multi-disciplinary research endeavor that seeks to monitor and assess the condition of coral reef ecosystems in the main Hawaiian Islands (MHI), the Northwestern Hawaiian Islands (NWHI), the Pacific Remote Island Areas (PRIA), the Commonwealth of Northern Mariana Islands (CNMI), American Samoa, and Guam. The project objective is to support effective management by providing high-quality scientific data on the health and vitality of coral reefs and reef fish communities including evaluating and reducing adverse impacts to coral reef ecosystems in the U.S. Pacific Islands. These impacts include: 1) land based sources of pollution (LBSP); 2) fishing impacts; and 3) climate impacts. Future goals include developing effective coral restoration and intervention strategies. This interdisciplinary, integrated approach to ecosystem monitoring requires coordinated research from the JIMAR staff in the NOAA NMFS Pacific Islands Fisheries Science Center (PIFSC) Ecosystem Science Division (ESD). Project goals accomplished during the reporting period are described below.



Figure 1. Final PRIMNM Report Workshop in December 2019.

Progress during FY 2020

Bleaching Surveys. In collaboration with the Hawaii Coral Bleaching Collaborative, JIMAR scientists in NOAA's ESD joined a multi-institution effort to document the extent and severity of coral bleaching in the main Hawaiian Islands. The goal was to lay the groundwork for tracking coral response and recovery through time by rapidly assessing bleaching stress in as many of Hawaii's coral reefs as possible. With this dataset, JIMAR and ESD aim to learn about which factors enhance coral resilience to bleaching, identify where coral appear most susceptible to bleaching, and inform active intervention and emerging restoration methods to help maintain Hawaii's corals into the future.



Figure 2. Structure from Motion (SfM) 'virtual' workshop held in May 2020 to train partners in methodology.

Pacific Remote Islands Marine National Monument (PRIMNM) Report and Workshops. During the reporting period, the comprehensive report entitled “Coral Reef Ecosystem Monitoring Report for the Pacific Remote Islands Marine National Monument: 2000–2017” was completed and disseminated to jurisdictional partners throughout the U.S. Pacific Islands. The report presents data and analyses of integrated, interdisciplinary ecosystem observations conducted from 2000–2017 as part of the Pacific Reef Assessment and Monitoring Program. The report includes individual island/atoll chapters for Palmyra, Johnston, Kingman, and Wake Atolls and Howland, Baker, and Jarvis Islands. The final chapter of the report adopted a “Pacific-wide” integration lens that compares coral reef ecosystems amongst the different islands and atolls of the PRIMNM with those of the other U.S.-affiliated Pacific Islands. The final workshop with Pacific Islands Regional Office on the Pacific-wide chapter was held on December 9, 2019.

LBSP efforts in American Samoa. A workshop was held for the American Samoa partners to report on the spatial LBSP products developed in FY 2019 and to teach partners how to navigate the Geographic Information Systems (GIS) layers. Project deliverables included a seminar led by ESD JIMAR staff in Pago Pago on January 30, 2020. Stakeholder partners that attended the seminar were from the following agencies: the American Samoa Department of Marine and Wildlife Resources, the Coral Reef Advisory Group, American Samoa Environmental Protection Agency, Department of Homeland Security, and the American Samoa GIS working group, among others. The seminar provided partners with an outline of the GIS layers, data sources and methodology for layer assemblage, as well as potential applications of the tool. The deliverable comprised three main products: 1) oceanography spatial layers; 2) a coastal habitat modification spatial layer; and 3) an estimated sediment loading spatial layer. The project also provided the stakeholders an external drive containing all data layers, scripts for data manipulation, as well as finalized visualization products. Local stakeholders received the tool with great interest and enthusiasm.

Summary report for the Kahekili Preserve on Maui. Due to funding limitations from the Coral Reef Conservation Program, the Kahekili monitoring was rescheduled for FY 2021. Hence, no summary report was produced this year.

Territorial Biosampling

P.I.: Douglas S. Luther [JIMAR Project Lead: Melanie Hutchinson]

**NOAA Office (of the primary technical contact): National Marine Fisheries Service/
Pacific Islands Fisheries Science Center**

NOAA Sponsor: Michael P. Seki, Joseph O’Malley

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

The JIMAR Territorial Biosampling project conducts both fundamental and innovative life-history research on federally-managed coral reef fish and bottomfish species of commercial, ecological, and cultural value, with a geographic focus on the Pacific Islands under U.S. jurisdiction. The project endeavors to generate life history parameters for species of interest and provides these data to those charged with the management of marine fishery resources as mandated by legislation. Additionally, the project strives for a more comprehensive understanding of the influence of biophysical and anthropogenic forces on fish life histories. This project



Figure 1. Fish reproduction training session with Saipan DFW and MES.

works to elucidate the spatial and temporal trends of these relationships to better predict the impacts they may have on harvested fish demographics with changing future ocean conditions.

Progress during FY 2020

Project work for the reporting period focused on delivering research output describing life-history strategies of several commercially-harvested and coral reef fish species and deep-water snappers from around the U.S. Pacific Islands. The project also focused on increasing sampling efficiency and prioritizing life history sampling for territory Management Unit Species (MUS). A Fish Life History Scientist was hired to increase data output for fish species of interest, facilitate communication with the Stock Assessment Program (SAP) to fulfill data requirements, and manage the territorial Commercial Fisheries Biosampling Programs. JIMAR project staff presented at the PIFSC Insular Fisheries Monitoring Assessment and Planning Summit (PIFMAPS) in August 2019. This meeting was crucial for the JIMAR Territorial Biosampling program in planning and developing future sample designs to achieve MUS mandates. To implement improved sampling techniques, JIMAR staff met with the Commercial Fisheries Biosampling Program teams of Guam and CNMI to develop a research plan for identifying and prioritizing the data gaps in territorial MUS that needed to be addressed. A technical report that examined different sampling designs for collecting biological specimens for life history research was prepared for stakeholders. This technical report will be used to develop the species-specific sampling ‘checklists’ that will be distributed to the territories for increased efficiency in life history sampling and analysis.

Other major project accomplishments included: manuscript documenting age, growth, and maturation of two goatfish species from Saipan; continuation and expansion of a collaborative sampling effort with local fishers and seafood vendors for a deep-water snapper (*Etelis coruscans*) in the MHI; and the life history analysis for two species (*C. melampygus* and *P. zonatus*). In addition, through continued education and



(top) Figure 2. Life History Program Cruise (SE-19-04) on the Oscar Elton Sette in June–July 2019. Erin Reed was the Project lead for *Onaga* (*Etelis coruscans*) sampling for this cruise. This sampling is part of a larger study Erin is leading on the updated reproduction characteristics of female *onaga* in the Main Hawaiian Islands. Pictured below is Erin Reed, Ryan Nichols NOAA federal LHP, and Mills Dunlap, coxswain from the NOAA ship.

Figure 3. JIMAR scientist Erin Reed teaching biology and anatomy of marine fishes to kindergarteners from Le Jardin elementary school. The students toured the Oscar Elton Sette and learned about the varied research topics that participating scientists study at PIFSC.

training, project staff explored other techniques to address temporal variability in fish life history traits including training in dendrochronology techniques applied to fish otoliths. A PIFSC LHP research cruise to American Samoa scheduled for 2020 was cancelled due to the Covid-19 pandemic shutdown. Despite the pandemic restrictions, JIMAR staff continued to work with Territorial partners to facilitate efficient data collection and processing of life history samples.

West Hawaii Integrated Ecosystem Assessment

P.I.: Douglas S. Luther [JIMAR Project Lead: Jonathan Whitney]

**NOAA Office (of the primary technical contact): National Marine Fisheries Service/
Pacific Islands Fisheries Science Center**

NOAA Sponsor: Michael P. Seki, Jamison Gove

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

The JIMAR West Hawai'i Integrated Ecosystem Assessment (IEA) project aims to produce robust scientific information to directly support current and future resource management concerns in West Hawai'i. This area (Kona coast of Hawaii Island) is home to a diverse group of species including ornamental fish, lush coral reefs, sea turtles, cetaceans and manta rays. The region supports a myriad of ecosystem services important to the community, including eco-tourism, an aquaculture industry, and recreational and aquarium fisheries. The balance of these human activities with the natural processes helps to sustain ecosystem health in this productive region.

The goals of this JIMAR project include understanding oceanographic processes that support local ecosystem productivity, assessing key food-web linkages across multiple trophic levels, and quantifying human activities, both on land and in the ocean, that impact marine ecosystem structure and function.

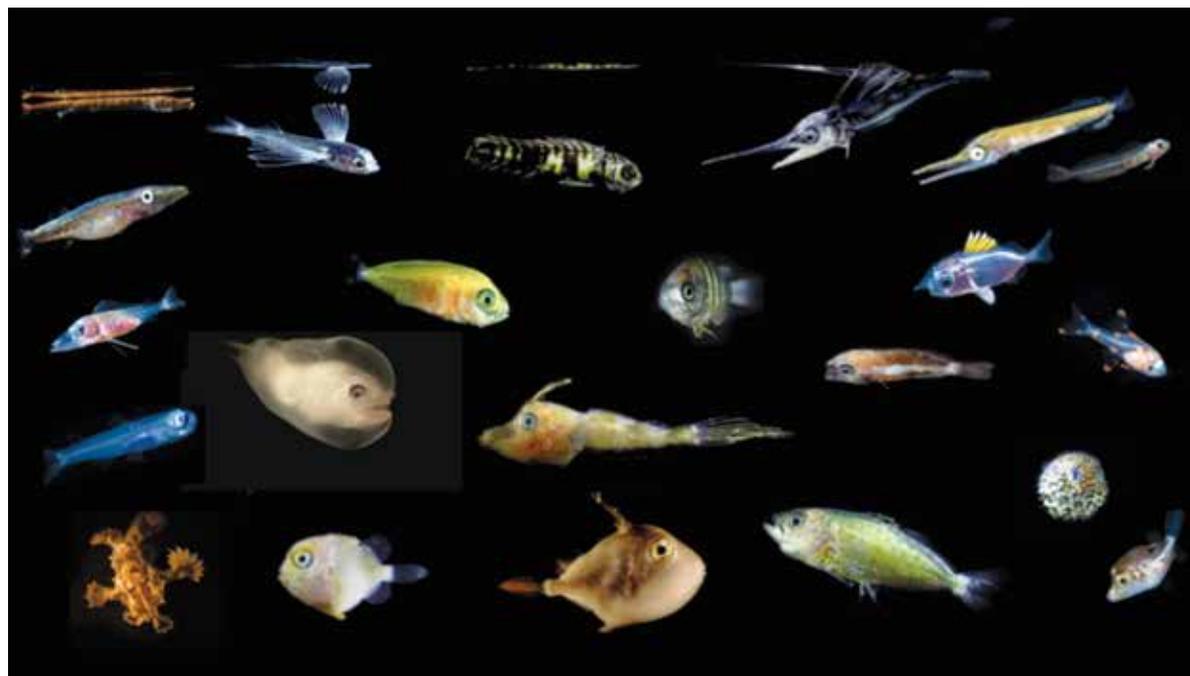


Figure 1. A snapshot of the impressive diversity of larval and juvenile fishes discovered using surface slick nurseries during West Hawai'i IEA research expeditions (Photo: Jonathan Whitney/JIMAR).

Progress during FY 2020

The West Hawai'i IEA Project continued efforts related to scientific information synthesis, manuscript development, and dissemination of research findings from recent JIMAR-led field efforts. Research on ocean processes that govern larval fish survivorship produced novel and widely publicized results that were recently published in the prestigious journal *Proceedings of the National Academy of Sciences*. The research findings demonstrated that surface slicks, meandering lines of convergence on the ocean surface, represent important larval fish nurseries that disproportionately accumulate non-nutritious, toxin-laden prey-size plastics. The project discovered for the first time that tropical larval fish are surrounded by, and ingesting, plastic pieces at a time when nutrition is critical for survival. This research has profound implications for marine ecosystems globally. Surface slicks are a ubiquitous coastal ocean feature, which suggest that plastic accumulation in these larval fish nurseries could have far reaching ecological and socioeconomic impacts.

Numerous international and local news outlets, science blogs, and social media outlets highlighted this groundbreaking research led by JIMAR scientists. The publication is currently in the top 5% of research articles tracked in terms of media attention.

During the reporting period the project also focused on understanding changes in nearshore marine ecosystems and the ability to parse human versus natural changes to marine ecosystem health. Long-term monitoring of corals and reef fish over the past 20 years by PIFSC, JIMAR, the State of Hawai'i, National Park Service, and other partner agencies of the West Hawai'i IEA show that coral reef communities have changed along West Hawai'i. Some geographic areas show positive change while other areas have declined in ecosystem health over the past two decades. Recently developed high-resolution human use information combined with oceanographic data will provide the information needed to elucidate the drivers of reef community change and resilience of reefs over time. Outcomes from these efforts will directly support the State of Hawai'i's research management objectives, including the State's marine management plan where 30% of the nearshore areas will be effectively managed by 2030.



Figure 2. Surface slick fish nurseries along the West Hawaii coastline. Image from long-term time-lapse camera deployment, which takes an image every minute to document movement and frequency of slicks along this dynamic coastline (Photo: Jonathan Whitney/JIMAR).

Western Pacific Fisheries Information Network (WPacFIN)

P.I.: Douglas S. Luther [JIMAR Project Lead: Frances Tong]

**NOAA Office (of the primary technical contact): National Marine Fisheries Service/
Pacific Islands Fisheries Science Center**

NOAA Sponsor: Michael P. Seki, Beth Lumsden

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

The objective of JIMAR's Western Pacific Fisheries Information Network (WPacFIN) project is to provide the best available fisheries monitoring data for research and sustainable management of fisheries in the Pacific Islands Region. WPacFIN partners with agencies in Hawaii, American Samoa, the Commonwealth of the Northern Mariana Islands (CNMI), and Guam. JIMAR and Pacific Islands Fisheries Science Center (PIFSC)

federal staff work with island agency staff, contractors, fishermen, and fish dealers to create data systems that implement quality control measures and synthesize fishery-dependent monitoring data. This technical support enables PIFSC and the partner agencies to produce timely reports of the best available fisheries data from each island area.

Progress during FY 2020

JIMAR project staff continued converting Visual FoxPro (VFP) database applications to MySQL and C# for WPacFIN Central and all partner agencies.

The full conversion of the obsolete Visual FoxPro (VFP)-based database to a MySQL database for the Hawaii Division of Aquatic Resources (HDAR) Fisher Reporting and Dealer System (FRDS) resumed in July 2019 and will be completed by the end of 2020. The goal of the project was to redesign the database at PIFSC that housed State of Hawaii commercial fisheries data to support the transition from VFP to MySQL, a relational database. These are some of the last datasets to be converted from Visual FoxPro to MySQL.

The database redesign project for the State of Hawaii commercial fisheries datasets started with designing a database from a Visual FoxPro database structure to a modern relational database structure following commonly accepted relational database design principles. Priority and large datasets were then identified and imported into the newly redesigned MySQL database.

The data portion of the project involved moving data from VFP to the new MySQL database and spanned the range of data management activities: consolidation of datasets; data cleanup (fixing typographical errors, removing duplicates, marking invalid data, etc.); data validation; and migration and import of data between systems, etc. As part of the data work, an import module for the data exchange between the Online Commercial Marine Dealer Reporting System (ODR) and FRDS was coded, tested and deployed to allow HDAR to manage that part of the data flow.

The following are completed datasets that were successfully imported to the new MySQL database.

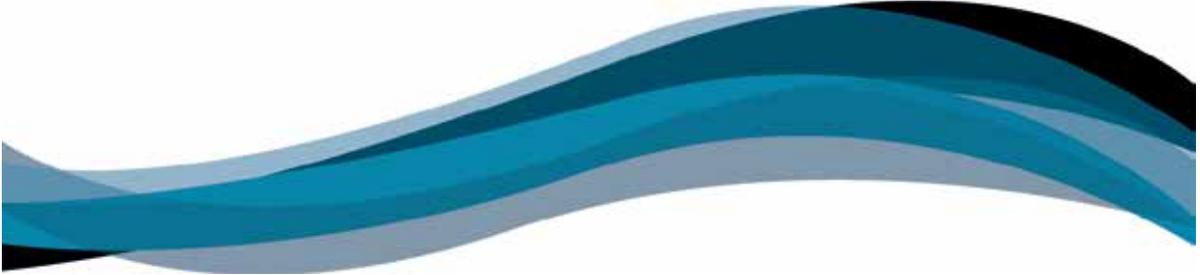
- Fisher Reporting System—data accumulated before online reporting
- Dealer Reporting System—data accumulated before online reporting, Year 2000 through October 2019
- Historical Catch Data—1948–2009
- Commercial Marine License System
- Online Fisher Reporting System
- Online Commercial Marine Dealer Reporting System
- Aquarium Data

The shift to modernize fisheries data access and reporting uncovered a need for a web-based reporting tool that could be used by all of PIFSC staff. Research yielded a software product called “Metabase”, which is a user-friendly, web-based reporting application. A pilot program was started in June 2020 with three databases and future expansion is expected to include other databases throughout PIFSC.

JIMAR project staff continued to provide technical support and training for WPacFIN-produced applications for HDAR. Throughout the year, JIMAR staff also completed data requests and participated in the annual Stock Assessment and Fish Evaluation (SAFE) Report project by programming, doing code reviews, creating or updating documentation, and producing final reports for Hawaii and the territories that are submitted to the Western Pacific Regional Fishery Management Council (WPRFMC).

All work was developed and implemented by Western Pacific Fisheries Information Network (WPacFIN) using Structured Query Language (SQL) and C# in a MySQL environment.

Ecosystem-Based Management



Ecosystem-Based Management

Research under this theme focuses on facilitating an ecosystem approach to management in the Pacific Islands region. JIMAR research interests include investigations of the human dimensions of fisheries management, studies of the economic impacts from changes in fisheries, assessments of pelagic and insular fisheries stocks, and extensive public outreach and education efforts.

Marine Debris Mitigation Project

P.I.: Douglas S. Luther [JIMAR Project Lead: James Morioka]

**NOAA Office (of the primary technical contact): National Marine Fisheries Service/
Pacific Islands Fisheries Science Center**

NOAA Sponsor: Michael P. Seki, Jennifer Samson

NOAA Goal(s)

- Healthy Oceans

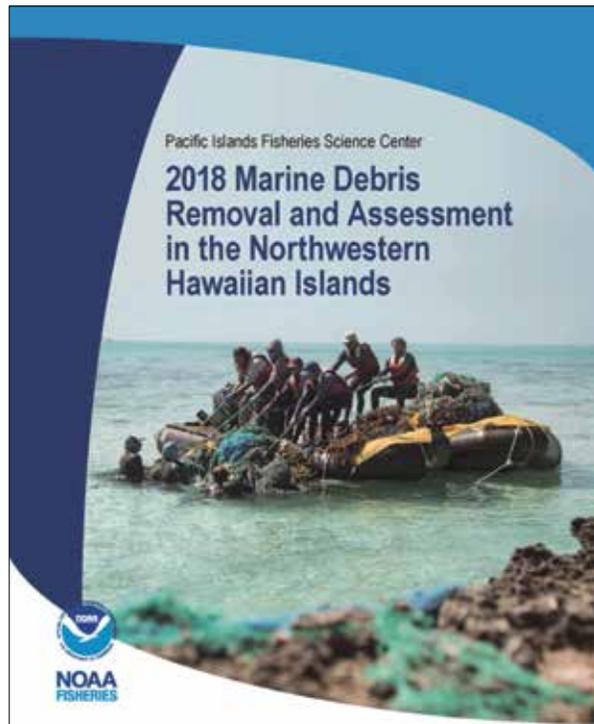
Purpose of the Project

The JIMAR Marine Debris Mitigation project is a research and management endeavor that focuses on derelict fishing gear removal within the U.S. Pacific Islands including the Northwestern Hawaiian Islands (NWHI) within the Papahānaumokuākea Marine National Monument (PMNM) and the main Hawaiian Islands. The overall project objective is to reduce the impact of derelict fishing gear and other sources of marine debris on the health and vitality of coral reefs and critical shoreline habitats.

Many of the islands and shallow water environments in the U.S. Pacific Islands are important habitats for rare species such as the threatened green turtle and the endangered Hawaiian monk seal, as well as millions of seabirds that breed, nest, and feed in these areas. This project supports episodic marine debris removal missions (every three years) that require coordinated efforts from the JIMAR staff in the NOAA Pacific Islands Fisheries Science Center (PIFSC) Ecosystem Sciences Division (ESD) along with support from numerous partner agencies

(below) Figure 1. Monk seal tangled in marine debris in the Northwest Hawaiian Islands.

(right) Figure 2. Cover of the Marine Debris booklet published this year.



to execute the removal of derelict fishing gear from these remote islands and atolls. Outcomes of the project will include improving the quality of shallow coral reef systems and shorelines, critical habitat for numerous marine and avian species.

Progress during FY 2020

No marine debris removal missions were completed during this reporting period. In support of the project objective to better understand the characteristics and spatial accumulation patterns of marine debris, spatial data continued to be collected on net movement. Satellite tracking tags attached to six nets are relaying net movement patterns within the NHWI. Data entry and quality control was completed for the in-water debris removal effort conducted during the fall of 2018. Analysis and report writing were completed to assess the use of structure-from-motion technology to generate photomosaics to measure and quantify impacts of derelict fishing nets on coral reef benthic communities. The manuscript detailing this study was recently accepted to the peer-reviewed journal *Marine Pollution Bulletin* for publication.

Socioeconomics of Western Pacific Fisheries

PI: Douglas S. Luther [JIMAR Project Lead: Hing Ling Chan]

**NOAA Office (of the primary technical contact): National Marine Fisheries Service/
Pacific Islands Fisheries Science Center**

NOAA Sponsor: Michael P. Seki, Justin Hospital

NOAA Goal(s)

- Resilient Coastal Communities and Economies

Purpose of the Project

This JIMAR project supports effective fishery and associated ecosystem management through fisheries socioeconomic data collection and socioeconomics research in Hawaii, American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands (CNMI). It is essential to collect fishery economic data and sociocultural information and monitor changes in key socioeconomic indicators for fisheries in the U.S. Pacific Islands due to the significant contribution of the fishery sector to the local economies and communities and due to constant changes in fishery management and regulations.

Progress during FY 2020

The project successfully supported socioeconomic database management of the Hawaii longline fishery and American Samoa longline fishery and continued economic research and database management in the American Samoa, Guam, and CNMI small-boat fisheries.

Project activities accomplished during FY 2020 are described below by sub-project.

- Project staff assisted with the National Community Social Vulnerability Indicators work plan by developing new data processing scripts and documentation to compile and generate annual social indicator updates to support the national social indicators database for the Pacific Islands Region. Metadata was completed and the database was submitted to the national program.
- To conduct socioeconomic monitoring for resilient communities in the Pacific, an analysis was done on the availability of socioeconomic and biophysical information needed in the Pacific Island Region for effective coastal and fisheries management that takes human well-being into consideration. Staff also assessed information gaps and community awareness. Research methods included a comprehensive review of existing socioeconomic and biophysical data, an online survey, and focus groups. The latter methods were conducted with key individuals involved in monitoring efforts in the Pacific Island Region and National Coral Reef Monitoring Program (NCRMP) and included both current and potential data users. The project also examined the NCRMP and non-NCRMP efforts in the Pacific Islands Region. A NOAA technical memorandum was published that summarized the project results and included recommendations on integrated socioeconomic



Figure 1. On November 16, 2019, JIMAR staff attended a high school seminar hosted by the Saipan Fishermen's Association to share the role of social science in fisheries management and details about the Marianas shark project.

monitoring efforts for the region. Selected key results were presented at the 72nd annual Gulf and Caribbean Fisheries Institute Conference in Punta Cana, Dominican Republic and published in the conference proceedings.

- For the cost-earnings studies of the Hawaii longline fleet and the Hawaii small-boat fisheries, Paperwork Reduction Act (PRA) packages were completed, submitted to the PRA coordinator and both studies are expected to be cleared for data collection in fall 2020. Pre-data collection preparation work including logbook data summary for the longline vessels, meeting with the Hawaii Longline Association, and logistics are underway. The next steps are to collect data and perform data analysis.
- A draft NOAA administrative report that examines the social and behavioral aspect of protected species interactions compliance in the Hawaii longline fleet will soon be submitted to the PIFSC editorial services for review. An infographic summarizing results was shared with Hawaii longline permit holders.
- A NOAA administrative report evaluating interactions between oceanic whitetip sharks and West Hawaii's small-scale fisheries in a human dimension context is in the final stages of the PIFSC editorial process. The report will also be developed into a manuscript for publication in a peer-reviewed journal. Another project that examined the socioeconomic context to mitigate fisher-shark interactions in the Marianas Archipelago is also in progress. Fieldwork was done in Guam and Saipan, and the preliminary results were shared with the community via YouTube videos. A draft NOAA administrative report is under development.
- A recently published peer-reviewed academic journal article entitled "Rights-based management, competition, and distributional equity in Hawaii's largest commercial fishery" examines how governing institutions affect distributional equity in the Hawaii longline fishery.
- The project also conducted an analysis to obtain an unbiased estimate of the inverse price elasticity of demand for bigeye tuna. A final draft of the research report was submitted to the Department of Economics at UH Manoa.
- A peer-reviewed journal article entitled "Examining the seascape of compliance in U.S. Pacific Islands fisheries" was also published during the report period. It examines fisheries compliance across the Pacific Islands and found that an integrated approach that employs non-regulatory tools could improve compliance.
- To integrate social, economic, and cultural components into a submodule for the Main Hawaiian Islands Atlantis Ecosystem Model, a literature review was done to help identify an appropriate set of social indicators and develop social-ecological relationships that can be applied to the Atlantis model. The next step is to develop

indicators and social-ecological systems modeling to identify social tipping points by defining the relationship between reef environmental conditions and societal functioning. The Atlantis model will predict ecological states based on climate futures and management scenarios and the social effects will be projected based on developed social-ecological relationships. For each climate and management scenario, a complete and concise set of indicators will be synthesized into a score. Project staff will explore multiple approaches for weighting and aggregation to find a method that is most amenable to the data available.

- To incorporate spatially explicit sociocultural values in the West Hawaii Integrated Ecosystem Assessment (IEA), a comprehensive literature review was conducted to understand assessment and elicitation of sociocultural values and the spatial representation of such values. At this stage of the project the staff is assessing how best to pilot methods for spatial representation in the wake of the COVID-19 pandemic shutdown because face-to-face interaction and interviews will not be possible in the immediate future.
- Two projects were re-assigned or delayed due to the departure of lead JIMAR staff: performing a value chain analysis of pelagic fish in Hawaii; and examining the economic impacts of changes in fisheries management regulations through bioeconomic modeling.

Stock Assessment Research Program

P.I.: Douglas S. Luther [JIMAR Project Lead: Melanie Hutchinson]

**NOAA Office (of the primary technical contact): National Marine Fisheries Service/
Pacific Islands Fisheries Science Center**

NOAA Sponsor: Michael P. Seki, Joseph O'Malley

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

This JIMAR project supports stock assessment research on pelagic (e.g., billfishes, sharks, tuna, etc.) and coastal (e.g., bottomfish and reef fish) management unit species (MUS). The objective of this project is to provide required support to assess the status of pelagic and coastal stocks and the impact of harvesting on these stocks. For pelagic species, the project explores the utility of integrated stock assessment models to improve the ability to

The screenshot shows a web interface for a bycatch report. On the left, a red box highlights filter controls: 'Select years' (2017, 2018), 'Select Species' (LOGGERHEAD SEA TURTLE, OCEANIC WHITETIP), 'Region' (Total, WCPFC), and a 'Download' button. At the top, a blue box highlights navigation tabs: 'Shallow Set', 'Deepset Observed', 'American Samoa Observed', 'Hawaii Deepset Estimates', 'Hawaii Deepset GRE Tips', 'Hawaii Deepset GRE Sets', 'All Estimates', and 'Marine Mammal Deepset'. The main table, outlined in purple, displays data for 'Show 50 entries'. The table has columns for X, Species, Year, Area, Observed.Take, Point.Estimate, Variance, and Standard.Error. The data rows are as follows:

X	Species	Year	Area	Observed.Take	Point.Estimate	Variance	Standard.Error
529	LOGGERHEAD SEA TURTLE	2017	Total	3	12.41	33.694	5.805
609	LOGGERHEAD SEA TURTLE	2017	WCPFC	3	12.41	33.694	5.805
751	LOGGERHEAD SEA TURTLE	2018	Total	1	4.116	12.824	3.581
835	LOGGERHEAD SEA TURTLE	2018	WCPFC	1	4.116	12.824	3.581
487	OCEANIC WHITETIP SHARK	2017	Total	242	1266.371	5659.209	75.228
569	OCEANIC WHITETIP SHARK	2017	WCPFC	230	1207.999	13687.183	116.992

Figure 1. A view in the bycatch report GUI. The red box highlights the drop down menus for selecting one or more options to display for the bycatch displayed including year, species, and management area. The blue box contains the different tab options for users to select in terms of deep-set vs shallow-set and the other options within those two headings. Finally the purple box contains the interactive output display, which varies with the user's selection in the dropdowns. This output is also searchable, enabling the user to quickly find the estimates they need.

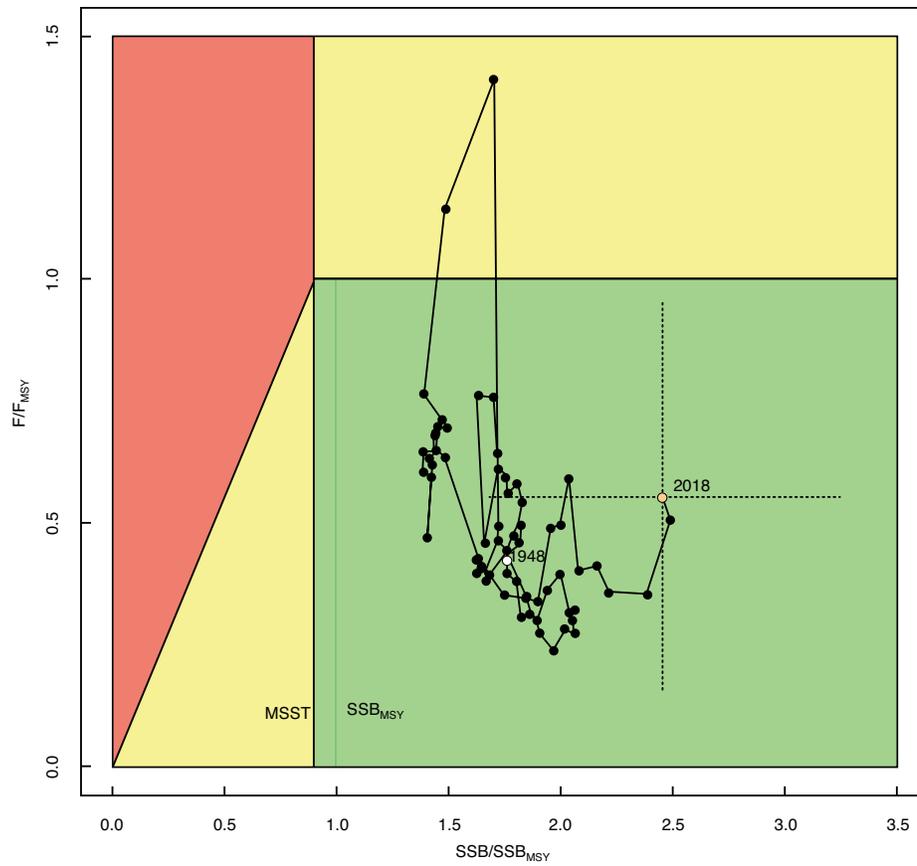


Figure 2. Kobe plot of the trends in estimates of relative fishing mortality (average of age 5–30) and spawning stock biomass of uku during 1948–2018. The white dot indicates 1948, the orange dot indicates 2018, and the dotted lines indicate the 95% confidence intervals around the final year values.



Figure 3. The mapping tool for visualizing bycatch events. In this instance, False Killer Whale takes for 2018 are represented with the blue pins plotted over the average sea surface temperature for the first quarter of 2018. There are dropdown menus on the left, and a sea surface temperature legend on the right. The bubble shaped polygons represent various management areas. Unfortunately, the fishing effort cannot be shown here for confidentiality reasons. Note that the example image is takes for False Killer Whales, which are publicly available and do not violate confidentiality per the MMPA.

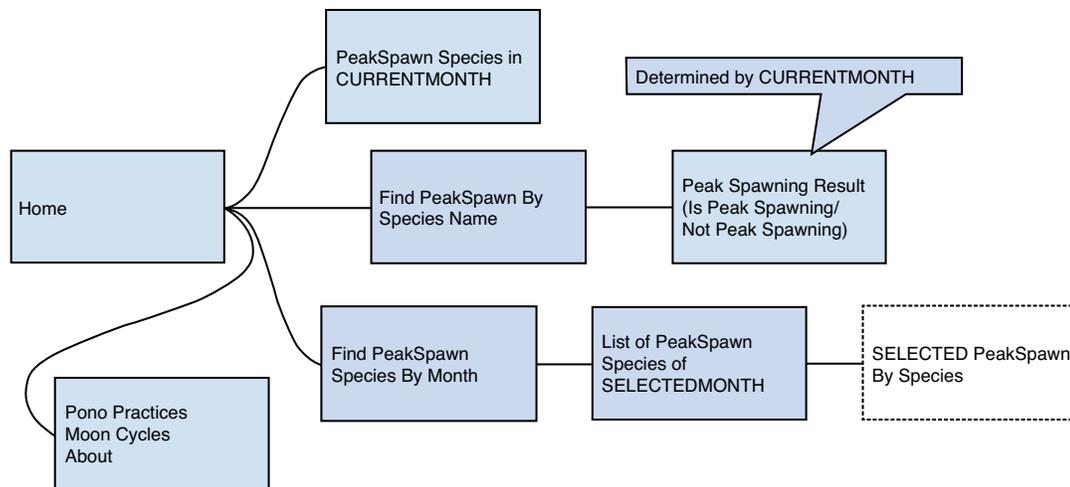


Figure 4. Workflow diagram for the Spawning Guide Application features.

understand and predict the status of stocks and impacts of exploitation. For coastal species, the project explores methods of catch per unit effort (CPUE) standardization to improve assessments through the inclusion of more precise abundance indices, habitat information and spatio-temporal information, as well as the development of an efficient fishery-independent sampling design, and the development of length-based stock assessment techniques. Of particular interest is the coordinated effort on bottomfish habitat characterization and integration of these data into stock assessments. Databases, software tools, and modeling approaches are also being developed to facilitate future analyses. The interdisciplinary nature of the project is a step towards building stronger capacity for effective marine resource stewardship and collaborations between JIMAR and PIFSC.

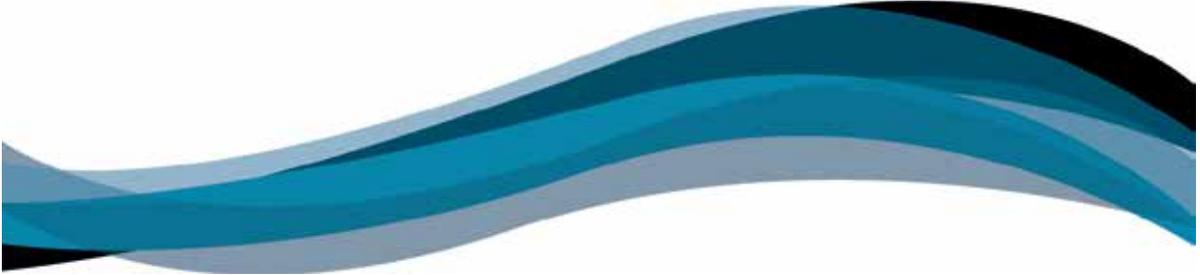
Progress during FY 2020

Research goals for FY 2020 focused on meeting the stock assessment schedule, developing a toolkit to improve bycatch estimations for the Hawaii deep-set and American Samoa tuna longline fisheries, continued support for existing SAP tools and developing a smart phone application to inform resource users on spawning periods of marketable fish species. Work was completed on the uku (*Aprion virescens*) stock assessment, and data processing, catch-per-unit-effort standardization, and the Stock Synthesis assessment model were completed. The assessment successfully passed independent expert review in February 2020 and a technical memorandum is now publicly available. The work was also presented at the June 2020 Scientific and Statistical Committee (SSC) of the Western Pacific Regional Fishery Management Council meeting with JIMAR Stock Assessment Scientist, Marc Nadon, PhD, as the lead.

The development of several tools to automate estimation of hundreds of bycatch species from the Western Pacific longline fisheries, including over twenty protected species, progressed quickly during FY 2020. The work will convert existing code into R so that PIFSC estimation methods can be implemented in developing user-friendly tools, perhaps in the form of a Graphical User-Interface (GUI), which a less technical person can use with minimal guidance from bycatch estimation scientists. During the reporting period, the first version of the software tool to automate annual bycatch estimation for the Hawaiian longline fisheries was completed and used to generate the marine mammal bycatch and fish bycatch estimates for 2019. A GUI was also completed so that users can now view bycatch estimates that were already generated. In addition, a mapping tool was developed that enables users to view an interactive map of the Pacific Ocean with bycatch events broken out by species plotted. This tool also visualizes fishing logbook effort and overlays monthly sea surface temperature.

The project continued its partnership with PIFSC leaders and Kohala Center scientists in developing a smartphone application to inform the public about the peak spawning months of main Hawaiian Islands fish and shellfish captured and sold locally. The application will have core features to inform resource users of the *pono* (balanced, appropriate) practices for avoiding spawning species. This product is based on an informational poster, “Spawning Guide for the Leeward Coast of Hawaii Island” published by the Kohala Center.

Protection and Restoration of Resources



Protection and Restoration of Resources

This theme seeks to develop tools and approaches for protection and restoration of living marine resources, habitats, and ecosystems in the Pacific Islands region. JIMAR scientists work to protect, restore, and educate the public on endangered species of marine turtles, Hawaiian monk seals, and cetaceans. JIMAR works to protect and restore pelagic and insular fisheries through stock assessments, fisheries monitoring, and fisheries information exchange. JIMAR also conducts research and mitigation efforts on marine debris around the Pacific Islands.

Cetacean Research Program

PI: Douglas S. Luther [JIMAR Project Lead: Marie Hill]

**NOAA Office (of the primary technical contact): National Marine Fisheries Service/
Pacific Islands Fisheries Science Center**

NOAA Sponsor: Michael P. Seki, Erin Oleson

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

The JIMAR Cetacean Research Program (CRP) project is charged with assessing the status of cetacean stocks within the U.S. Exclusive Economic Zone (EEZ) waters of the Pacific Islands Region (PIR), which encompasses the EEZ around the entire Hawaiian Archipelago, Johnston Atoll, Kingman Reef and Palmyra Atoll, Baker and Howland Islands, Jarvis Island, American Samoa, Wake Island, Guam, and the Commonwealth of the Northern Mariana Islands (CNMI). At least 34 cetacean stocks occur in the Hawaiian EEZ alone, and many more exist in the other PIR EEZs, though most are largely unstudied. Assessment of cetacean stocks includes conducting inventories of species within each PIR EEZ, followed by evaluation of the structure of the stocks within each EEZ, the population status of each stock, and evaluation and mitigation of human impacts on cetacean stocks.

Progress during FY 2020

In October 2019, the JIMAR CRP staff (Marie Hill, Jennifer McCullough, Kym Yano, Yvonne Barkley, and Pina Gruden) participated in an excursion aboard the Schmidt Ocean Institute's *R/V Falkor* to investigate beaked whale presence using a combination of environmental DNA (eDNA) and passive acoustic techniques. The team deployed an array of three Drifting Acoustic Spar Buoy Recorders (DASBRs) at locations of known beaked whale occurrence (off the west coast of Oahu and the southeastern coast of Maui) to collect vocalizations from cetaceans within the area. The ship was positioned in the middle of the configuration of DASBRs and 24 hours of Conductivity-Temperature-Depth casts (CTD) were conducted to collect water samples for eDNA



Figure 1. A CTD cast is conducted off Oahu from the R/V Falkor to collect water samples in order to look for beaked whale eDNA (Photo credit: Marie Hill).

analysis. Acoustic detections of beaked whales on the DASBRs will then be associated with CTD sampling periods indicating appropriate sample sets to process to look for presence of beaked whale DNA in the water column. The data provided by these approaches will begin to fill data gaps that are crucial to accurate population assessment and will also shape future survey efforts. Gathering and understanding eDNA from water samples collected near a whale sighting could greatly increase the success rate of genetic sampling.

In January 2020, project staff participated in small-boat surveys for humpback whales off Farallon de Medinilla (FDM) and Anatahan in the Mariana Archipelago. This was a collaborative project with the U.S. Navy and is related to the 2015–2019 CRP winter surveys conducted off Saipan that determined the Mariana Archipelago is a contemporary breeding ground for endangered western North Pacific humpback whales (Hill et al. 2020). The survey team encountered competitive groups, adult pairs, and individual humpback whales off FDM and at an offshore reef (37 Fathom Bank) east of Anatahan. Some of the individuals matched photos in the CRP photo-identification catalog. This survey confirmed that the humpback whales are using a wider area within the Mariana Archipelago to breed.

Pina Gruden, PhD, is working on a post-doctoral investigation for this project at the University of Hawaii's Department of Ocean and Resources Engineering. Her work aims to develop automated acoustic multi-target tracking and localization techniques that could be used towards estimating false killer whale (and other cetacean) abundance with acoustics. A common approach to localizing a whale or dolphin underwater is based on computing the time difference of arrival (TDOA) of a vocalization between pairs of hydrophones on the towed array. Depending on the animal's position relative to the hydrophones, the vocalization will reach the sensors at different times, leading to a position dependent TDOA that changes as the animal moves. Localization of a single animal is complicated by the presence of multiple animals or periods of silence. The time evolution of TDOA for each animal is typically tracked manually but is ideally suited for a multi-target tracking (MTT) approach. This project used a non-traditional MTT framework based on random finite sets and a probability hypothesis density filter to track multiple TDOA (or bearing) tracks simultaneously and automatically. The statistical models and parameters underpinning the framework had to be developed for this application. While this is still a work in progress, it already shows promise in automating a tedious and time consuming task that is typically done manually.

Yvonne Barkley is a PhD candidate at the University of Hawaii whose research focuses on characterizing patterns in cetacean populations using passive acoustic monitoring data. She investigated whether the three genetically distinct false killer whale populations in Hawaiian waters could be distinguished using their whistle characteristics with a machine-learning classification algorithm. Results showed that the classifier did not confidently identify whistles to the correct populations, but the findings provided insight into other patterns in the whistles that could help guide future whistle classification studies for false killer whales (Barkley et al. 2019). Her work included developing a three-dimensional localization algorithm for passive acoustic data collected with towed hydrophone arrays that uses a model-based approach to account for the possible depths of the animals and incorporates sources of uncertainty to provide error estimates for the distance and location estimates. A simulation experiment using sperm whale echolocation clicks to test the algorithm resulted in a demonstration of a method that visually and quantitatively confirmed that it functioned as expected. Barkley is currently focused on exploring the relationship between the Hawaii population of sperm whales and their habitat using both visual and passive acoustic data, and she will test the hypothesis that sperm whales prefer deeper, more productive waters unassociated with emergent land masses by building species distribution models that include biologically-relevant environmental data as indicators for upwelling and increased primary productivity.

High-frequency Acoustic Recording Packages (HARPs) are an integral part of the CRP's passive acoustic monitoring program. The CRP uses two different types of HARPs; one that is moored to the ocean floor for long-term recording (6–12 months); and another that is attached to longline gear for the period of the soak (5–20



Figure 2. Marie Hill photographs a breaching humpback whale off Farallon de Medinilla in the Mariana Archipelago (Photo credit: Mark Deakos).

hours). Moored HARPs are used to better understand cetacean presence and temporal patterns in remote locations where regular visual surveys are not possible. In addition, they are used to monitor ocean ambient noise at various sites to assess differences in order to understand the potential effects on cetacean populations. Sites currently maintained by the CRP include, off of the Kona coast (west side of Hawaii Island), Pearl and Hermes Reef in the Papahānaumokuākea Marine National Monument, Saipan and Pagan Islands in the CNMI, and Wake Island in the central North Pacific. These sites have been maintained for years with the Kona HARP operating for 15 years. The longline HARPs are used to better understand the interactions between cetaceans and the gear of commercial longline fishing boats. This project is carried out with the assistance of NOAA Fisheries' Observer Program and voluntary fishing vessels from the Hawaii longline fleet. By understanding the acoustic cues associated with false killer whale presence and depredation of longline bait and catch, it may be possible to modify gear or operations to reduce interactions that lead to serious injury or death of the whales and potential closure of the fishery.

Effects of Nitrogen Sources and Plankton Food-Web Dynamics on Habitat Quality for the Larvae of Atlantic Bluefin Tuna in the Gulf of Mexico

P.I.: Karen E. Selph

**NOAA Office (of the primary technical contact): National Marine Fisheries Service/
Southeast Fisheries Science Center**

NOAA Sponsor: John Lamkin

NOAA Goal(s)

- Healthy Oceans
- Resilient Coastal Communities and Economies

Purpose of the Project

The Gulf of Mexico (GoM) is one of the most economically important marine regions in the U.S. Exclusive Economic Zone (EEZ). The country's largest recreational fisheries occur in the GoM, targeting a multitude of species including bluefin, skipjack and yellowfin tuna, billfish, mahi mahi, coastal pelagics, snappers and groupers. Atlantic bluefin tuna (ABT) and other highly migratory species spawn in the GoM but are distributed as adults throughout the northern Atlantic Ocean, including the EEZs of many European, American and African nations. Despite various management measures, the western ABT stock is considered to be over exploited. Current stock assessments for the GoM require better ecosystem understanding to effectively evaluate how bottom-up processes limit or enhance ABT recruitment. The objective of this proposal is to elucidate the underlying mechanisms that link variability in nitrogen sources and food-web fluxes in the GoM to habitat quality, feeding, growth and survival for ABT larvae.

Progress during FY 2020

Project researchers participated in a two-day workshop held November 14–15, 2019 at the University of Miami Rosenstiel School of Marine and Atmospheric Science (RSMAS) in Miami, FL. The workshop included data reports and discussions of data and deliverables from all the project PIs. Selph presented phytoplankton data derived from flow cytometry and *Trichodesmium*-related microscopy data. A summer 2020 timeline for submission of manuscripts to a special issue in the *Journal of Plankton Research* was developed. All data from Selph's part of the project was submitted to the NOAA NCCOS data archive. In addition, graduate student Natalie Yingling made a presentation about the project's phytoplankton data research at the Ocean Sciences Meeting held February 16–21, 2020, in San Diego, CA. Her travel was supported with project funds.

Fishing Impacts on Non-target Species

P.I.: Douglas S. Luther [JIMAR Project Lead: Melanie Hutchinson]

NOAA Office (of the primary technical contact): National Marine Fisheries Service/
Pacific Islands Fisheries Science Center

NOAA Sponsor: Michael P. Seki, Keith Bigelow

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

The purpose of this JIMAR project is to improve understanding of the impacts of commercial purse seine and longline tuna fishing on non-target species with an emphasis on oceanic sharks. Project efforts will concentrate on bycatch reduction research, post-release survival and ecological research on sharks commonly encountered in commercial purse seine and longline fisheries in the Pacific, Atlantic and Indian Oceans. To improve post-release survival rates and crew safety methods, project researchers will conduct post-release survival studies to identify and develop best handling methods in recreational, purse seine and longline fisheries. The analysis of deployed electronic tags will generate robust post-release survival estimates which will improve the rigor of stock assessments and aid in the development of best handling practices for fisheries impacting shark populations. The project will consult and coordinate with the Pacific Islands Fisheries Science Center (PIFSC), Pacific Islands Regional Office (PIRO), Hawaii Institute of Marine Biology (HIMB) and the International Seafood Sustainability Foundation (ISSF) to assist in the design, execution and analysis of bycatch reduction, physiological and ecological experiments.

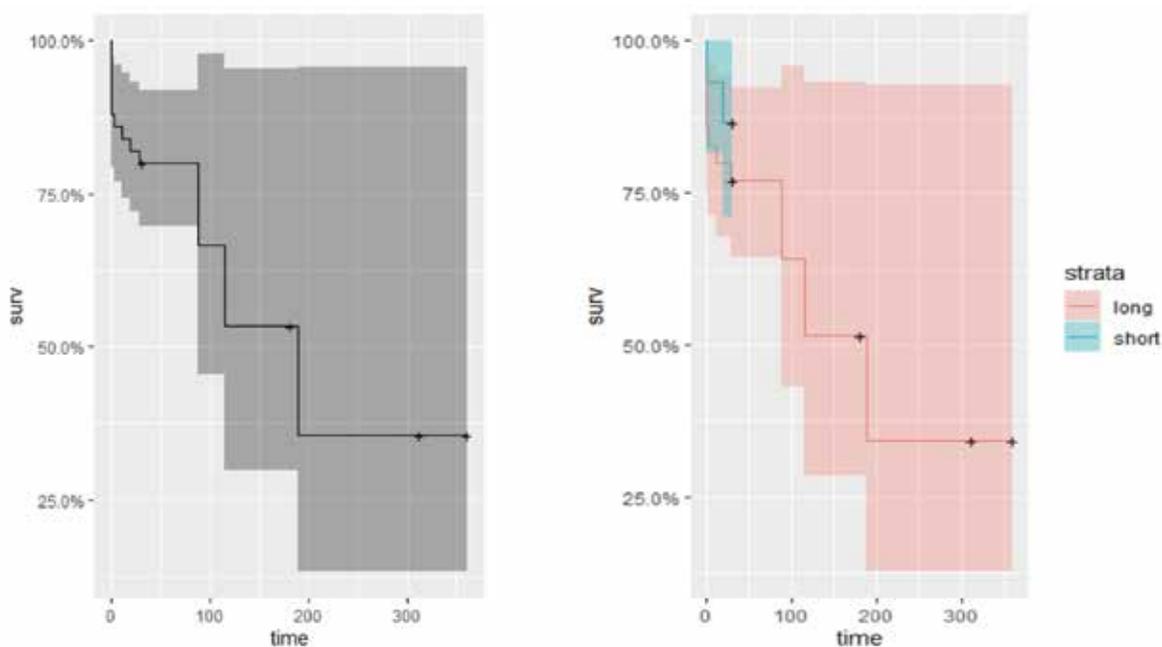


Figure 1. Kaplan-Meier (KM) survivorship probabilities for blue sharks (BSH) captured as bycatch in the Hawaii Deepset tuna fishery. At right KM survival probabilities are illustrated by trailing gear (TG) length. TG was the factor identified in the Cox proportional hazard analysis that was the most influential on post release survival times for all BSH. Long corresponds to gear lengths > 2.5 meters and short are gear lengths \leq 2.5 m. The + marks indicate tags that are censored at that time. A censoring event shows when a tag left the study (floater or completed deployment) not due to mortality.

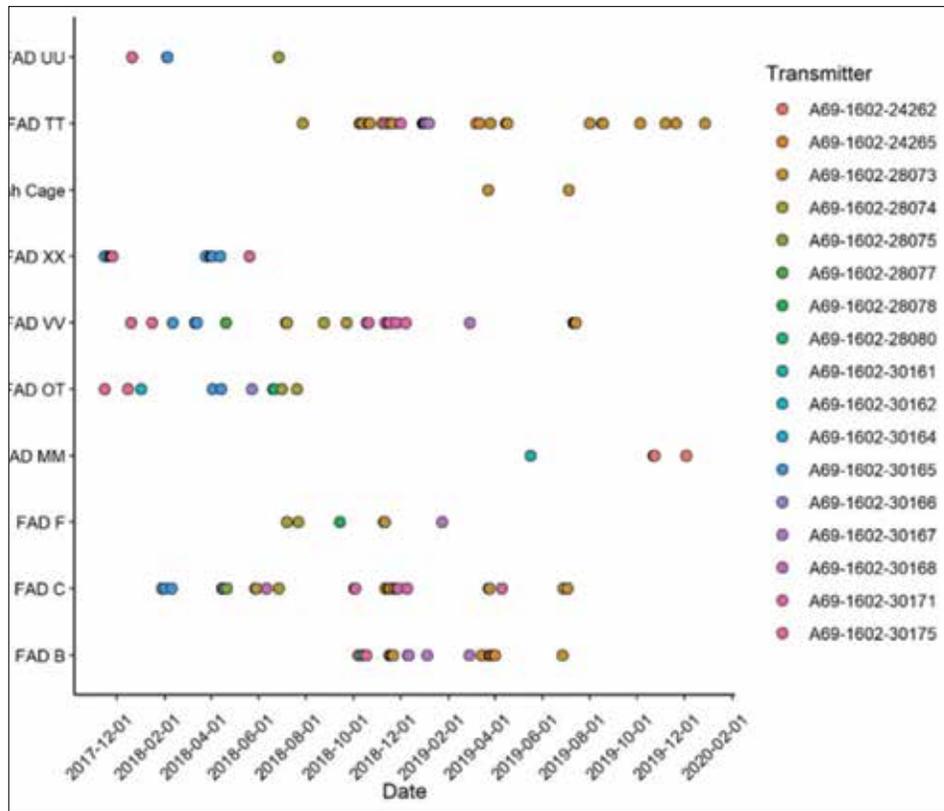


Figure 2. Abacus plot showing acoustic tag detections from oceanic whitetip and silky sharks tagged by HCTP fishers around Kona. The colors correspond to the transmitter (acoustic tag) IDs. Seventeen of 35 tagged sharks have been detected on the receivers mounted on the FADs. Several of these were detected repeatedly over multiple years indicating that both species return to the same locations over time.

Progress during FY 2020

During the reporting period, the project received 87 unused survivorship tags and was able to expand the scope of the post release mortality (PRM) study to include additional species and fill some data gaps identified during the course of the initial study. To date, the project deployed 224 tags on sharks incidentally captured in U.S. tuna longline fleets and generated the first quantitative assessment of PRM rates for four species. These data were presented to the 15th Regular Session of the Scientific Committee to the Western Central Pacific Fisheries Commission (WCPFC) and integrated into the stock assessment of the oceanic whitetip shark (OCS), significantly affecting the outcome of the assessment. This was a huge win for this study because the WCPFC later accepted the study’s recommendations for best handling practices and these recommendations were adopted at its annual meeting in December 2019. The project also completed the gear trials on the longline fishing vessel *F/V Gutsy Lady 4*. A report on the catch results of these four trips and telemetry data was compiled for the funding agency and is being used as an early draft manuscript as the project waits for the last tags to transmit scheduled for July 2020.

During the year, the project hired two support staff which greatly facilitated data acquisition, analysis, manuscript development and database development. These staff enhanced the project’s capability to communicate with the participants of the Hawaii Community Tagging Program (HCTP) which encouraged continued participant engagement. This year, the project published a second newsletter reporting that the community taggers tagged 146 sharks to date including 66 OCS. The project continued its partnership with Hawaii Uncharted to create a photo identification library for OCS around Hawaii and identified over 100 individuals, revealing a great deal about the population demographics and residency in combination with the telemetry data. Manuscript development is taking longer than expected due to tag malfunctions.

Hawaiian Monk Seal Northwestern Hawaiian Islands Research Seasonal Support

P.I.: Douglas S. Luther [JIMAR Project Lead: Lizabeth Kashinsky]

**NOAA Office (of the primary technical contact): National Marine Fisheries Service/
Pacific Islands Fisheries Science Center**

NOAA Sponsor: Michael P. Seki

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

JIMAR's Hawaiian Monk Seal Research Program (HMSRP), in collaboration with the NOAA Pacific Islands Fisheries Science Center Protected Species Division (PIFSC PSD), conducts studies on the Hawaiian monk seal (*Neomonachus schauinslandi*), the most endangered marine mammal occurring entirely within U.S. jurisdiction. The Northwestern Hawaiian Islands (NWHI) Research Seasonal Support project implements monk seal population assessment, health and disease, survival enhancement, foraging, and behavioral research, as well as standard enhancement activities. Research and enhancement activities are conducted primarily in the NWHI to augment year-round program activities in the Main Hawaiian Islands (MHI). JIMAR field staff and volunteers are deployed on a seasonal basis at up to five main breeding sites and conduct field studies opportunistically at Midway Atoll, Mokumanamana, Nihoa, Niihau, and within the MHI. Field research activities include visual and photographic monitoring, tagging, pelage bleach marking, health screening, necropsies, specimen collection, and vocalization and foraging studies. Field staff also participate in translocation and other recovery actions including hazing or removal of aggressive male seals, shark predation mitigation and deterrence, entrapment surveys, behavioral modification, vaccination research, disentanglement, reuniting mother-pup pairs, abscess treatment, marine debris removal, inter- and intra-atoll translocation, evaluation and capture of seals for rehabilitation, and feeding and soft release of rehabilitated seals. JIMAR field staff also provided assistance to other programs and agencies, including activities such as establishing and maintaining marine debris plots, conducting insect, plant, and Laysan duck surveys, monitoring for invasive species, and collecting sea turtle nesting data.

Progress during FY 2020

Field camps consisting of eleven field staff and four University of Hawaii volunteers were already established at the beginning of the project period at five of the six major reproductive sites in the NWHI at French Frigate Shoals (FFS), Laysan Island, Lisianski Island, Pearl and Hermes Reef (PHR), and Kure Atoll to conduct Hawaiian monk seal population research and enhancement activities. Field teams gathered data on the number of pups born, number that survived to weaning, number marked, number of older animals identified, inter-atoll movements, causes of mortality, and other key demographic variables. Survival enhancement activities included vaccinating seals against morbillivirus, disentangling seals, reuniting mom/pup pairs, freeing seals and other wildlife entrapped in disintegrating infrastructure at Tern Island, translocating weaned pups away from areas with high shark predation or areas with high levels of male aggression, fishing for predatory sharks, treating abscesses and administering antibiotics to otherwise compromised seals, and identifying and capturing animals in need of rehabilitation.

Monk seal field teams supported research by other groups within PIFSC by tagging and monitoring turtles in collaboration with the Marine Turtle Biology and Assessment Program (MTBAP). While deployed, they also conducted a variety of conservation activities in collaboration with the U.S. Fish and Wildlife Service and other groups, including post-Hurricane Walaka cleanup entrapment surveys and mitigation at FFS, Laysan duck surveys at Laysan Island, and *Verbesina* eradication efforts at North Island, PHR. Short term field efforts were also conducted at Midway Atoll by a project field camp leader and volunteer. Surveys of Niihau, Nihoa, and Mokumanamana (Necker) Islands were conducted and a short term field effort was undertaken at Nihoa Island via the *F/V Searcher* from September 16–27. Cruise-related research and recovery activities included instrumenting seals at FFS during the field camp deployment cruise, releasing rehabilitated yearlings at Laysan Island during the deployment cruise, and collecting undersized weaned pups during the pickup cruise and providing supportive



Figure 1. JIMAR staff deployed to Laysan Island for the summer of 2019 survey Hawaiian monk seals from a distance (work conducted under NMFS Permit No. 16632 and PMNM-19-012).



Figure 2. Field teams conducting boat operations at Pearl and Hermes Reef. Teams use small boats to navigate to the different islands within the atoll to survey Hawaiian monk seals (work conducted under NMFS Permit No. 16632 and PMNM-19-012).

care during their transport to Ke Kai Ola, a monk seal hospital on the Island of Hawaii. Upon return to Honolulu, field personnel cleaned and inventoried gear and supplies and completed reports summarizing field research and population status at each site.

A total of ten JIMAR staff and six volunteers were selected to participate in the 2020 field season which commenced in February 2020. Field personnel participated in training to secure and pack food stores and conduct field activities. Due to the COVID-19 pandemic shutdown, the training period was converted to online in mid

March and the deployment cruise was postponed indefinitely. Due to the uncertainty of the field season the encampment was canceled and the field staff positions were terminated as of June 22. The outcome of the 2020 field season is unknown at this time. In the event a deployment occurs, it will be an abbreviated version and staffed with regular program staff and possibly partners.

Hawaiian Monk Seal Research Program

P.I.: Douglas S. Luther [JIMAR Project Lead: Lizabeth Kashinsky]

**NOAA Office (of the primary technical contact): National Marine Fisheries Service/
Pacific Islands Fisheries Science Center**

NOAA Sponsor: Michael P. Seki

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

The JIMAR Hawaiian Monk Seal Research Program (HMSRP) collaborates with the NOAA Pacific Islands Fisheries Science Center Protected Species Division to conduct research on the Hawaiian monk seal (HMS; *Neomonachus schauinslandi*), the most endangered marine mammal occurring entirely within U.S. jurisdiction. There are approximately 1,400 monk seals remaining, the majority of which occur at the six highly studied sites in the Northwestern Hawaiian Islands (NWHI) where abundance is estimated to have declined by two thirds since the late 1950s. Apparent stability or population growth in the NWHI in recent years substantially influences overall trends and the average growth rate of the overall population has been approximately 2% per year since 2013. The program conducts research designed to promote sound conservation and management of the species by characterizing natural and anthropogenic factors that may impede population recovery. Research focuses on connections between population biology, foraging ecology, individual health, and environmental and oceanographic parameters in the North Pacific. The program develops, tests, and implements tools to assist in recovering the species.

Progress during FY 2020

Accomplishments during FY 2020 included population monitoring and assessment, survival enhancement activities, foraging ecology characterization, health and disease evaluation, and behavioral research. Project activities and accomplishments are described in detail below.

JIMAR staff played a crucial role in the breakdown of the 2019 field research camps as well as in the preparation for the 2020 field research camps in the NWHI. Ten field staff and six University of Hawaii volunteers were selected for the 2020 field season. Field camp leaders began training on February 28 and the remaining staff and volunteers began training on March 2. Program staff reviewed and revised protocols and trained field personnel in conducting field activities such as data collection and handling and tagging, vaccination, and specimen collection. They also procured, tested, and packed field supplies and equipment, and



Figure 1. JIMAR staff assist to anesthetize and restrain seal to remove ingested hook (work conducted under NMFS Permit No. #18786).

provided other logistical support necessary to deploy the camps. Due to the COVID-19 pandemic shutdown, all training was converted to online training in mid-March and the deployment cruise, which was due to depart on April 9, was delayed indefinitely. If deployment occurs, it will be beyond the reporting period.

In addition to preparing for the 2020 field season, HMSRP staff bleach-marked and photo-identified seals throughout the main Hawaiian Islands (MHI) as they conducted population and monitoring surveys, emergency response activities, inter-island foraging ecology projects, and flipper-tagging events. HMSRP staff traveled to Molokai and Lanai to assist with the tagging of weaned pups, vaccination efforts,

and conducted focused population assessment surveys on Molokai. Staff implemented a pup monitoring plan at Kalaupapa, assisted with monitoring and marking mothers and pups, and helped train new NPS staff on monk seal monitoring and tagging. Project personnel also participated in collaborative efforts to collect, rehabilitate, and release MHI and NWHI seals in concerted efforts with The Marine Mammal Center's Kei Kai Ola monk seal hospital.

Additional accomplishments by the project included ensuring data resources remain compliant with the NOAA Plan for Increasing Public Access to Research Results requirements. Program staff continued to improve and refine the Seal Population Assessment database, providing for greater efficiency. A new email system for field camper personnel was implemented. The project investigated using Bluetooth+LoRa tags to improve identification of the seals and performing a census of the seals. Program staff operated Unmanned Aircraft Systems to learn skills on a newly acquired platform for surveying and assessing monk seals, continued ongoing vaccinations of wild seals against morbillivirus, and trained partners in vaccination and pole syringe techniques and protocols.

Health and disease research included collecting biomedical samples for disease surveys in the MHI in conjunction with response to stranded animals, and shipping samples for analysis at various laboratories. Emergency response efforts included de-hooking, antibiotic treatment, assessment for other health concerns, and performing necropsies. Project staff were involved in the removal of ingested hooks from three individual seals on Oahu. In all three cases the hooks were successfully removed without requiring surgery. Staff also traveled to Molokai and Hawaii Island to lead emergency response efforts for injured or compromised seals. JIMAR staff were intensely involved in the capture, care and treatment of an adult female seal on Oahu suffering from toxoplasmosis infection. Staff also assisted with the transport of the seal via a U.S. Coast Guard flight from Oahu to The Marine Mammal Center's Hawaii Island facility for long-term care where she was treated for several weeks. Although the seal ultimately did not survive, the program learned valuable information on this disease that threatens monk seal recovery.

Project staff and University of Hawaii volunteers continued organizing and maintenance of tens of thousands of samples in the frozen specimen archive. JIMAR personnel implemented a new specimen labeling system that allows specimens to be automatically numbered and barcoded upon collection. The new system greatly increased efficiency and accuracy. Staff also participated in ongoing maintenance of the IRC veterinary laboratory and seawater system for live animal care.

JIMAR personnel continued collaboration with outside researchers to assess risks posed by *toxoplasma gondii*. The program organized the Technical Workshop on Toxoplasmosis in Hawaiian Monk Seals to review current knowledge and gain expert insights on the most severe disease threat impacting Hawaiian monk seal recovery.



Figure 2. Busy season of pup monitoring and tagging at Kalaupapa National Historical Park, Molokai Island (work conducted under NMFS Permit No. 16632).

Approximately twenty experts from universities, NGOs, state and federal agencies attended the workshop held October 28–30, 2019 in Honolulu, Hawaii, to address the threat of toxoplasmosis to Hawaiian monk seals. They identified knowledge gaps and prioritized future research directions based on their ability to inform management approaches and solutions.

Marine Turtle Recovery in the Pacific Islands Region

P.I.: Douglas S. Luther [JIMAR Project Lead: Camryn Allen]

**NOAA Office (of the primary technical contact): National Marine Fisheries Service/
Pacific Islands Fisheries Science Center**

NOAA Sponsor: Michael P. Seki, Timothy T. Jones

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

The research conducted by the Pacific Islands Fisheries Science Center (PIFSC) Marine Turtle Biology and Assessment Program (MTBAP) includes nine discrete elements which are mirrored in the JIMAR project: 1) research to reduce or mitigate high-seas and coastal fishery by-catch of sea turtles; 2) research on the general biology, life history and ecology of sea turtles in coastal marine habitats and on nesting beaches; 3) monitoring of sea turtle population trends for stock assessments; 4) simulation modeling of long term sea turtle datasets to better understand population dynamics; 5) assist with health assessments and disease investigations; 6) administration of a sea turtle stranding and salvage network for research and live turtle rehabilitation; 7) educational outreach to the public focused on sea turtle research results; 8) maintenance of efficient and secure computerized storage, management, and retrieval of sea turtle research data; and 9) training of observers learning to conduct the collection of sea turtle data while aboard commercial longline fishing vessels.

Progress during FY 2020

Multiple MTBAP core objectives were accomplished by JIMAR staff including: 1) captive sea turtle care and rehabilitation; 2) necropsy of dead turtles, biological sample collection, and management of biological samples;



Figure 1. JIMAR field researchers, Marylou Staman, Alexander Gaos, Camryn Allen, and Jan Willem Staman (clockwise starting at the far left) conduct an ultrasound on an adult female turtle to determine her reproductive status. The turtle, Punahale, was fertile so the team deployed a satellite transmitter on her carapace to track her migration to, and location of, her nesting beach.

3) educational outreach; 4) participation in field capture of marine turtles on Oahu and periodically on the neighbor islands; 5) organization of existing databases from aerial and in-water tow board surveys obtained through ongoing partnerships with PIFSC programs and territorial agencies; 6) longline observer training sessions; 7) research on the general biology, life history, and ecology of sea turtles in coastal marine habitats and on nesting beaches; and 8) participation in the planning, preparation, and data analysis/reporting of annual nesting field work at French Frigate Shoals (FFS), Northwestern Hawaiian Islands (NWHI).

The deployment of MTBAP's three field researchers (Marylou Staman, Jan Willem Staman, and Christina Copenrath) to FFS was delayed due to the COVID-19 pandemic shutdown. During the mandatory telework period the field researchers created Standard Operating Procedures (SOPs) and templates for annual reports; all extremely valuable products for MTBAP efficiency and effectiveness. The FFS encampment is an annual field endeavor and with the team only being on island for 27 days at most (if at all), it will likely be a rapid-assessment of sea turtle nest abundance and hatchling sampling (for genetic and sex studies).

JIMAR Marine Ecological Researcher, Dr. Alexander Gaos continued to bolster the program's ability to obtain additional demographic data and understand aspects of sea turtle ecology in the Pacific Islands Region (PIR), e.g., hawksbill abundance, sex and sex ratio, and effects of climate change. Additionally, Gaos led the deployment of 19 temperature data loggers in hawksbill nests on Hawaii Island and three satellite tags on nesting females. He also coordinated sampling and shipment of approximately 1,000 hawksbill embryos to the SWFSC facilities for parentage/breeding sex ratio analysis. He also participated in multiple leatherback conservation projects and led the creation of joint USFWS-NMFS general and specialized research protocols. Recently, Dr. Gaos undertook a monumental effort to collate decades of satellite tag deployment data and upload to the animal telemetry network (ATN) to comply with making federally funded data publicly available.

The JIMAR Supervisor and Marine Biological Researcher, Dr. Camryn Allen, continued to oversee laboratory-related research and head sea turtle endocrinology research for investigation of sex, sex ratio, capture stress, and reproductive related questions. Preliminary results suggest that the sex ratio of immature green sea turtles foraging in the Main Hawaiian Islands (MHI) is biased toward females at 1 male to every 3.4 females. The ultimate goal is to understand changes and climate impacts in sex ratio over time and during the past season the team obtained samples from over 100 turtles around Oahu and Hawaii Island.

Nine University of Hawai'i (UH) Marine Option Program (MOP) JIMAR student assistants and one JIMAR volunteer participated in stranding response and rehabilitation for sea turtles and conducted studies on nest abundance, age and growth, and hatching success at FFS.

Pacific Islands Deep Sea Coral and Sponge Initiative

P.I.: Douglas S. Luther [JIMAR Project Lead: Virginia Moriwake]

**NOAA Office (of the primary technical contact): National Marine Fisheries Service/
Pacific Islands Fisheries Science Center**

NOAA Sponsor: Michael P. Seki, Frank Parrish

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

This JIMAR project seeks to advance NOAA's Deep Sea Coral Research and Technology Program (DSCRTP) priorities and gather information on the diversity and abundance of deep-sea coral and sponge communities in the U.S. Pacific Islands to improve the management of these important resources. The project focuses on extracting, compiling, and synthesizing deep-sea coral and sponge video data from Remotely Operated Vehicle (ROV) or manned submersible surveys in the Pacific. The goal is to produce detailed records of animal observations, including the taxonomic identification, location, and oceanographic data for incorporation into the DSCRTP national database in order to improve understanding of the conditions that promote the formation of deep-sea coral and sponge communities.

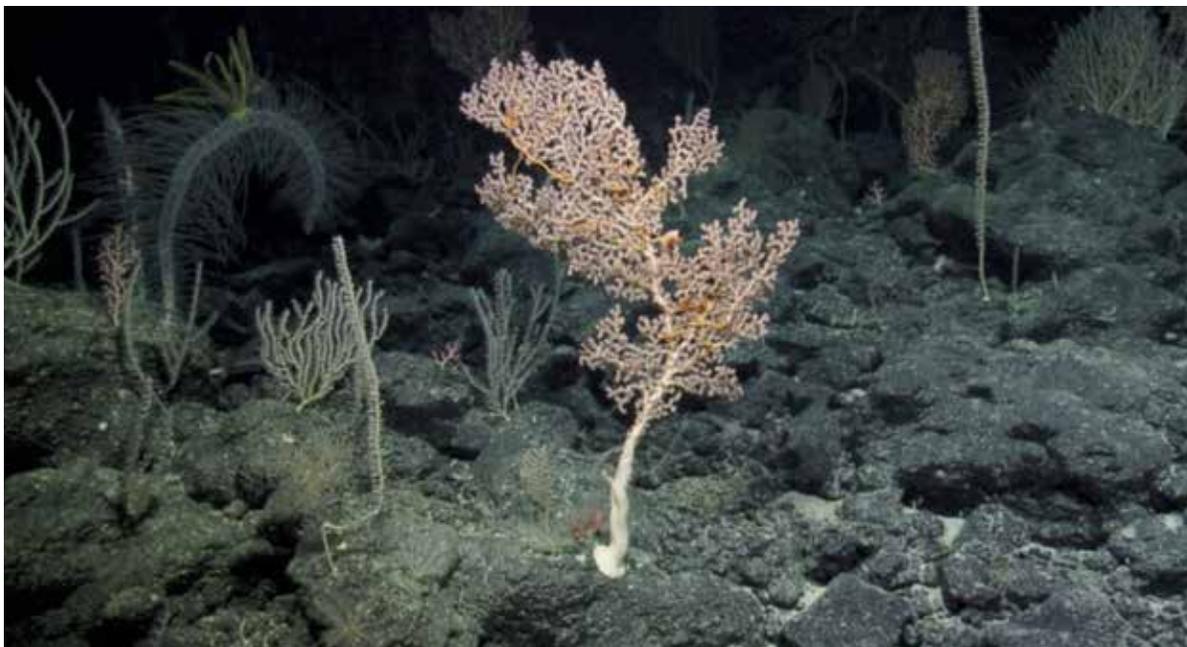


Figure 1. A high-density coral and sponge community documented during the E/V Nautilus Cruise to PMNM (image courtesy of the Ocean Exploration Trust, Exploring Enigmatic Seamounts in the Papahānaumokuākea Marine National Monument).

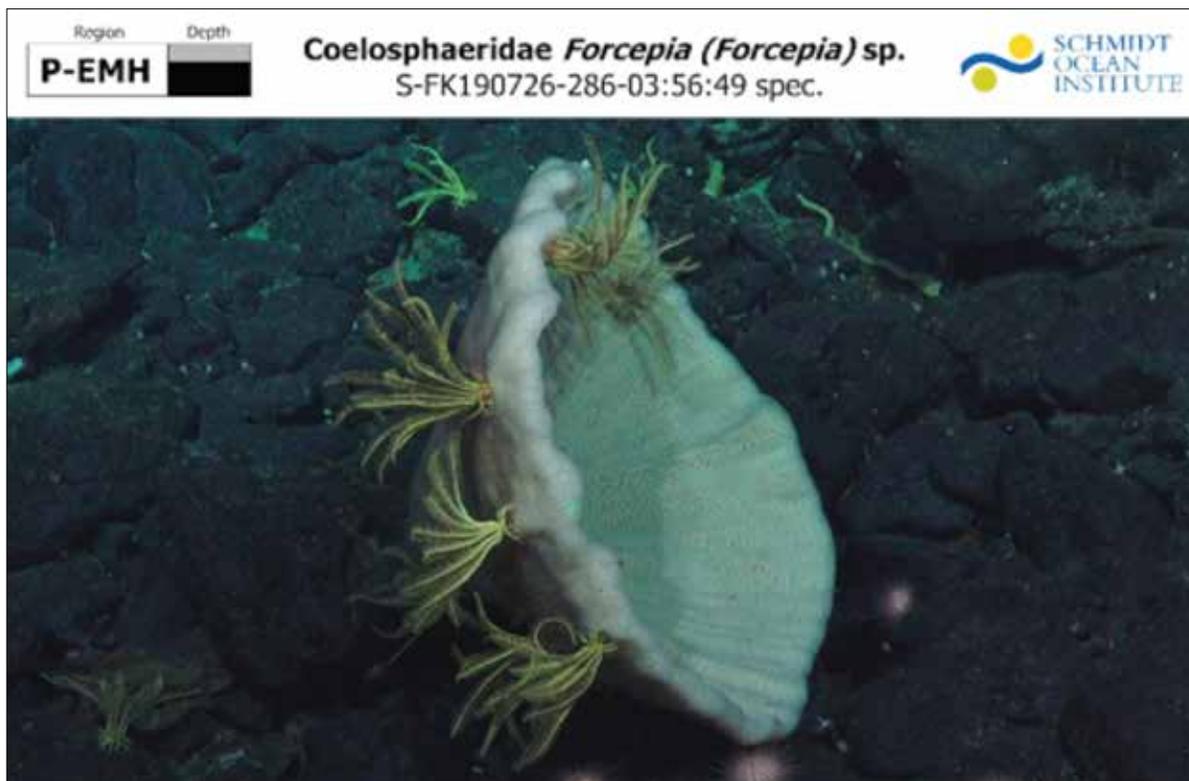


Figure 2. Example of a slide created for an animal identification guide and sent to experts for review. A piece of this demosponge was also collected and identified as a species of *Forcepia* by Dr. Rob van Soest and Dr. Christopher Kelley (image courtesy of the Schmidt Ocean Institute, Deep Coral Diversity at Emperor Seamount).

Progress during FY 2020

The project continued providing the DSCRTP with animal records and images for their national database (<https://deepseacoraldata.noaa.gov/>). The annotation protocol involves creating records of deep-sea corals, sponges, fishes, and associated fauna captured on the dive video. Supplemental information documented for these records includes sizes, counts, substrate and habitat data, and comments regarding the identification or occurrence. JIMAR staff used the Video Annotation and Reference System (VARS) software for annotating, then merged the annotations with available location and oceanographic data, reviewed the records for quality control and formatted them for inclusion into the DSCRTP's database. During this reporting period, the team submitted records and images to the DSCRTP from 21 ROV dives conducted in 2018. Eleven dives were from a cruise to Papahānaumokuākea Marine National Monument (PMNM) aboard the *E/V Nautilus* (cruise NA101), five of which documented the presence of high-density coral and sponge communities. More than 53,000 animals were identified and counted, including approximately 45,300 corals and sponges, 4,800 animals associated with those corals or sponges, 160 fish, and 3,000 other animals. Coral and sponge records were also compiled from annotations of still images captured from a downward-facing camera attached to the ROV *Lu'ukai* during ten dives on a cruise to the Clarion-Clipperton Zone by the *R/V Kilo Moana* (KM1808).

During the report period, JIMAR staff received and processed video and data from 46 ROV dives conducted during five cruises in 2019. The cruises were aboard the *E/V Nautilus* (NA110, NA112, and NA114), the *R/V Falkor* (FK190726), and the *E/V Okeanos Explorer* (EX1905L2). The video clips from the benthic portion of each dive were transcoded into a single dive video in MP4 format. JIMAR staff compiled and formatted the data from tracking and environmental sensor data files for each dive into a single file containing latitude, longitude, depth, temperature, oxygen, salinity, and date/time fields that can be imported directly into ArcGIS for visualization of the dive tracks or merged with video annotation records. In an effort to maintain consistent and accurate animal identifications, JIMAR staff created slides from video frame grabs of in situ animal observations for the cruises to PMNM (NA101), the Emperor Seamount chain (FK190726), and American Samoa (NA112), and received feedback on animal identifications from more than 35 taxonomist experts from images and/or examination of collected specimens. Ten ROV dives conducted in 2019 were annotated during this report period, identifying 27,700 animals. These records are being reviewed for quality control in preparation for submission to the DSCRTP.

Papahānaumokuākea Marine National Monument Monitoring and Research

P.I.: Douglas S. Luther [JIMAR Project Lead: Brian Hauk]

NOAA Office (of the primary technical contact): National Ocean Service

NOAA Sponsor: Randall Kosaki

NOAA Goal(s)

- Healthy Oceans

Purpose of the Project

The JIMAR Papahānaumokuākea Marine National Monument (PMNM) Monitoring and Research Project conducts primary research and monitoring activities to characterize the spatial distribution and composition of marine ecosystems within the PMNM and other partner NOAA Marine Sanctuary sites. This research also serves to better manage and protect PMNM resources from anthropogenic and natural threats through the PMNM Resource Protection Program. Research and monitoring activities utilize scuba gear, technical diving gear [including closed-circuit rebreathers (CCR)], remotely operated vehicles, small boats, remote sensing technologies and other scientific equipment to collect data on the marine ecosystems of primarily the Northwestern Hawaiian Islands (NWHI) during research cruises. Subsequent specimen processing, data analyses, and scientific publication are based out of PMNM's offices at the NOAA Inouye Regional Center (IRC) in Honolulu. The objective of this characterization is to advise management and policy decisions in order to conserve, protect and enhance the biodiversity of the PMNM.

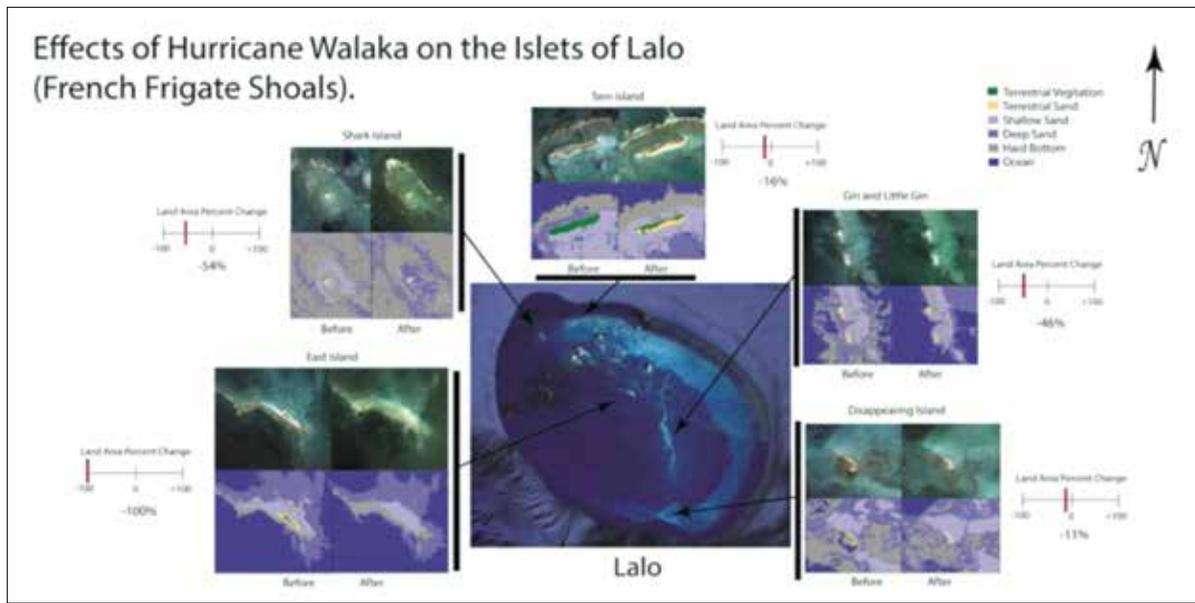


Figure 1. Photo evidence of effects of Hurricane Walaka on the French Frigate Shoals.

Progress during FY 2020

The primary objectives of the JIMAR PMNM project are: coral reef monitoring; characterization of mesophotic coral ecosystems; quantification of benthic habitats; PMNM resource protection; and maritime archeology. Milestones and accomplishments of each objective include the following.

Coral Reef Monitoring. PMNM was allotted 25 days at sea (DAS) in July and August 2019 on the NOAA Ship *Rainier* cruise RA-19-02 to perform shallow-water coral reef surveys at French Frigate Shoals (FFS), Lisianski Island, Pearl and Hermes Atoll, Midway Atoll and Kure Atoll. A discovery of an invasive red algae prevented the ship from reaching beyond Pearl and Hermes Atoll, and a ship mechanical problem also resulted in a shorter cruise with 22 DAS. In collaboration with researchers from the University of Hawai'i at Hilo, JIMAR staff completed benthic surveys at Lisianski Island using photogrammetric techniques for post-bleaching assessments. This was part of ongoing efforts to record changes in the reef habitat since the 2014 mass coral bleaching event and assessments of damage resulting from NOAA weather buoy groundings in 2015 and 2018. Visual and photogrammetric surveys for the distributions of corals and diseases were also completed at permanent monitoring sites at FFS, Lisianski Island and Pearl and Hermes Atoll. JIMAR staff also participated in rapid visual surveys for the invasive red alga at Pearl and Hermes Atoll.

JIMAR staff took the lead on quantitative analyses of damages to an iconic coral reef called Rapture Reef at FFS caused by Hurricane Walaka in 2018 and co-authored a manuscript with collaborators from University of Hawai'i at Hilo. The manuscript was submitted to the journal *Coral Reefs* and currently under review.

The project processed the photogrammetry imagery from the NOAA weather buoy grounding site at Lisianski Island to generate three-dimensional (3D) reconstructions of the site and quantify the damages to the coral reef. Preliminary assessment showed localized damages likely caused by the chain attached to the weather buoy. Further assessments and formal analysis are scheduled to be completed before the end of FY 2021.

During the 2019 summer, project staff mentored a NOAA Hollings Scholar to compare results of in situ visual surveys of the distributions of corals and diseases with those extracted from 3D models that were constructed using photogrammetric techniques. The student was presented this work at the symposium for IRC summer interns and at a science and education symposium at NOAA headquarters at the end of the internship.

Characterization of Mesophotic Coral Ecosystems. PMNM conducted visual fish surveys and benthic photogrammetric surveys on mesophotic reefs of FFS, Lisianski Island and Pearl and Hermes Atoll. JIMAR staff participated in these surveys, collected data, worked on data management during and after the cruise and processed all imagery from the photogrammetric surveys to generate 3D reconstructions of surveyed mesophotic reefs. JIMAR staff are currently mentoring a NOAA Educational Partnership Program scholar from late May to July 2020 to extract benthic data from the resulting 3D models.

Quantification of Benthic Habitats. JIMAR analyzed data on habitat metrics and benthic composition extracted from 3D reconstructions of shallow-water coral reefs in the NWHI to examine relationships between specific habitat metrics and the distribution of benthic organisms in the NWHI. This important analysis revealed that the contribution of different coral morphologies to the structural complexity of reef habitats varied among habitat metrics and spatial resolutions at which these habitat metrics were obtained. With JIMAR staff listed as first author, a manuscript detailing these findings was published in the journal *Remote Sensing*.

JIMAR staff developed Python scripts to directly extract several different habitat metrics from a full 3D mesh model in the Agisoft Metashape software, which is now widely used by coral reef researchers to generate 3D reconstructions of coral reefs. The results of their work were presented at the Third JIMAR Symposium. These scripts can be run within the Metashape software, thus allowing for quantification of reefs' structural complexity to be integrated into routine post-survey procedures of 3D model generations. The project further extended this work by comparing the properties of these habitat metrics with those extracted from

2.5-dimensional digital elevation models using simulated surfaces and coral colonies. The staff is currently preparing a manuscript as a first author to report the results of this work.

Resource Protection. The project works to reduce or mitigate resource threats by working inside the ecosystem management framework established for the Papahānaumokuākea Marine National Monument. This involves working within the realms of the policy/permitting system, field operations, research, and education/outreach programs. The overarching goal is to minimize risks to natural resources by anthropogenic influences and to safeguard the human presence in the monument that is involved in conservation and research activities.

JIMAR staff monitored vessel notification phone lines and email communications to track vessels entering/exiting the monument. As part of the permitting process for entry to the PMNM, the project also conducted several vessel hull inspections during the year utilizing ROVs and SCUBA equipment to verify the absence of alien species. This process helps protect the marine ecosystems of the NWHI noted for their low abundances of alien species. Staff worked with Monument co-trustee partners to standardize survey methods and techniques



(above) Figure 2. JIMAR Staff practice whale disentanglement techniques with USCG and PIFSC partners.

(below) Figure 3. JIMAR Staff utilizing CCR technology conduct invasive species survey at mesophotic depths around Pearl and Hermes Atoll while on NOAA research expedition in PMNM.



to increase capacity and conducted joint survey operations to better manage non-indigenous species archipelago wide. Staff networked with managers in New Zealand to improve risk analysis and vessel profiling techniques to further assist with alien species prevention and management. JIMAR created a new PMNM Alien Species Database to track all known non-indigenous species found within the PMNM and are currently working with partners to expand this database to include an archipelago wide species list and spatial distribution maps. The project is also working to publish this checklist data and make it readily available to the public. Additionally, project staff reviewed several PMNM access permits to ensure applicants' activities comply with resource protection objectives and do not harm any PMNM resources.

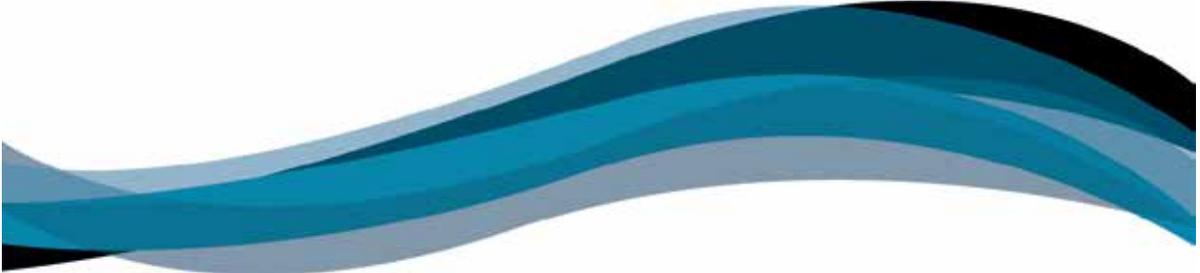
Project staff continued to represent the PMNM office at several multi-agency/co-trustee working groups and coordinated response partnerships to ensure that PMNM's resources are protected in the event of a ship grounding, oil spill or other natural/anthropogenic disturbance. Some of the agencies involved include Logistics Working Group, Alien Aquatic Organism Task Force, Hawaii Invasive Species Council, Hawaii Ocean Safety Team, U.S. Coast Guard (USCG) Area Committee, Western Regional Panel, Large Whale Entanglement Group and marine debris partners.

As mentioned earlier in the report, JIMAR Resource Protection Staff participated in the cruise RA-19-02 and performed follow-up surveys at the Lisianski mass bleaching and buoy grounding sites. Project staff are still working on the logistical actions required to remove the grounded buoy. JIMAR staff were also intensely involved in the invasive algae research at Pearl and Hermes Reef and are working to develop new Best Management Practices (BMPs) to allow continued operations in affected areas. In addition to the FFS Hurricane Walaka damage surveys, staff utilized remote sensing technology to monitor the recovery of East Island via satellite imagery.

JIMAR staff participated in the Large Whale Entanglement training with the USCG to assist partners in marine mammal emergency response operations for whale disentanglement across Oahu. Finally, JIMAR provided small boat operation, diving and logistical support for SANCTsound (joint NOAA Navy Sanctuary Soundscape Monitoring Project) by deploying/recovering Ecological Acoustic Recorder (EAR) devices. SANCTsound entails deploying and retrieving these EARs in the PMNM and Hawaiian Islands Humpback Whale National Marine Sanctuary in order to better understand marine mammal communications and attempt to monitor the environment for events such as vessel activity.

Maritime Archeology. No efforts have been made towards Maritime Archaeology during the reporting period.

Equatorial Oceanography



Equatorial Oceanography

Research under this theme is associated with the collection and analysis of physical, biological, and chemical observations across the equatorial regions of the Pacific Ocean to yield important information on large-scale ocean dynamics and variability. JIMAR hosts the University of Hawaii Sea Level Center (UHSLC) which maintains a coordinated network of tide gauge stations and provides sea level data for the oceanographic and climate communities. JIMAR is also home for the Pacific Islands Ocean Observing System (PacIOOS) which is one of 11 regional centers coordinating oceanographic observational data.

Characterization and Dynamics of Mesoscale and Submesoscale Oceanic Variability in the Solomon Sea Simulated by a Nested ROMS Model

P.I.: Douglas S. Luther

NOAA Office (of the primary technical contact): Pacific Marine Environmental Laboratory

NOAA Sponsor: Gary Matlock, William S. Kessler

NOAA Goal(s)

- Climate Adaptation and Mitigation

Purpose of the Project

High sea level variability is a prominent feature of the southwest tropical Pacific Ocean where interactions between western boundary currents, equatorial currents and mesoscale processes have the potential to influence the properties of waters upwelled at the equator. While the implications of changing ocean conditions in the equatorial Pacific for the El Niño Southern Oscillation (ENSO) and longer timescale climate variability have long been recognized, the dynamics and origin of enhanced variability in the southwest Pacific are largely unknown. The purpose of this project is to study eddy variability in the Solomon Sea western boundary current system with focus on the meso/submesoscale range (10–200 km) using a high-resolution numerical ocean model supplemented by satellite and in-situ (glider, Argo) data. The project's main objectives are: 1) to characterize the spatial and temporal scales, subsurface structure and evolution of the meso/submesoscale eddies in low latitudes; and 2) to assess the interactions between the submesoscale, mesoscale and large-scale circulation. The results will inform the physical interpretation of satellite sea surface height observations of these eddies by clarifying their subsurface structures and generation processes.

Progress during FY 2020

During the last half of the reporting period, project researchers worked on characterizing small-scale features of the Solomon Sea in the western tropical Pacific, detectable in glider observations, with those simulated by a fine-resolution forced ocean model. These small scales are relevant to the large-scale circulation of the tropical Pacific because the mixing they produce affects the properties of the water masses that arrive on the equator and form the background for El Niño events. As part of this work, Hristina Hristova produced a quality-controlled data set of glider temperature, salinity and velocity data suitable for distribution and convenient model comparisons.

Observation and Dynamics of Oceanic Variability in the Solomon Sea

P.I.: Douglas S. Luther

NOAA Office (of the primary technical contact): Pacific Marine Environmental Laboratory

NOAA Sponsor: Gary Matlock, William S. Kessler

NOAA Goal(s)

- Climate Adaptation and Mitigation

Purpose of the Project

The equatorward boundary current in the Solomon Sea is the primary pathway by which waters from the subtropical South Pacific reach the equatorial zone. It is thus a crucial pathway of the ocean circulation that supports interannual to decadal climate variability in the Pacific and enables the long-term “memory” carried by the ocean. Underwater gliders are used to conduct 12-16 transects each year, crossing the Sea to build a time series of flow variability. Analysis of this now 11-year time series is determining how and why transport and water properties vary; how these affect and are affected by ENSO (El Niño/Southern Oscillation) and decadal variability. The project objective is to produce, study, and publicly distribute value-added products that will enable wider use of the data by project researchers and others. This would include modelers, model developers and ENSO/climate analysts, and will provide an ongoing description of this boundary current system interacting with the basin-scale circulation. The result will foster improved modeling of this key piece of the tropical Pacific climate system and provide a basis for the study of this variability.

Progress during FY 2020

During the first year of this project research staff met both stated objectives as described below.

Near-Realtime Glider Data. The project produced near real-time total transport values that addressed questions on how much mass is coming through the Solomon Sea in a given month, and what is its effect on the temperature of the equatorial strip. These are critical time series that can be compared with present-generation models, or ocean reanalyses, and that allow interpretation for their contribution to the overall tropical Pacific mass balance

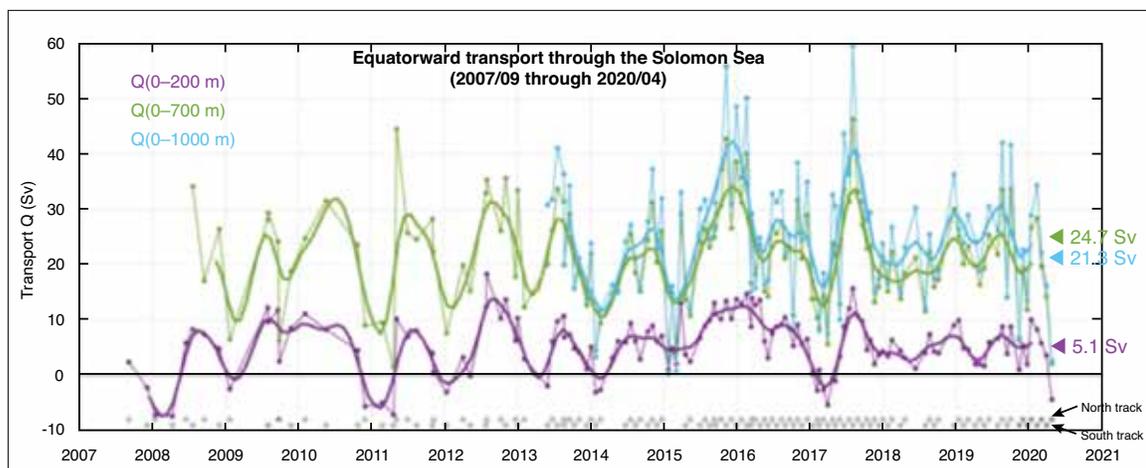


Figure 1. Time series of coast-to-coast volume transport Q (Sv) through the Solomon Sea. Three depth ranges are shown 0–200 m (purple), 0–700 m (green), and 0–1000 m (blue). Sampling to 700 m began in 2008, to 1000 m in 2013. Values at right give the mean transport for each case. Dots show individual section values and are noisy. Smooth curves show “low-frequency variability”, defined as the sum of the average annual cycle plus the anomalies from this smoothed by a 5-month triangle filter. Gray symbols along the time axis show the date and track (northern or southern) for each section, with stars indicating real-time data that has not yet been quality-controlled.

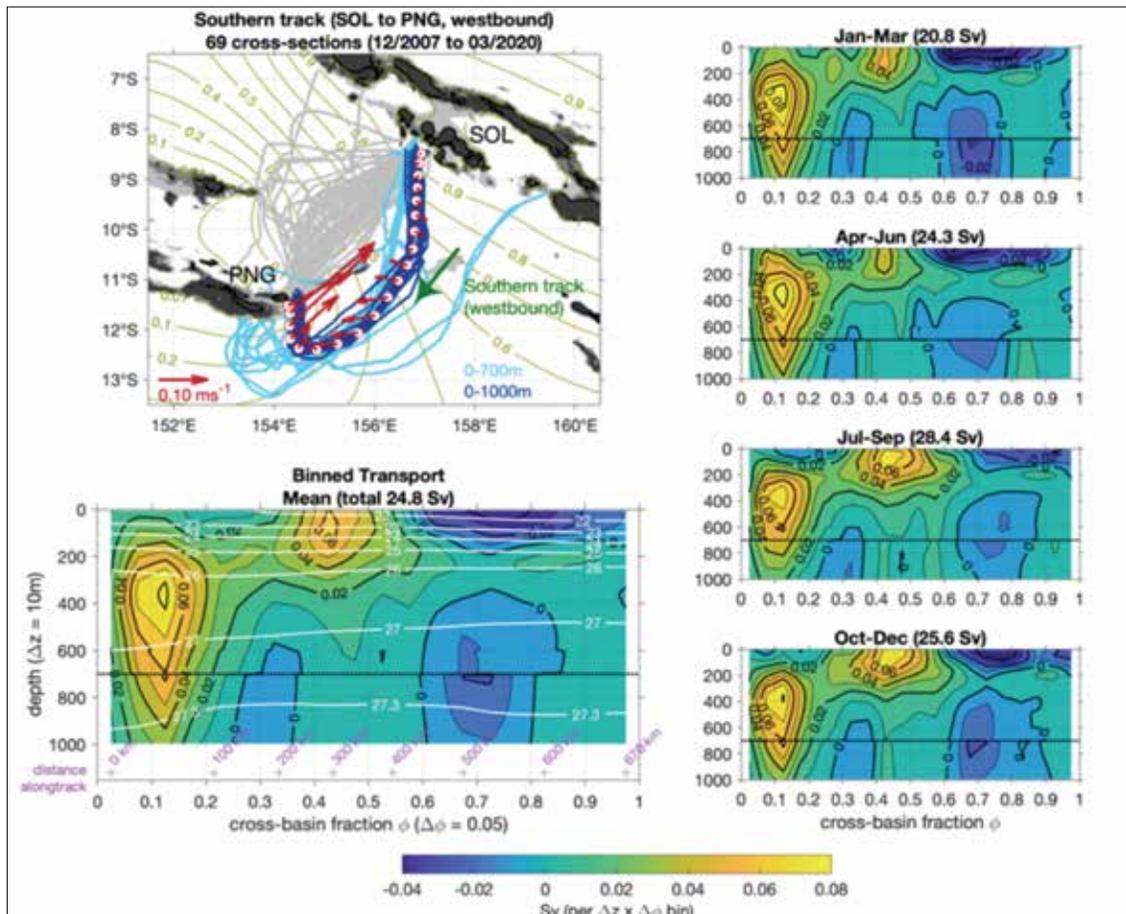


Figure 2. Mean and average annual cycle of binned equatorward transport through the Solomon Sea, southern track. On the southern track, the velocity structure shows two distinct cores: shallow mid-basin inflow; and a much thicker western boundary current, the New Guinea Coastal Undercurrent (NGCU), that extends with great magnitude to and below the sampling depths of 700 m and 1000 m. Positive values indicate equatorward transport. Transport is maximum in Jul-Sep, and weakest in Jan-Mar, varying by ± 3 Sv from its mean of 25 Sv. The annual cycle of transport is largely controlled by the variations of the mid-basin inflow strength.

and property evolution. The transport time-series is produced shortly after each glider transect is completed, and distributed through <https://spraydata.ucsd.edu/SolomonSea/>.¹

Value-Added Products. The project developed value-added products including tide-filtered fields and geostrophic currents that again make the data more accessible to non-specialists. High-resolution data like this measures the tides which are a substantial source of noise, another barrier to wider use. The project employed methods to filter this which produces clean fields that are more directly comparable to basin models and other products. The project produced a dataset containing a climatology of Solomon Sea currents and plans to distribute it publicly through a website similar to the transport time-series. The website is currently in draft mode and not yet publicly available.²

References

- ¹ Kessler, W.S. and H.G. Hristova, 2019. Solomon Sea volume transport time-series measured by glider [Data set]. Scripps Institution of Oceanography, Instrument Development Group. doi: 10.21238/S8SPRAY2718A
- ² Kessler, W.S. and H.G. Hristova, 2020. Climatology of Solomon Sea currents measured by glider [Data set]. Scripps Institution of Oceanography, Instrument Development Group (doi pending).

Optimizing Routine Ocean Current Measurements by the NOAA Fleet: Renewal for FY 2017–2021

P.I.: Eric Firing

NOAA Office (of the primary technical contact): Office of Marine and Aviation Operations

NOAA Sponsor: Solomon Tadele

NOAA Goal(s)

- NOAA Enterprise-wide Capabilities: Observing, Modeling, and Engaging for all Goals

Purpose of the Project

The NOAA research fleet includes many ships with acoustic Doppler current profilers (ADCPs). These instruments have the potential to aid a wide variety of NOAA programs using the ships and to contribute to the global climatology of ocean current measurements. However, without suitable data acquisition and processing software installed, and used routinely, this potential is not realized. The primary purpose of this project is to continue applying project software and expertise to the NOAA fleet that began with the original five years of project funding, and continue with installations, maintenance, and consulting that began during the original two years of funding. In addition, researchers are working with NOAA to establish the data pipeline from the ship to NCEI so that the observations are available for future researchers.

Progress during FY 2020

The project is now in its sixth year and on track with project tasks and accomplishments. Researchers installed and maintained UHDAS on all 11 NOAA ships with ADCPs ready to run. NOAA ship *Oscar Dyson* was added but the *Hi'ialakai* was out of service, leaving the total unchanged from last year. During the reporting period the project made additional improvements in the UHDAS system diagnostics and tracking software, which enabled them to better monitor ancillary data feeds, particularly GPS systems. Establishment of a fully standardized “NOAA to NOAA” (N2N) data pipeline for getting all data submitted to the National Centers for Environmental Information has progressed. The project began work on automated checking of IT security configuration requirements for their shipboard computer systems.

An important component of this work involved interfacing with a wide range of NOAA personnel and providing training. In December 2019, Mr. Toby Martin served as an instructor in the NOAA Survey Technician Training in Norfolk, VA. He also conducted “UHDAS for Bridge Operations” and “UHDAS Care and Feeding” training sessions on each of the three ships. In October 2019, Mr. Martin participated in the RVTEC meeting in Fairbanks, AK, and in February, 2020 he attended the N2N NOAA Information Management meeting in Pascagoula, MS.

University of Hawaii Sea Level Center

P.I.: Philip Thompson

NOAA Office (of the primary technical contact): Climate Program Office

NOAA Sponsor: David Legler

NOAA Goal(s)

- Climate Adaptation and Mitigation
- Resilient Coastal Communities and Economies

Purpose of the Project

The purpose of the University of Hawaii Sea Level Center (UHSLC) project is to ensure that tide gauge data from around the world are collected, quality assessed, distributed, and archived for use in monitoring and research applications related to climate, oceanography, ocean engineering, and geophysics. While UHSLC assembles

time series from many tide gauge stations, the primary focus is the set of stations that constitute the IOC/UNESCO Global Sea Level Observing System (GLOSS) and the Global Climate Observing System (GCOS). The GLOSS and GCOS networks cover most major oceanic islands and island chains, with a subset of available continental coastal stations distributed evenly around the margins of ocean basins. The UHSLC fulfills this purpose via two parallel and complementary activities. First, the UHSLC is a primary data center in the international GLOSS system, curating and distributing two tide gauge datasets: the Fast Delivery dataset, which provides preliminary, quality-assured, hourly and daily tide gauge data within 4–6 weeks of collection; and the Research Quality dataset, which is an archive of hourly and daily tide gauge data that have undergone a complete quality assessment within one year of collection. The Research Quality database is maintained in collaboration with the National Oceanographic Data Center, and toward this purpose, the UHSLC acquires tide gauge data from nearly 500 tide gauge stations maintained by 65 international agencies. Second, UHSLC technicians and data analysts collaborate directly with international partners to maintain more than 80 high-profile



(right, top) Figure 1. Rebuilt tide gauge and GPS installation at Settlement Point, Bahamas. The previous installation was destroyed by Hurricane Dorian in September 2019.



(right, bottom) Figure 2. UHSLC exhibit on “Melting Ice, Rising Seas” at the 2019 SOEST Open House. Students (pre-K through 12th grade) experimented with melting large blocks of ice that were placed in pools either floating or above the water level, which was recorded over time to simulate how the sea level responds differently to melting ice that occurs on land versus in the ocean.

water level stations that are essential for the sea level and tsunami observing efforts. In addition, vertical land motion monitoring is recommended at all GLOSS and GCOS stations for the proper attribution of local sea level changes, and for this purpose, the UHSLC maintains continuous Global Positioning System (GPS) receivers at eleven stations. UHSLC involvement ensures that research-quality and near-real-time monitoring datasets are available from otherwise sparsely sampled areas of the global ocean, and that developing nations have access to training, technical support, and data processing services as needed.

Progress during FY 2020

Data management objectives for FY 2020 were met, as the Fast Delivery and Research Quality databases were updated and expanded to accommodate new data and stations. These datasets are essential to global research efforts in oceanography, geodesy, and climate change. During FY 2020, UHSLC datasets were utilized in 60 peer-reviewed research articles, three books, six governmental agency reports, and four academic theses. The project continued efforts to improve and modernize data flow within the center. New quality-control routines applied via a modern graphical user interface are now in daily operation, increasing the efficiency of the data processing team. In addition to other data services already offered, the project recently implemented an ERDDAP server for UHSLC data (<https://uhslc.soest.hawaii.edu/erddap/>) which provides more robust search capabilities, an extensive application programming interface (API), multiple download formats, and the potential for more unified data access across the various GLOSS data centers. A new tool for exploring the climatology of mean sea level and sea level extremes is near completion (link to prototype: <https://uhslc.soest.hawaii.edu/stations/?stn=007#climatology>). Tide gauge network and station maintenance objectives were only partially met during FY 2020 due to travel restrictions imposed by the COVID-19 pandemic shutdown. Plans for the station visits were weighted toward the second half of the fiscal year so just five of 14 targeted visits were made. One success was the complete rebuild of the tide gauge and GPS installation at Settlement Point, Bahamas (Fig. 1), which was destroyed by Hurricane Dorian in September 2019. For other problematic stations, UHSLC technicians and engineers worked with local contacts to fix issues remotely when possible, and also arranged for local contacts on Chuuk, FSM, to install a brand-new station. The new Chuuk station was assembled and tested at the UHSLC, then disassembled and shipped to Chuuk with detailed assembly and installation instructions. The installation will occur with remote assistance from the UHSLC technicians. UHSLC technicians and engineers made progress on a variety of other endeavors during the travel hiatus: testing new radar sensors for inclusion in future installations; testing Iridium-capable data loggers for low-power installations; developing software for streaming data from Iridium to GTS; developing in-house station monitoring tools for rapid detection of battery problems; and other technical endeavors. The rebuilt GPS station at Settlement Point met the project's objective of one new GPS installation during FY 2020. GPS/GNSS data from UHSLC stations were provided to the GLOSS TIGA data center.

UHSLC researchers participated in multiple research projects that led to peer-reviewed articles in FY 2020, including published papers on the causes of high sea level anomalies in Hawaii and decadal sea level trends in the Pacific. UHSLC researchers were also the lead authors on the sea level section in the State of Climate in 2019 Report to be published later this summer. Collaboration is a key component of UHSLC research goals, and the project collaborated with researchers outside the center on a variety of efforts related to oceanography and climate, including three review papers on the following topics: relationship of sea level to climate oscillations; interactions between mean sea level and other coastal processes; and seasonal-to-interannual forecasting of marine ecosystems. Project researchers also contributed to a manual and guide entitled, Quality Control of in-situ Sea Level Observations, for the UNESCO IOC as part of an international collaboration to inform on best practices for supporting reliable global tide gauge measurements.

University of Hawaii Sea Level Center cGPS

P.I.: Philip Thompson, James Foster

NOAA Office (of the primary technical contact): Climate Program Office

NOAA Sponsor: David Legler

NOAA Goal(s)

- Healthy Oceans
- Climate Adaptation and Mitigation
- Resilient Coastal Communities and Economies

Purpose of the Project

Vertical land movements can significantly alter the rates of sea-level rise expected from the sole climatic contributions of ocean thermal expansion and land-based ice melting, possibly magnifying the impacts of sea-level rise on the coast. This motion can be determined through continuous measurements of the Global Navigation Satellite System (GNSS) at tide-gauge sites; GNSS sites are required for all tide-gauge stations within the Global Sea-level Observing System Core Network (GCN). This project will install, maintain, and manage the data flow from GNSS sites at GCN tide gauges operated by the University of Hawaii Sea Level Center (UHSLC).

Progress during FY 2020

The project's field maintenance and installation effort were scheduled for late spring and early summer 2020 in order to allow field technician Jon Avery to complete his Master's program. The COVID-19 pandemic crisis and corresponding travel ban meant that the project was unable to perform its planned field program.

Outside of the field program, the project continued to maintain its own data archive and ensured that all data were archived at SONEL. They worked with collaborators to download the data from their GNSS receiver on Wake (whose VSAT data connection was down) and updated the data archives. Hurricane Dorian impacted the Bahamas GNSS installation and the project replaced the receiver and cell modem that were destroyed. The receiver was successfully replaced with a new NetR9 and is collecting data, but the replacement cell modem broke when it was connected to the old power system. The project configured a new replacement cell modem in the lab and it will be deployed to the Bahamas as soon as field work can commence again. A modem was also configured for the HNLC station (Honolulu) to bring that receiver back online. It will be installed once the USCG grants the project permission to access the pier where it is located.

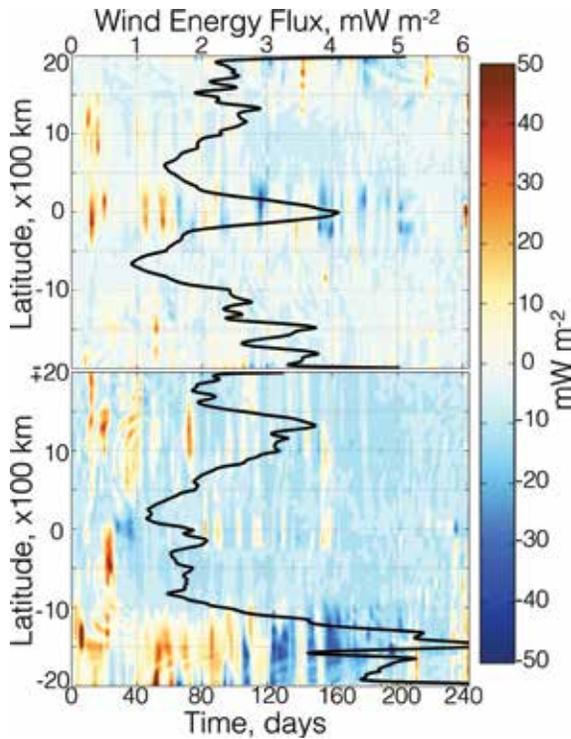
Progress Reports from JIMAR-supported Graduate Students and Postdoctoral Researchers

A Beyond Ray-Tracing Toolbox for the Analysis of Internal Wave Activity

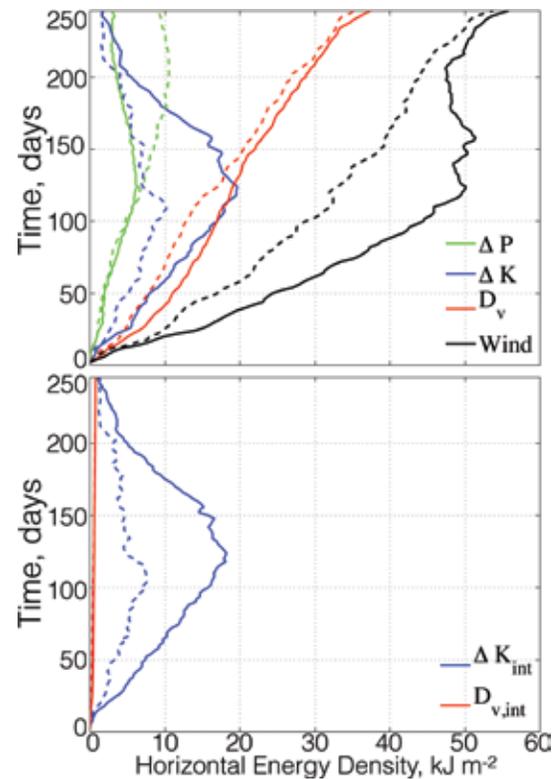
Andrei Natarov, IPRC Assistant Researcher

Purpose of the Research

The main research objective is to investigate novel ways of modeling internal waves and small-scale instabilities in the equatorial ocean and quantify their role in the distribution of mixing along with the effect on large scale tropical circulation. Developing new methods are necessary because of resolution-related limitations in traditional modeling approaches. The current activities include developing proposals and writing papers that continue to extend the theory, use the method in idealized and realistic modeling settings, and apply the method to in situ and satellite-based observations. To communicate research findings to a larger multidisciplinary community, Natarov accepted an invitation to submit a book proposal to AGU. The AGU/Wiley book project, "Small Scale Oceanic Processes and Climate Modeling" was accepted for publication in the AGU Geophysical Monograph series, and a part of his research activities is dedicated to working on this project.



(left) Figure 1. Wind energy flux into the ocean as a function of time and latitude (contour plots) and its temporal average (solid black lines). The upper panel corresponds to period I (from April 1, 2008 to November 30, 2008), the lower panel corresponds to period II (from January 1, 2007 to August 30, 2007). During period I most of the wind energy input into the ocean occurs close to the equator, whereas during period II most of the wind energy input occurs in the Southern Hemisphere.



(right) Figure 2. Total energy partition as a function of time. The upper panel shows the horizontal energy density through the entire ocean depth; the lower panel shows horizontal densities in the ocean interior (e.g., below the mixed layer). Dashed lines correspond to period I (equatorial wind), solid lines correspond to period II (off-equatorial wind). Ocean interior contains almost all mechanical energy in the system (blue lines represent the kinetic energy and green lines represent the potential energy), but most energy dissipation due to vertical mixing (red) occurs in the mixed layer.

Progress during FY 2020

The planned objectives (develop and submission of NSF proposals, publications, AGU book proposal) were largely met by the project.

Future Research Plans

The main objective is to submit proposals to NSF (by August 15, 2020) and possibly other agencies (NASA and NOAA). Other objectives include completion of papers on gyroscopic internal waves and a model of the internal wave energy flux, and work on the AGU/Wiley Book project.

Publications

Moum, J.N., A. Natarov, K.J. Richards, E.L. Shroyer, and W.D. Smyth, 2020. Mixing in equatorial oceans, *Ocean Mixing*, under review.

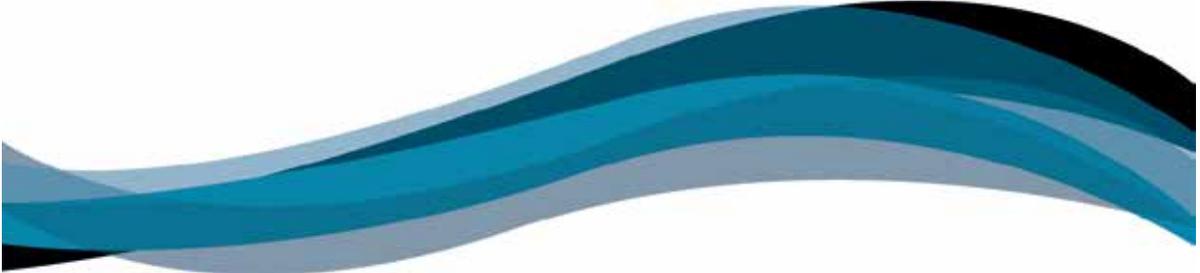
Natarov, A., and K.J. Richards, 2019. Enhanced energy dissipation in the equatorial pycnocline by wind-induced internal wave activity, *J. Geophys. Res.-Oceans*, 124, 6200-6217, doi: 10.1029/2019JC015228. (Add to publications list?)

Presentations

Richard, K.J., et al. Enhanced turbulent mixing in the equatorial thermocline. Presentation at the Ocean Sciences Meeting 2020, San Diego, CA, Feb. 16-21, 2020.

Richards, K.J., et al. The important role of mixing in scale interactions in the tropics and the coupled ocean/atmosphere system. Presentation at the online EGU General Assembly 2020, May 4-8, 2020.

Climate Research and Impacts



Climate Research and Impacts

Oceanic and atmospheric processes drive global and regional climate, and climate change and impacts are associated with changes in these processes as well. Under this theme, JIMAR collaborates in research efforts with the International Pacific Research Center (IPRC) in SOEST, and hosts the Pacific ENSO (El Nino Southern Oscillation) Applications Center (PEAC).

Analysis of Vulnerability of Military Installations in the Pacific Basin to Coastal Flooding

P.I.: Mark A Merrifield

NOAA Office (of the primary technical contact): National Environmental Satellite, Data, and Information Service, National Centers for Environmental Information

NOAA Sponsor: John J. Marra

NOAA Goal(s)

- Weather-Ready Nation
- Climate Adaptation and Mitigation
- Resilient Coastal Communities and Economies

Purpose of the Project

The purpose of the project is to advance the practical application of statistical and other analytical techniques that can be used to assess the vulnerability of built and natural environments to the impacts of coastal flooding in a changing climate. The results will advance the practical applications of coastal flooding analysis and lead to an improved understanding of which components of U.S. Department of Defense (DoD) facilities and infrastructure are potentially vulnerable to coastal flooding, how they could be affected, and how species and ecosystems associated with DoD lands and waters will respond in a changing climate. They will be amenable to incorporation into site and region-specific tools and models to inform decision and policy making. The results will have broad interest within the region and the nation. In summary, the project will: 1) enhance the historical diagnosis of site-specific still water level patterns and trends; 2) explore techniques that can be used to support regional analysis to address poor spatial coverage of tide gauge (TG) records; 3) extend the diagnosis and prognosis of extreme water level patterns and trends by applying it total water levels; and 4) address gaps that exist in the types of assets as well as the measures used to evaluate impacts of coastal flooding in all its forms to assets on an individual basis and in aggregate under different climate change scenarios.

Progress during FY 2020

The Regional Frequency Analyses (RFA) for both the Continental U.S. (CONUS) and the Pacific region (OCONUS) were completed and manuscripts of the methodologies almost ready for journal submissions. Regions were identified differently between the two analyses: CONUS used a 1° coastal grid to identify regions and OCONUS used Rueda et al. (2017) physical classifications for its regions. The Pacific Disaster Center (PDC) will use this and previous extreme-value assessments on their DisasterAWARE platform.

The mixed distributions to the analysis of lesser extremes will be completed by August 2020. Six different methodologies were identified and are currently being analyzed on a set of seven TGs with differing characteristics (continental vs island, west coast of CONUS vs east coast of CONUS, or tropical-cyclone (TC) dominated areas vs areas not dominated by TCs).

Site visits to Naval Amphibious Base Coronado (NABC) occurred in February 2020. During this visit, command and planning personnel were briefed on the status of the project. Discussions were held with command and planning personnel to refine the depth consequence relations for several asset classes (e.g., docks, roads, electrical) as part of the sensitivity and impact analysis. Field surveys were conducted to ascertain threshold elevations for several assets classes (e.g., docks, breakwaters, stormwater) to support sensitivity and impact analysis. This information is part of much larger set of element attribute data that was developed into a geospatial

format database so that it can be used to support impacts analysis and visualization using GIS. The geospatial database is nearly complete.

Reference

Rueda, A., et al., 2017. A global classification of coastal flood hazard climates associated with large-scale oceanographic forcing, *Scientific Reports*, 7, 5038.

Atmospheric Gases in the Remote Pacific Marine Free Troposphere Measured in Hawaii

P.I.: Douglas S. Luther

NOAA Office (of the primary technical contact): Earth System Research Laboratory/ Mauna Loa Observatory

NOAA Sponsor: Brian Vasel [Darryl T. Kuniyuki]

NOAA Goal(s)

- Weather-Ready Nation

Purpose of the Project

The primary purpose of this project is the collection of atmospheric mercury speciation data. The project collects and analyzes semi-continuous high altitude (11,144 feet) measurements of elemental mercury (Hg⁰), reactive gaseous mercury (RGM), and particulate mercury (Hg^P) at the Mauna Loa Observatory (MLO), Hawaii. The objectives of this task will be to accumulate a long-term record of ambient Hg⁰, RGM, and Hg^P chemistry to: 1) support atmospheric mercury chemistry research; 2) establish a baseline mercury measurement station; 3) investigate the long range transport of mercury from South East Asia across the Pacific; and 4) deploy and evaluate improved methodologies for accurate measurements of atmospheric mercury species. In addition to this primary task, other data are measured and collected which may elucidate the transport and transformation mechanisms of atmospheric mercury. This includes measurements of atmospheric aerosols, ozone, sulfur dioxide, elemental carbon, and meteorological variables. All of the data will be organized and archived in a database.

Progress during FY 2020

Activity was centered on continuing additional tests and measurements to mitigate observed mercury measurement artifacts at MLO. Prior testing at MLO provided conclusive evidence for the presence of Hg⁰–Hg^P measurement artifacts in the inlet glassware of the commercial system. In addition, measurement biases in the monitoring of RGM were also identified. Routine monitoring of mercury species continued at the site although staffing limitations and changes at the Mauna Loa Observatory negatively impacted observations there. In early 2020, a newly hired site operator was trained in instrument operation and calibration, and training is ongoing. To date, data quality has improved markedly.



Figure 1. Drs. Akane Yamakawa (National Institute for Environmental Studies, Japan) and Winston Luke (NOAA Air Resources Laboratory) install a prototype sampler for collecting atmospheric mercury species for isotopic composition analysis at the Mauna Loa Observatory, July 2019.

In February 2020, two systems for determining mercury isotopic composition were installed by NOAA personnel and Dr. Akane Yamakawa of the National Institute for Environmental Studies (NIES) in Japan. This new instrumentation will be operated seasonally and will remain at MLO until the end of summer 2020. The main goal of Dr. Yamakawa's research is to understand atmospheric cycle of mercury using Hg isotope analysis. The use of multi-collector inductively coupled plasma mass spectrometry (MC-ICP-MS) for Hg isotopic measurements has led to a better understanding of sources and biogeochemical processes. The development of highly precise Hg isotopic measurement has resulted in the recognition of mass-dependent fractionation (MDF) and mass-independent fractionation (MIF) of Hg isotopes in environmental samples.

MIF occurs under a specific photochemical reaction condition, which leads to a variation in the Hg isotopic composition of various natural and anthropogenic emission sources and to atmospheric processes that cause isotopic fractionation (e.g., transport, oxidation/reduction, deposition, and re-emission). Therefore, Hg isotopic measurement may be a useful way to trace the sources and cycles of atmospheric Hg.

Enhancement of Data and Research Activities for Climate Studies at the International Pacific Research Center (IPRC)

P.I.: Niklas Schneider

NOAA Office (of the primary technical contact): National Environmental Satellite, Data, and Information Service/National Climatic Data Center

NOAA Sponsor: Howard Diamond

NOAA Goal(s)

- Weather-Ready Nation
- Climate Adaptation and Mitigation
- Resilient Coastal Communities and Economies

Purpose of the Project

This project is a continuation of activities at the Asia-Pacific Data-Research Center (APDRC) in support of climate research within the International Pacific Research Center (IPRC) at the University of Hawaii. The project's primary goal is to meet critical regional needs for ocean, climate and ecosystem information. The APDRC does this through local support of climate research activities but also by generating relevant data products for a broad spectrum of users throughout the Asia-Pacific region. The vision of the APDRC is to link data management and preparation activities to research activities within a single center, and to provide one-stop shopping of climate data and products to local researchers and collaborators, the national climate research community, and the public. The APDRC is organized around three main goals: providing integrated data server and management systems for climate data and products; developing and serving new climate-related products for research and applications users; and conducting climate research in support of the IPRC and NOAA research goals.

Progress during FY 2020

The APDRC maintains a wide suite of data transport and discovery servers including: Open-source Project for a Network Data Access Protocol (OPeNDAP)-based Thematic Real-time Environmental Distributed Data Services (THREDDS) Distributed Ocean Data System (DODS) Server (TDS); Grid Analysis and Display System (GrADS) DODS Server (GDS); Data Access Protocol server (DAPPER); a Live Access Server (LAS); and a web-based server for display on in situ and gridded data set (DCHART). These servers continue to be maintained. Due to restrictions in funding, no new servers were added this year.

At present the APDRC hosts over 125 different data sets from in situ platforms, satellites, and numerical models. Together, these data amount to approximately 450 TB. Some of the more popular and larger data sets include: operational ocean model output from the Hybrid Coordinate Ocean Model (HYCOM; 215 TB); high-resolution ocean model hindcast from the Ocean Model for the Earth Simulator (OFES; 76 TB); coupled model output from Intergovernmental Panel on Climate Change (IPCC) runs (CMIP-5; 76 TB); and output from the National Centers for Environmental Prediction (NCEP) operational coupled climate model (CFSv2; 17 TB). The data are stored

on a set of disks in a redundant array of inexpensive disks (RAID) configuration. In addition to maintaining the hardware, several datasets themselves required continual updating. Examples include on-going observations or computations (e.g., monthly forecasts, active satellites). The APDRC runs scripts, conversion programs and other processing steps to ensure all data sets are kept up-to-date. Maintenance of the data servers is at the minimal level of support but keeping data sets up-to-date is also a priority. This second activity can sometimes require a great deal of time and effort as data sets often change.

The APDRC intends to continue support for the World Meteorological Office (WMO) Regional Climate Center (RCC) for the Pacific Islands (known as RA-V) activities but partly due to a reduction in staff, support was minimal during this reporting period. The APDRC web programmer left the prior year and there were insufficient funds to rehire this position. There is currently a proposal under consideration now for staffing support in this regard.

Pacific ENSO Applications Climate (PEAC) Center

P.I.: James Potemra

NOAA Office (of the primary technical contact): National Weather Service/Pacific Region Office

NOAA Sponsor: Raymond Tanabe

NOAA Goal(s)

- Weather-Ready Nation
- Climate Adaptation and Mitigation
- Resilient Coastal Communities and Economies

Purpose of the Project

The Pacific ENSO Applications Climate Center (PEAC) conducts research and develops information products on the El Niño-Southern Oscillation (ENSO) climate cycle that are targeted for the U.S.-Affiliated Pacific Islands (USAPI).

Progress during FY 2020

Since the mid-1990s the NOAA National Weather Service (NWS) provided funding support towards PEAC activities. However in recent years the NWS recognized that this would no longer be sustainable and efforts are ongoing to move PEAC services into the operational NWS workflow. Described below are the final activities funded under the original JIMAR PEAC project grant; a separate report detailing how the PEAC activities were transitioned to the NWS using separate funding is provided. See, Transferal of Pacific ENSO Applications Climate (PEAC) Center Products and Services to Weather Forecast Office (WFO) Honolulu.

The traditional PEAC grant funded four main activities: 1) monthly conference calls with regional weather service personnel to develop seasonal forecasts; 2) evaluating regional data products; 3) maintenance of the PEAC web site and a hard-copy newsletter (discontinued); and 4) conducting education/outreach activities. The University of Hawaii worked closely with the local Honolulu WFO for primarily Hawaii-related forecasts. The University of Guam (UoG) worked to provide western Pacific regional support. This included working with NWS personnel in Guam, American Samoa, the Republic of Palau, the Federated States of Micronesia and the Republic of the Marshall Islands. UoG researchers visited the regions, helped with climate monitoring efforts, and assisted in preparing the quarterly climate statements for the region. The only activities during this reporting period were part of these UoG efforts.

Profiling CTD Float Array Implementation and Ocean Climate Research

PI: Douglas S. Luther

NOAA Office (of the primary technical contact): Pacific Marine Environmental Laboratory

NOAA Sponsor: Gary Matlock

NOAA Goal(s)

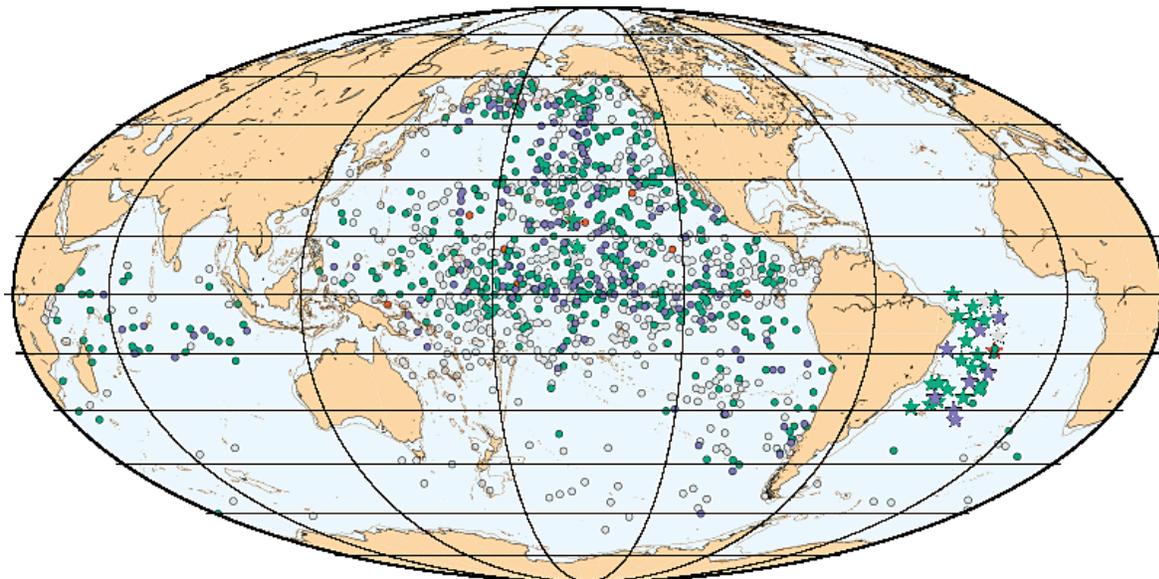
- Healthy Oceans
- Weather-Ready Nation
- Climate Adaptation and Mitigation

Purpose of the Project

JIMAR works with U.S. and International Argo Project partners, especially NOAA/PMEL, on three aspects of the Argo Program. The first objective involves conventional Argo float testing, deployment, and data/engineering evaluation. The second objective involves Deep Argo float testing, deployment, and data/engineering evaluation. The third objective involves delayed-mode quality control of conventional and Deep Argo float data and ocean climate research using data from these floats and other sources.

Progress during FY 2020

At the PMEL float lab Dr. Elizabeth Steffen and JIMAR Float Research Associate Chanelle Cadot continued to test floats, monitor float performance (Fig. 1), diagnose and coordinate repairs of problems discovered with the floats, and work with the manufacturer to resolve problems. They also arranged for many Core Argo float deployments and notified the national and international databases of those deployments. Dr. John Lyman continued to perform scientific analyses of Argo and other data and contributed to the Global Oceans chapter of the annual State of the Climate report published as a special supplement to the *Bulletin of the American Meteorological Society*. He also contributed to two other scientific publications using Argo data. He worked with other members of the group on Deep Argo IT infrastructure and performed scientific delayed-mode quality control on data from



All Argo Float locations as of 2020-05-12

Figure 1. Recent locations of PMEL conventional and Deep Argo floats, for which Dr. Elizabeth Steffen and Ms. Chanelle Cadot perform the logistics, testing, and much of the monitoring. As of 12 May 2020, conventional Argo floats reporting in the past 30 days (green and blue circles) numbered 567, and deep Argo floats (green and blue stars) numbered 29.



Figure 2. A Deep Argo float just prior to release in the Brazil Basin from the R/V Petrel in January 2020.

substantial numbers of PMEL Argo float profiles. From December 2019–January 2020, Chanelle Cadot deployed 17 Deep Argo floats in the Brazil Basin from the R/V *Petrel* (Fig. 2). Stated goals were met.

Transferal of Pacific ENSO Applications Climate (PEAC) Center Products and Services to Weather Forecast Office (WFO) Honolulu

P.I.: James Potemra

NOAA Office (of the primary technical contact): National Weather Service/Pacific Region Office

NOAA Sponsor: Raymond Tanabe

NOAA Goal(s)

- Weather-Ready Nation
- Climate Adaptation and Mitigation
- Resilient Coastal Communities and Economies

Purpose of the Project

The Pacific ENSO Applications Climate Center (PEAC) conducts research and develops information products on the El Niño–Southern Oscillation (ENSO) climate cycle that are targeted for the U.S.–Affiliated Pacific Islands (USAPI). One objective of PEAC is to provide timely and easily accessible information that supports planning and management activities in climate-sensitive sectors such as water resource management, fisheries, agriculture, civil defense, public utilities, and coastal zone management (for more details see PEAC Center annual report). As PEAC operations are reduced due to limited resources, this project was tasked with identifying those functions within PEAC that can be moved over to the operational component of the NWS. Once identified, the project will work with PEAC and NWS staff to execute this transition. This includes the training expertise provided by PEAC Center to build capacity within the Weather Forecast Office (WFO) Honolulu, Hawaii and Guam. This project will contribute to supporting the development of a regional capacity to deliver climate services within the Pacific Region.

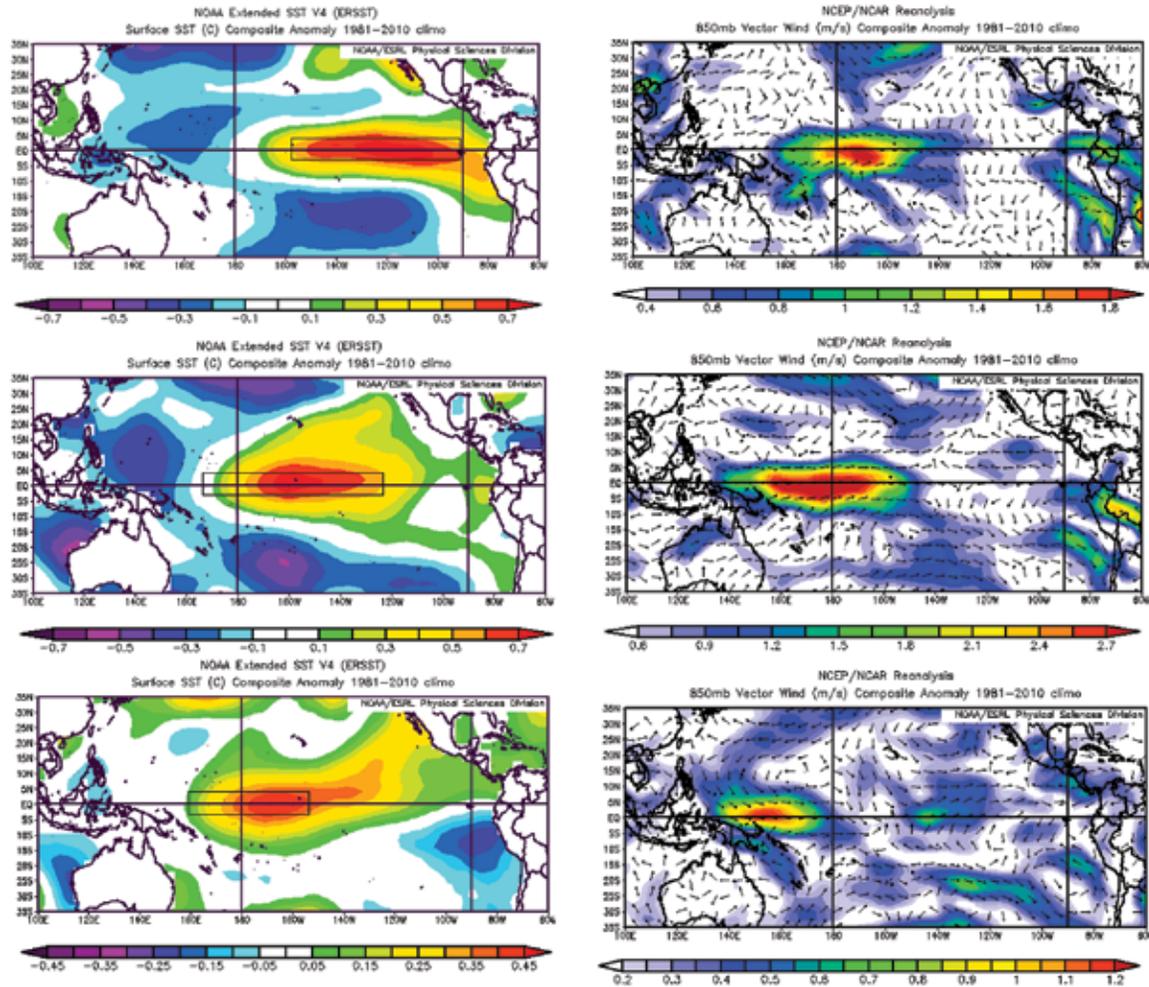


Figure 1. Composites of SST (°C) (left) and 850 mb Vector Wind (m/s) (right) anomalies of El Niño events during 1981-2010. The anomalies are averaged from September to the following February. The El Niño events are classified into several categories: Eastern Pacific El Niño (EPE; top); Mixed El Niño (ME; middle); and Western Pacific El Niño (WPE; bottom). The black thick boxes (left panel) indicate Niño-3 (top), Niño-3.4 (middle), and Niño-4 (bottom).

Progress during FY 2020

As part of the current transition of PEAC to the National Weather Service (NWS), PEAC Scientist Dr. Rashed Chowdhury continued working with the NWS operational products for transition. During the first half of the report period (July to December of 2019), the project continued its regular ‘regional climate monitoring and reporting’ task, developed operational rainfall and sea level forecasts, and conducted outreach, training and capacity building activities. In order to improve understanding of “El Niño impacts on the USAPIs” and support the island-specific short-to-mid-term planning and management in climate-sensitive sectors, project staff made significant progress in the study to understand the physical interpretations of three different types of El Niño (e.g., Western Pacific/Warm pool El Niño [WPE], Eastern Pacific/cold tongue El Niño [EPE], and mixed El Niño [ME]) on island-wide seasonal rainfall and sea level variability.

In addition, Dr. Chowdhury co-taught a graduate course with Dr. Karl Kim entitled, “PLAN 670: Interdisciplinary seminar in disaster management and humanitarian assistance” at the Department of Urban and Regional Planning, University of Hawaii at Manoa. Dr. James Potemra (project PI) also presented a lecture during this course. The course provided an overview of disaster management and humanitarian assistance with a specific focus on strategies for risk reduction and resilience. It serves as the entry course for the Graduate Certificate in Disaster Management and Humanitarian Assistance (DMHA) at the University of Hawaii.

Progress Reports from JIMAR-supported Graduate Students and Postdoctoral Researchers

West Maui Wave Runup Forecasts

Camilla Tognacchini, JIMAR Graduate Student

Purpose of the Research

The main objectives of this research are to: 1) acquire nearshore observations of wave energy, sea level heights and currents along the West Maui coastline; 2) analyze the collected data to identify and quantify the components that contribute wave induced run-up as a function of distance along the West Maui coastline; and 3) compare the analysis of the collected data to the runup estimate forecast by a model that has been set up for this domain.

Progress during FY 2020

To meet the objectives, a field program funded by the UH Sea Grant Program was developed to acquire measurements of the components that contribute to runup as a function of distance along the West Maui coastline. Instruments were deployed along

the coast of West Maui as shown in Fig. 1. Sea level observations collected to date were analyzed to identify the components of sea level that contribute to wave runup in different regions of West Maui.

In collaboration with a NOAA coastal resilience grant, a two-dimensional phase-resolving nearshore gravity wave model was set up on a grid wrapping around the West Maui coast. Methods and techniques for model validation were established and the runup forecast model was validated for over half of the domain. The model was calibrated with both the in situ measurements of sea level and currents as well as photographs of runup at the shore from the citizen scientist observational program (Fig. 2).

Analyses of the collected observations and modeled simulations are ongoing and have already produced interesting results that were presented at the UH Manoa Physical Oceanography student seminar as well as at two international conferences. Due to travel restrictions related to the COVID-19 pandemic shutdown, the field program could not be concluded in FY 2020 and will be concluded as soon as possible in FY 2021.

Future Research Plans

During FY 2021 all deployed instrumentation will be collected and the field program will conclude. Final analysis of the data collected and validation of the forecast model with observations and with the citizen scientist validations of runup is in process and will be concluded in FY 2021 to meet the third objective. These analyses will be presented in Tognacchini's master's thesis in fall 2020 as well as a manuscript for publication.



Figure 1. Map of West Maui with locations of instrumentation deployed. Google Maps, 2019.



Figure 2. Impacts of wave runup in West Maui. Photo taken by a citizen scientist (N. Runyan) as part of the “West Maui wave runup forecast validation” online photo project.

Presentations

Tognacchini, C., M. Guiles, A. Azouri, V. Roeber, M. Iwamoto, F. Langenberger, T. Owens, and D. Luther, 2019. Advances in near term run-up forecasting: PacIOOS 2D run-up model for West Maui coastline. Poster presentation at Ocean Obs '19, Honolulu, HI, Sept. 16–20, 2019.

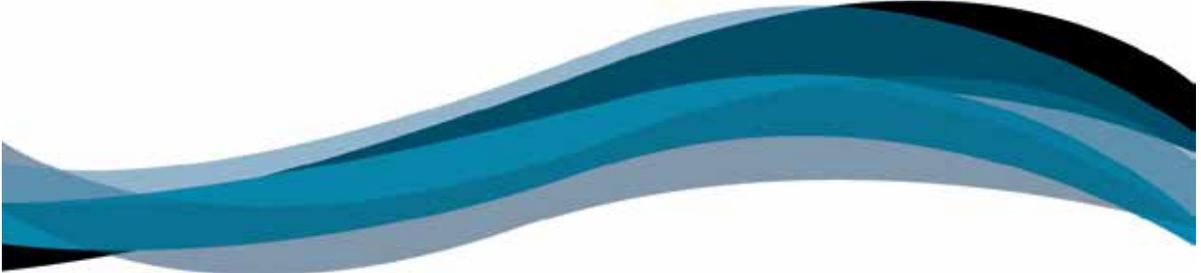
Tognacchini, C., M.D. Guiles, A. Azouri, V. Roeber, and D.S. Luther, 2020. West Maui—A stellar example of spatial variability of the wave-driven components of runup and inundation. Presentation at the Ocean Sciences Meeting 2020, San Diego, CA, Feb. 16–21, 2020.

Tognacchini, C., M.D. Guiles, A. Azouri, V. Roeber, and D.S. Luther, 2020. West Maui—A stellar example of spatial variability of the wave-driven components of runup and inundation. Presentation at the RBR Technical Workshop, Feb 16, at the Ocean Sciences Meeting 2020, San Diego, CA, Feb. 16–21, 2020.

Guiles, M.D., C. Tognacchini, A. Azouri, V. Roeber, N. Li, M. Iwamoto, F. Langenberger, T. Owens, and D.S. Luther, 2020. Forecasting wave driven inundation in West Maui—Modelling a complicated nearshore environment to predict runup. Presentation at the Ocean Sciences Meeting 2020, San Diego, CA, Feb. 16–21, 2020.

Owens, T., D.S. Luther, F. Langenberger, M.D. Guiles, V. Roeber, A. Azouri, C. Tognacchini, and M. Iwamoto, 2020. Enhancing coastal community resilience with real-time notifications, and long term projections of hazardous wave-driven flooding and erosion events in West Maui. Presentation at the Pacific Risk Management Ohana Conference, Honolulu, HI, March 10–13, 2020.

Tropical Meteorology



Tropical Meteorology

SOEST is uniquely qualified for geophysical research in tropical regimes, and the Department of Atmospheric Sciences provides world-class research in the areas covered under this theme. In addition to facilitating IPRC and Department of Atmospheric Sciences research, JIMAR hosts NOAA National Weather Service fellowship programs in the SOEST academic departments.

National Weather Service Pacific Region Fellowship Program

P.I.: Douglas S. Luther

NOAA Office (of the primary technical contact): National Weather Service/Pacific Region Office

NOAA Sponsor: Raymond Tanabe

NOAA Goal(s)

- Weather-Ready Nation

Purpose of the Project

As part of the memorandum of understanding between the University and the National Weather Service (NWS), the NWS supports graduate students in SOEST academic units.

Progress during FY 2020

During FY 2020, the NWS Fellowship Program provided ongoing educational support to the departments of Earth Sciences (formerly Geology and Geophysics), Atmospheric Sciences (DAS, formerly Meteorology) and Oceanography. The NWS Fellowship funds were used to: 1) support graduate teaching assistantships; 2) provide administrative support via undergraduate student helpers, purchase of scientific software and office research supplies; and 3) provide scientific equipment and supplies to support the Oceanography Department's Global Environmental Science (GES) program.

During the reporting period, funding was provided for Department of Atmospheric Sciences graduate student Jan van der Veken, to continue his Master's research. A summary of his ongoing research is provided below.

Van der Veken continued research on a tropical cyclone (TC) downscaling project. The data acquisition process demanded substantial troubleshooting and manifesting in optimizing Weather Research and Forecasting Model Advanced Research (WRF-ARW) simulations of hurricane Lane (2018). Initial results showed that WRF is working fairly well to represent rainfall events associated with Lane. This validation process will be used to motivate the downscaling of climate model resolved tropical cyclones using WRF. Using climate model data, he will downscale "Lane-like" tropical cyclones (ones that follow a similar path). The downscaled tropical cyclones should give insight into regional and localized impacts of tropical cyclones near the Hawaiian Islands.

Through this analysis, he will be looking for changes that may occur in extreme rainfall and wind events associated with TCs. The time frames being contrasted are the end of the 20th century and end of the 21st century. He seeks to discover if anthropogenic climate change may increase the amount/reoccurrence interval of TC-associated extreme events near the islands. He also plans to integrate a deep learning neural network into these studies. The idea would be to train the neural network on WRF outputs and then have it model the same future data as the purely dynamical process. The statistical downscaling results could then be compared to the dynamical downscaling results.

Department of Atmospheric Sciences PhD student Zachary Menzo, was also supported during the reporting period. The following summary is from a poster produced by Menzo.

Recently a novel technique to analyze geographic variations of convective heating vertical structures in the tropical Pacific was proposed by Torri et al. (2017). By comparing fractionation rates in the east and west Pacific, the authors noted a geographical disparity that could not be described by the amount effect. They hypothesized that due to the natural stratification of stable water isotopes in the atmosphere, higher levels of convergence results in more depleted precipitation (referred to as *convergence technique* for the remainder of the proposal). In the publication, the authors created two metrics to determine the vertical profile of convective heating. The first is

the ratio of vertical convergence over evaporation (C/E), and the second is the pressure velocity-weight average pressure (p_w). When evaporation is held constant, a higher C/E ratio suggests more depleted precipitation while higher values of p_w suggest a lower vertical profile, and subsequently more enriched precipitation.

The goals of the project are to: 1) test both metrics and the overall ability of the convergence technique to determine vertical extent of convective heating; 2) conduct a temporal test through the development of a *proxy forward $\delta O18$ model*; and 3) use *pseudo $\delta O1$ model* to examine the response of the climate to paleoclimate conditions and future warming scenarios.

Reference

Torri, G., D. Ma, and Z. Kuang, 2017, Stable water isotopes and large-scale vertical motions in the tropics, *J. Geophys. Res.-Atmos.*, 122, doi: 10.1002/2016JD026154.

Progress Reports from JIMAR-supported Graduate Students and Postdoctoral Researchers

'Eli'eli Kau Mai: Utilizing Citizen Science from the Waihona 'Ike Kupuna/ Institute for Hawaiian Language Research and Translation

Paige Okamura, JIMAR Graduate Student

Purpose of the Research

At the beginning of the reporting period, Ms. Okamura was still translating articles on the 1881 eruption but completed translation work in late 2019. She submitted an article for publication to the local newspapers (*Star Advertiser* and *Big Island Tribune*) and although the *Star Advertiser* showed interest, unfortunately it didn't get published. For the remainder of the year and the first half of 2020, her focus shifted towards editing and organizing the project's database of articles (currently over 4,000 articles) and making sure that their numbers and accounting are accurate because at least four different graduate students have worked on this project.

A sub-objective of the project was to update the website by posting all the translations online. As reported in Okamura's previous reports, the research work has outgrown the current website's capacity, resulting in slow, cumbersome search and uploading capabilities. The system is not as user-friendly as project staff would like. Currently, a new website is being developed for the Native Hawaiian Place of Learning office at which time all the articles will be uploaded to.

The link to the current database that Ms. Okamura works with is available at <https://docs.google.com/spreadsheets/d/12cgW6MxXUP7fPfEgLYFIcVPEsrpOtQAJvsp5xIo30Z8/edit#gid=0>

Progress during FY 2020

Okamura's primary focus was to clean up the record keeping of the articles on the database by tallying the number of translations already uploaded online and the number of articles marked as translated. As of 6/19/20 the numbers, including work done by previous GRAs before Okamura, are as follows: 763 articles indicated as translated; 321 total translations uploaded online to the SeaGrant website (<http://manoa.hawaii.edu/ihlrlt/>); and 442 articles that need to be located.

The biggest problem in record keeping over the years has been due to the multiple GRAs that held this position and no standard operating procedure implemented on how best to organize and archive translations as the project focuses shift and as new GRAs come and go. Another problem has been maintaining the website, which has been in transition for the last year or so.

Ms. Okamura's last day of employment is June 30, 2020 so until then she will be locating as many files as possible at which time she will submit the most up to date numbers to supervisor, Dr. Punihei Lipe and JIMAR Director Dr. Douglas Luther.

Tropical Cyclone Climatology of the Central North Pacific

Haley Okun, JIMAR Graduate Student

Purpose of the Research

The initial purpose of this research is to create an updated climatology for the Central North Pacific (CNP, 140°W to 180°), for tropical storms (34–63 knots), hurricanes (categories 1 and 2), and major hurricanes (categories 3–5). This was further expanded to calculate the overall accumulated cyclone energy (ACE) and then ACE1, ACE2, and ACE3, to investigate whether intensity, lifetime, or storm number was the most important factor. Additionally, with both the Eastern Pacific (EP) and Central Pacific (CP) warming, the impact of ENSO is also being investigated to determine hurricane seasonality patterns in the CNP. The long-term goal of this project is to enhance forecasting of hurricane tracks through classification and improve understanding of hurricane behavior in relation to large scale atmospheric features and interannual influences.

Progress during FY 2020

An updated CNP and ENP climatology was created with data from 1966 (the beginning of satellite technology) through 2018 (the last verified year) using the NOAA HURDAT2. They were then categorized into TS, HU, and Major HU, and labeled accordingly with their origin basin to determine CNP genesis or the passage rate of storms into the CNP. Once these were all verified, the ACE, ACE1, ACE2, and ACE3 were calculated according to Camargo and Sobel (2005). Once these variables were calculated, they were then analyzed for EP type El Niño years and CP type El Niño years. This comparison gives insight into the importance of the favorable conditions on the genesis, number, and intensity of tropical cyclones, and how this has changed throughout the 50-year period and analysis of 845 storms.

The master list of all the storms over the 52 year period during hurricane season (June–November) for ENP and CNP includes: location (latitude and longitude), date, time, wind speed, maximum type, ACE, intensity, lifetime, origin basin, end basis, landfalling (if applicable) and ENSO type (if applicable).

Future Research Plans

Building off of the data collection of the tropical cyclones in the ENP and the CNP, a comprehensive track clustering analysis will be completed. This is currently being applied with the Clustering Trajectories outlined by Camargo et al. (2007). Once the track types of the Eastern and Central North Pacific have been categorized, an analysis of features can begin, followed by an investigation to determine what causes the differences of each track type and why, to further enhance the forecasting of tropical cyclones in the CNP, especially concerning Hawaii.

References

Camargo, S. J., and A. H. Sobel, 2005, Western North Pacific tropical cyclone intensity and ENSO, *J. Climate*, 18(15), 2996-3006, <https://doi.org/10.1175/JCLI3457.1>.

Camargo, S. J., et al., 2007, Cluster analysis of typhoon tracks. Part I: general properties, *J. Climate*, 20(14), 3635-3653, <https://doi.org/10.1175/JCLI4188.1>.

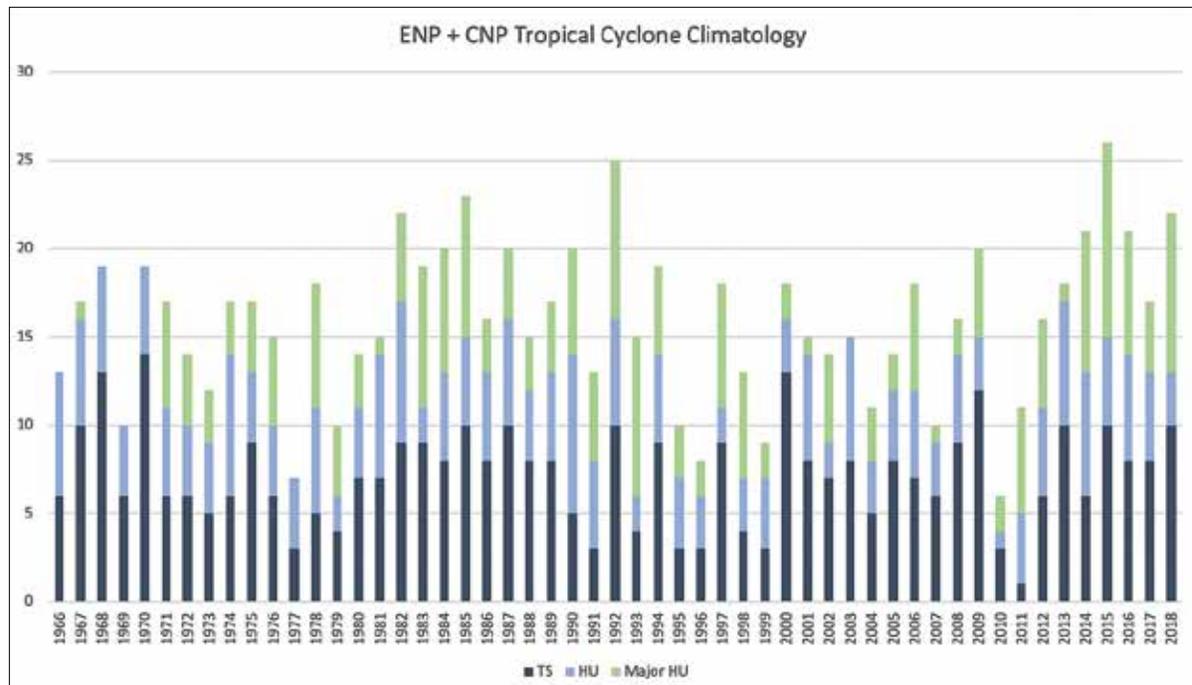


Figure 1. Climatology of the Eastern North Pacific and Central North Pacific for 1966–2018, showing the number of TS, HU, and Major HU for each year.

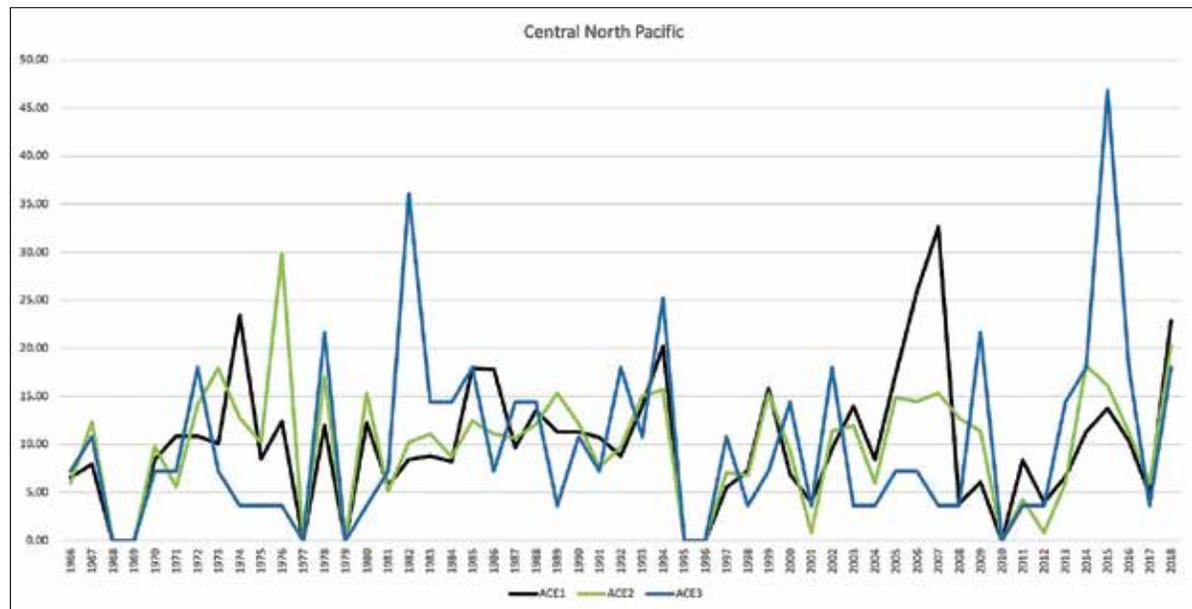
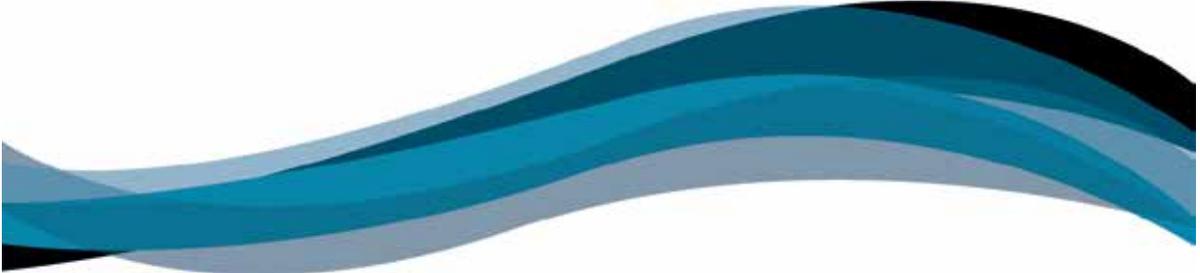


Figure 2. ACE values for Central North Pacific from 1966–2018. ACE1 is calculated with a variation in TC intensity (while lifetime and number remain constant), ACE2 is calculated with a variation in TC lifetime (while intensity and number remain constant), and ACE3 is calculated with a variation in TC number (while intensity and lifetime remain constant). Because there is no variable that remains constant throughout the climatology, intensity, lifetime, and number are all important in gauging the strength of a hurricane season.

Tsunamis and Other Long-Period Ocean Waves



Tsunamis and Other Long-Period Ocean Waves

JIMAR efforts in tsunami detection include development of monitoring systems for the Indian Ocean. Further collaboration in this theme is affected through interactions with the UHSLC.

Archive of Rapidly Sampled Hawaiian Sea Level

P.I.: Douglas S. Luther

**NOAA Office (of the primary technical contact): National Marine Fisheries Service/
Pacific Islands Fisheries Science Center**

NOAA Sponsor: Michael P. Seki

NOAA Goal(s)

- Weather-Ready Nation
- Resilient Coastal Communities and Economies

Purpose of the Project

The Archive of Rapidly Sampled Hawaiian Sea Level (ARSHSL) is intended to provide an Internet-accessible, public database of rapidly-sampled ($\Delta t \leq 6$ minutes) sea level observations from Hawaiian coastal sea level gauges previously or currently maintained by National Ocean Service (NOS) and Pacific Tsunami Warning Center (PTWC). The main objective of ARSHSL, originally established by NOAA in 1997, is to ensure a consistent repository for rapidly-sampled sea level in the Hawaiian Islands for the study of tsunamis and related infra-gravity wave signals (including coastal-trapped waves and harbor oscillations) at periods of 2–40 minutes. The archive has been maintained with funding by JIMAR. Sea level (SL) data from two-thirds of the Hawaiian gauges that are accessed is not generally available to the public or research communities; that is, the data is not prepared and offered to the public by the agency (PTWC) responsible for maintaining the gauges, because these activities are not part of the mission of that agency. Therefore, this data archiving and dissemination activity is intended to provide as complete a dataset as possible of sea level fluctuations at the coasts of the Hawaiian Islands for current and future research and practical applications. Past applications of the archived data have ranged from hydrogeology to gravity wave studies to dock design. Predominant users in the past year focused on infragravity waves at periods of two minutes to several hours in support of the NOAA-funded development and maintenance of high-spatial-resolution numerical models of coastal runup nowcasts and forecasts along the west coast of Maui. A long-term objective of this program is to achieve harbor surge forecasts and coastal runup forecasts in other Hawaiian harbors or along other coasts respectively, using the archived high-temporal-resolution sea level data in ARSHSL to validate empirical or numerical models. Such forecasts are disseminated on the PacIOOS web site as they are established (<http://www.pacioos.hawaii.edu/shoreline-category/harborsurge/> and <http://www.pacioos.hawaii.edu/shoreline-category/runup/>).

Progress during FY 2020

As planned, the processing, integration and archiving of ongoing 1-minute and 6-minute SL observations for the 6 NOS gauges in Hawaii was achieved through 5/31/20. The automated data acquisition codes continued to function flawlessly apart from a glitch where the software created an empty file for each of the 6-min stations during one month. The origin of the glitch was not fully determined, but the likely culprit was an interplay between how the timestamped filenames are constructed and what date of the month the weekly cron task gets scheduled. The problem was easily corrected using the manual data acquisition code. This code needed to be converted from <http://> to the secure <https://> as the data repositories all use secure transfer now. This code upgrade was accomplished last year for the automated scripts. Further progress was made on automating the year-end transition for the 1-min data. The QC application (designed and implemented in previous years under this funding) will now populate any data that was not archived in the previous year. This alleviates 90 percent of the inconvenience of conducting manual checks and corrections when transitioning from one year to the next. The 1-min archive was QC'd and now up to date. Logs of missing data continued to be automatically generated and are functioning correctly.

Also per the plans for this past year, the ARSHSL has been maintained online (<http://ilikai.soest.hawaii.edu/arshsl/techrept/arshsl.html>) by M. Guiles and D. Luther, in collaboration with the NOAA-funded UH Sea Level Center (P. Thompson, Director).

Tsunami Research and Modeling

P.I.: Douglas S. Luther

NOAA Office (of the primary technical contact): Pacific Marine Environmental Laboratory

NOAA Sponsor: Gary Matlock

NOAA Goal(s)

- Resilient Coastal Communities and Economies

Purpose of the Project

This project is focused on the identification of tsunami source parameters that may have a direct effect on the height of tsunami waves in the far-field. Results from this investigation may provide guidance to operational

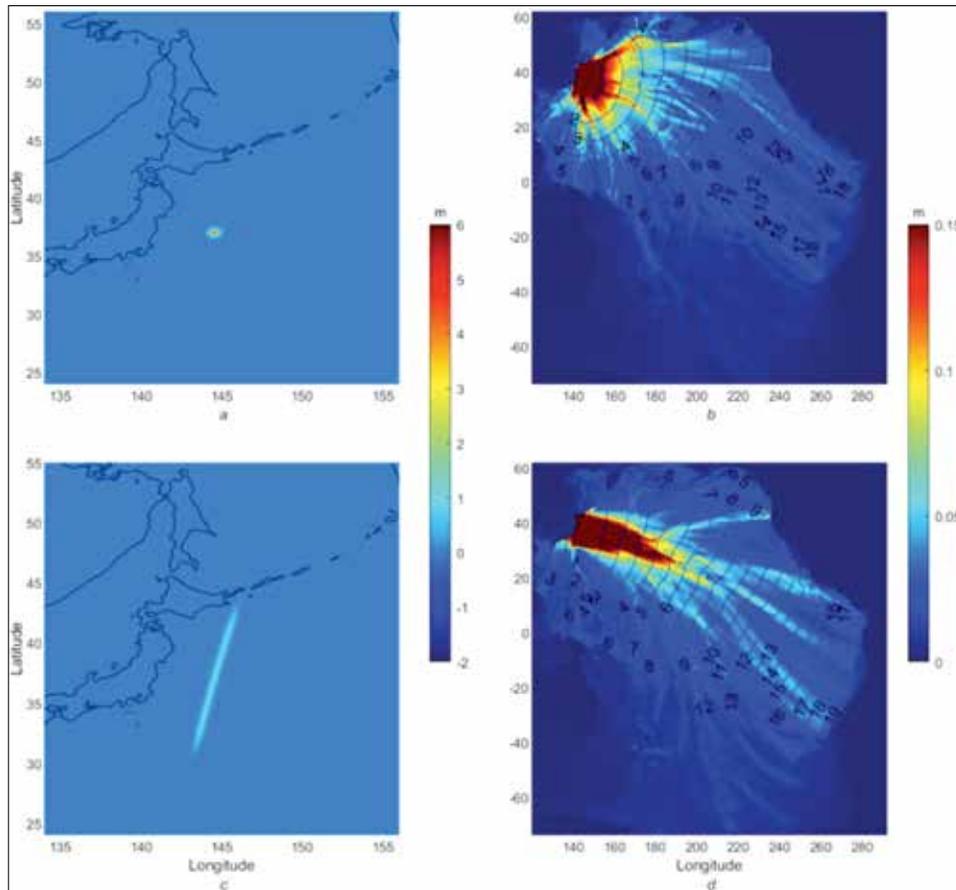


Figure 1. Initial water surface elevation and maximum tsunami amplitude distribution for tsunamis generated by two different hypothetical sources off the coast of Japan and normalized amplitudes: a short rupture source (upper panels) and a long rupture source (lower panels). Panels on the left column show the initial water surface deformation for each of the sources and panels on the right show the maximum water surface elevation throughout the Pacific Ocean.

Tsunami Warning Centers in order to better estimate the appropriate tsunami alert level immediately after the earthquake when very limited seismic or water level data are available for a more quantitative assessment of the tsunami. Additionally, some of the conclusions of the project can be used as a first selection criteria to help identify worst-case scenarios for tsunami hazard assessment studies at specific locations by reducing the total number of candidate sources requiring computationally expensive numerical simulations.

Progress during FY 2020

An extensive numerical parametric study was conducted to investigate the influence of the aspect ratio of the generating source on the decay rate of generated tsunami waves. Results indicate that earthquakes of large magnitude which tend to rupture a long stretch of the subduction zone while keeping the width of the rupture approximately fixed, typically result in tsunamis with very slow-decaying wave amplitude and asymptotically tending towards one dimensional plane waves. By contrast, short-rupture tsunami sources, while exhibiting larger wave amplitudes in the near-field, tend to experience a more pronounced decay rate resulting in smaller amplitudes in the far-field.

Scientific and numerical investigations were recently completed and a research article presenting the results of the study is in preparation by Dr. Sannikova for submission to *Geophysical Research Letters*.

University of Hawaii Sea Level Center—Tsunami Research

P.I.: Philip Thompson

NOAA Office (of the primary technical contact): NOAA Tsunami Program

NOAA Sponsor: Michael Angove

NOAA Goal(s)

- Resilient Coastal Communities and Economies

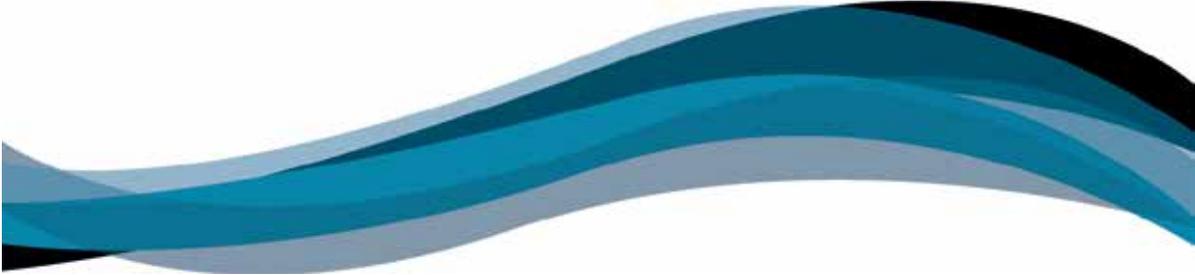
Purpose of the Project

The University of Hawaii Sea Level Center (UHSLC) maintains nine water level stations in the Caribbean Sea and ten water level stations in the Pacific Ocean in support of regional tsunami warning and sea level monitoring. The Caribbean portion of the project was developed in collaboration with the Puerto Rico Seismic Network (PRSN). UHSLC oversees the operation of the stations and provides ongoing technical support, data processing, and quality assessment services. The Pacific portion of the project is primarily focused on the maintenance of tsunami water level stations previously maintained by the Pacific Tsunami Warning Center (PTWC). UHSLC involvement ensures that the water level stations remain operational and transmitting real-time, high-frequency data while also complying with global sea level observing system requirements for oceanographic and climate research.

Progress during FY 2020

Progress fell short of stated objectives due to travel restrictions imposed in response to the COVID-19 pandemic shutdown. Two Pacific stations were visited: Cocos Island for routine maintenance and Tern Island to rebuild the tide gauge station destroyed by Hurricane Walaka. None of the Caribbean stations were visited. The project is currently in discussion with the Tsunami Program regarding alternative work plans. All tsunami station data underwent daily and monthly quality assessments and data were archived in the UHSLC's publicly available datasets.

JIMAR Publications



JIMAR Publications

Journal Articles and Books					
Author(s) Names	Publication Date	Title	Published In (journal name, vol. and page no.)	Citation No. or Hyperlink	Project Title
Asher, J., I.D. Williams, and E.S. Harvey	11/7/2019	Is seeing believing? Diver and video-based censuses reveal inconsistencies in roving predator estimates between regions	Mar. Ecol. Prog. Ser., 630, 115-136	https://doi.org/10.3354/meps13107	Sustaining Healthy Coastal Ecosystems
Ayers, A., and H. Chan	5/14/2020	Rights-based management, competition, and distributional equity in Hawai'i's largest commercial fishery	Int. J. Commons, 14(1), 262-277	https://doi.org/10.5334/ijc.996	Socioeconomics of Western Pacific Fisheries
Ayers, A., and K. Leong	1/31/2020	Examining the seascape of compliance in U.S. Pacific Island fisheries	Mar. Policy, 115, 103820	https://www.sciencedirect.com/science/article/pii/S0308597X19305573	Socioeconomics of Western Pacific Fisheries
Banerjee, S.M., et al. [A.R. Gaos]	9/5/2019	Single nucleotide polymorphism markers for genotyping hawksbill turtles (<i>Eretmochelys imbricata</i>)	Conserv. Genet. Resour., 2019	https://doi.org/10.1007/s12686-019-01112-z	Marine Turtle Recovery in the Pacific Islands Region
Banerjee, S.M., et al. [C.D. Allen]	11/20/2019	Baseline health parameters of eastern Pacific green turtles at Southern California foraging grounds	Chelonia Conserv. Biol., 18(2), 163-174	https://www.chelonianjournals.org/doi/abs/10.2744/CCB-1347.1	Marine Turtle Recovery in the Pacific Islands Region
Barkley, Y., E.M. Oleson, J.N. Oswald, and E.C. Franklin	10/18/2019	Whistle classification of sympatric false killer whale populations in Hawaiian waters yields low accuracy rates	Front. Mar. Sci., 6, 645	https://doi.org/10.3389/fmars.2019.00645	Cetacean Research Program
Barraza, A., et al. [C.D. Allen]	2/29/2020	Persistent organic pollutants in green sea turtles (<i>Chelonia mydas</i>) inhabiting two urbanized Southern California habitats	Mar. Pollut. Bull., 153, 110979	https://www.sciencedirect.com/science/article/abs/pii/S0025326X20300977	Marine Turtle Recovery in the Pacific Islands Region
Bowen, B., et al. [Z. Forsman]	1/14/2020	Species radiations in the sea: What the flock?	J. Heredity, 111(1), 70-83	https://doi.org/10.1093/jhered/esz075	West Hawaii Integrated Ecosystem Assessment
Briggs, E.M., E.H. De Carlo, C.L. Sabine, N.M. Howins, and T.R. Martz	4/1/2020	Autonomous ion-sensitive field effect transistor-based total alkalinity and pH measurements on a barrier reef of Kāne'ohe Bay	ACS Earth Space Chem., 4(3), 355-362	doi:10.1021/acsearthspacechem.9b00274	National Ocean Acidification Observing Network-Oahu NCRMP Class III
Brown, J., et al. [M.J. Widlansky]	in press	South Pacific Convergence Zone dynamics, variability, and impacts in a changing climate	Nat. Rev. Earth Environ.		University of Hawaii Sea Level Center
Cazenave, A., et al. [P. Thompson]	9/27/2019	Observational requirements for long-term monitoring of the global mean sea level and its components over the altimetry era	Front. Mar. Sci., 6, 582	https://doi.org/10.3389/fmars.2019.00582	University of Hawaii Sea Level Center
Chan, H.	2/14/2020	Economic impacts of Papahānaumokuākea Marine National Monument expansion on the Hawaii longline fishery	Mar. Policy, 115, 103869	https://doi.org/10.1016/j.marpol.2020.103869	Socioeconomics of Western Pacific Fisheries
Cheng, S., et al. [S. Wongbusarakum]	3/20/2020	Strengthen causal models for better conservation outcomes for human well-being	PLOS One, 15, 3, e0230495	https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0230495	Socioeconomics of Western Pacific Fisheries
Chikamoto, Y., et al. [M.J. Widlansky]	9/1/2019	A drift-free decadal climate prediction system for the Community Earth System Model	J. Climate, 32(18), 5967-5995	https://doi.org/10.1175/JCLI-D-18-0788.1	University of Hawaii Sea Level Center
Chowdhury, M.R., P.-S. Chu, and J. Potemra	submitted	Rainfall and sea level variability in the face of changing El Niño: Evidence from the US-Affiliated Pacific Islands	Theoret. Appl. Climatol.		Transferal of Pacific ENSO Applications Climate (PEAC) Center Products and Services to Weather Forecast Office (WFO) Honolulu
Fukunaga, A., J.H.R. Burns, K.H. Pascoe, and R.K. Kosaki	3/21/2020	Associations between benthic cover and habitat complexity metrics obtained from 3D reconstruction of coral reefs at different resolutions	Remote Sens., 12(6), 1011	https://www.mdpi.com/2072-4292/12/6/1011	Papahānaumokuākea Marine National Monument Monitoring and Research
Gove, J., et al. [J. Whitney, K. Smith, J. Phipps, E. Contreras]	11/11/2019	Prey-size plastics are invading larval fish nurseries	PNAS, 116(48), 24143-24149	https://www.pnas.org/content/116/48/24143	West Hawaii Integrated Ecosystem Assessment
Griffiths, E.T., et al. [J.L. Keating]	5/15/2020	Detection and classification of narrow-band high frequency echolocation clicks from drifting recorders	J. Acoust. Soc. Am., 147(5), 3511-3522	https://doi.org/10.1121/10.0001229	Cetacean Research Program

Habel, S., C. Fletcher, T. Anderson, and P. Thompson	3/2/2020	Sea-level rise induced multi-mechanism flooding and contribution to urban infrastructure failure	Sci. Rep., 10, 3796, 2020	https://doi.org/10.1038/s41598-020-60762-4	University of Hawaii Sea Level Center
Han, W., et al. [P. Thompson]	11/11/2019	Impacts of basin-scale climate modes on coastal sea level: A review	Surv. Geophys., 40, 1493-1541	https://doi.org/10.1007/s10712-019-09562-8	University of Hawaii Sea Level Center
Heenan, A., G.J. Williams, and I.D. Williams	12/9/2019	Natural variation in coral reef trophic structure across environmental gradients	Front. Ecol. Environ., 18(2), 69-75	https://doi.org/10.1002/fee.2144	Sustaining Healthy Coastal Ecosystems
Hill, M.C., et al.	1/30/2020	Found: a missing breeding ground for endangered western North Pacific humpback whales in the Mariana Archipelago	Endanger. Spec. Res., 41, 91-103	https://doi.org/10.3354/esr01010	Cetacean Research Program
Howe, B., et al. [P. Thompson, D. Luther]	8/2/2019	SMART cables for observing the global ocean: Science and implementation	Front. Mar. Sci., 6, 424	https://doi.org/10.3389/fmars.2019.00424	University of Hawaii Sea Level Center
Idier, D., X. Bertin, P. Thompson, and M. Pickering	11/1/2019	Interactions between mean sea level, tide, surge, waves and flooding: Mechanisms and contributions to sea level variations at the coast	Surv. Geophys., 40, 1603-1630	https://doi.org/10.1007/s10712-019-09549-5	University of Hawaii Sea Level Center
Jacox, M., et al. [M. Widlansky, P. Thompson]	4/1/2020	Seasonal-to-interannual prediction of North American coastal marine ecosystems: Forecast methods, mechanisms of predictability, and priority developments	Prog. Oceanogr., 183, 102307	https://doi.org/10.1016/j.pocean.2020.102307	University of Hawaii Sea Level Center
Johnson, G.C., et al. [J.M. Lyman]	9/1/2019	Salinity	State of the Climate in 2018, Global Oceans, Bull. Am. Meteorol. Soc., 100(9), S77-S81	https://www.ametsoc.org/ams/index.cfm/publications/bulletin-of-the-american-meteorological-society-bams/state-of-the-climate/	Profiling CTD Float Array Implementation and Ocean Climate Research
Johnson, G.C., et al. [J.M. Lyman]	9/1/2019	Ocean heat content	State of the Climate in 2018, Global Oceans, Bull. Am. Meteorol. Soc., 100(9), S74-S77	https://www.ametsoc.org/ams/index.cfm/publications/bulletin-of-the-american-meteorological-society-bams/state-of-the-climate/	Profiling CTD Float Array Implementation and Ocean Climate Research
Kennedy, B.R.C., et al. [C. Kelley, V. Moriwake, S.R.D Bingo, M. Putts]	8/6/2019	The unknown and the unexplored: Insights Into the Pacific deep-sea following NOAA CAPSTONE Expeditions	Front. Mar. Sci., 6, 480	https://doi.org/10.3389/fmars.2019.00480	Pacific Islands Deep Sea Coral and Sponge Initiative
Long, X., et al. [M. Widlansky, F. Schloesser, P. Thompson, H. Yoon]	3/11/2020	Higher sea levels at Hawaii caused by strong El Niño and weak trade winds	J. Climate, 33(8), 3037-3059	https://doi.org/10.1175/JCLI-D-19-0221.1	University of Hawaii Sea Level Center
Lopes, K.H., I.D. Williams, R.K. Kosaki, A.E. Gray, and J.C. Leonard	12/18/2019	Effects of SCUBA bubbles on counts of roving piscivores in a large remote marine protected area	PLOS One, 14(12), e0226370	https://doi.org/10.1371/journal.pone.0226370	Papahānaumokuākea Marine National Monument Monitoring and Research
Luippold, A.M., M.S. Gustin, S.M. Dunham-Cheatham, M.S. Castro, W. Luke, S. Lyman, and L. Zhang	in press	Use of multiple lines of evidence to understand reactive mercury concentrations and chemistry in Hawai'i, Nevada, Maryland, and Utah, USA	Environ. Sci. Technol., 2020	https://doi.org/10.1021/acs.est.0c02283	Atmospheric Gases in the Remote Pacific Marine Free Troposphere Measured in Hawaii
Obura, D., et al. [S. Wongbusarakum]	9/19/2019	Coral reef monitoring, reef assessment technologies, and ecosystem-based management	Front. Mar. Sci., 6, 580	https://doi.org/10.3389/fmars.2019.00580	Socioeconomics of Western Pacific Fisheries
Papastamatiou, Y.P., D. Verbeck, M. Hutchinson, H.D. Bracken-Grissom, and D. Chapman	in press	An encounter between a pelagic shark and giant cephalopod	J. Fish Biol.	https://onlinelibrary.wiley.com/doi/10.1111/jfb.14415	Fishing Impacts on Non-Target Species
Piecuch, C., P. Thompson, R. Ponte, M. Merrifield, and B. Hamlington	10/31/2019	What caused recent shifts in tropical Pacific decadal sea-level trends?	J. Geophys. Res.-Oceans, 124, 7575-7590	https://doi.org/10.1029/2019JC015339	University of Hawaii Sea Level Center
Ponte, R., et al. [P. Thompson]	7/25/2019	Towards comprehensive observing and modeling systems for monitoring and predicting regional to coastal sea level	Front. Mar. Sci., 6, 437	https://doi.org/10.3389/fmars.2019.00437	University of Hawaii Sea Level Center
Punt, A., A. Dunn, B. Elvarsson, J. Hampton, S. Hoyle, M. Maunder, R. Methot, and A. Nielsen	5/14/2020	Essential features of the next-generation integrated fisheries stock assessment package: A perspective	Fish. Res., 229, 105617	doi: 10.1016/j.fishres.2020.105617	Open Source ADMB Project

Putts, M.R., F.A. Parrish, F.A. Trusdell, and S.E. Kahng	11/7/2019	Structure and development of Hawaiian deep-water coral communities on Mauna Loa lava flows	Mar. Ecol. Prog. Ser., 630, 69-82	https://doi.org/10.3354/meps13106	Pacific Islands Deep Sea Coral and Sponge Initiative
Sterling, E., et al. [S. Wongbusarakum]	5/25/2020	Creating a space for place and multidimensional well-being: lessons learned from localizing the SDGs	Sustain. Sci., 15, 1129-1147	https://doi.org/10.1007/s11625-020-00822-w	Socioeconomics of Western Pacific Fisheries
Suka, R., B. Huntington, J. Morioka, K. O'Brien, and T. Acoba	6/1/2020	Successful application of a novel technique to quantify negative impacts of derelict fishing nets on Northwestern Hawaiian Island reefs	Mar. Pollut. Bull., 157, 111312	https://doi.org/10.1016/j.marpolbul.2020.111312	NCRMP Pacific Reef Assessment and Monitoring Program (RAMP)
Sullivan, M., S. Robinson, and C. Littnan	10/23/2019	Social media as a data resource for monkseal conservation	PLOS One, 14(10), e0222627	https://doi.org/10.1371/journal.pone.0222627	Hawaiian Monk Seal Research Program
Thompson, P., et al. [M. Widlansky]	9/1/2019	Sea level variability and change	State of the Climate in 2018, Global Oceans, Bull. Am. Meteorol. Soc., 100(9), S84-S87	https://doi.org/10.1175/2019BAMSStateoftheClimate.1	University of Hawaii Sea Level Center
Tolotti, M.T., et al. [M. Hutchinson]	6/1/2020	Association dynamics of tuna and purse seine bycatch species with drifting fish aggregating devices (FADs) in the tropical eastern Atlantic Ocean	Fish. Res., 226, 105521	https://www.sciencedirect.com/science/article/abs/pii/S016783620300382	Fishing Impacts on Non-Target Species
Vargas-Ángel, B., et al. [B. Huntington, R. Venegas, H. Barkley]	7/1/2019	El Niño-associated catastrophic coral mortality at Jarvis Island, central Equatorial Pacific	Coral Reefs, 38, 731-741	https://link.springer.com/article/10.1007%2F00338-019-01838-0	Sustaining Healthy Coastal Ecosystems
Venegas, R.M., et al. [N. Pomeroy, C. Young]	12/23/2019	The rarity of depth refugia from coral bleaching heat stress in the Western and Central Pacific Islands	Sci. Rep., 9, 19710	https://doi.org/10.1038/s41598-019-56232-1	Sustaining Healthy Coastal Ecosystems
Wongbusarakum, S., et al. [M. Iwane]	9/17/2019	Achieving social and ecological goals of coastal management through integrated monitoring	J. Appl. Ecol., 56(11), 2400-2409	https://besjournals.onlinelibrary.wiley.com/doi/full/10.1111/1365-2664.13494	Socioeconomics of Western Pacific Fisheries
Zanowski, H., G.C. Johnson, and J.M. Lyman	9/23/2019	Equatorial Pacific 1000-dbar velocity and isotherm displacements from Argo data: Beyond the mean and seasonal cycle	J. Geophys. Res.-Oceans, 124, 7873-7882	https://doi.org/10.1029/2019JC015032	Profiling CTD Float Array Implementation and Ocean Climate Research
Dove, D., M. Weijerman, A. Grüss, T. Acoba, and J. R. Smith	11/8/2019	Chapter 37-Substrate mapping to inform ecosystem science and marine spatial planning around the Main Hawaiian Islands	In Harris, P.T., and E. Baker (eds.), Seafloor Geomorphology as Benthic Habitat: GeoHAB Atlas of Seafloor Geomorphic Features and Benthic Habitat, Second Ed., Elsevier, pp. 619-640	https://www.sciencedirect.com/science/article/pii/B9780128149607000373	Sustaining Healthy Coastal Ecosystems
Holbrook, N., et al. [M. J. Widlansky]	in press	ENSO-driven ocean extremes and ecosystem impacts	In McPhaden, M., A. Santoso, and W. Cai, (eds.), El Niño Southern Oscillation in a Changing Climate, Chapter 18, AGU Geophys. Monog. Ser.	https://www.wiley.com/en-us/El+Ni%2Fand%2F3Bos%2F3Bosouth+Oscillation+in+a+Changing+Climate-p-9781119548126	University of Hawaii Sea Level Center

Reports

Author(s) Names	Publication Date	Title	Published In (Journal Name, vol. and page no.)	Citation No. or hyper-link	Project Title
Barkley, H.	9/5/2019	Pacific Reef Assessment and Monitoring Program: Ocean and climate change monitoring summary, American Samoa 2018	Pacific Islands Fisheries Science Center, PIFSC Data Report, DR-19-034	https://repository.library.noaa.gov/view/noaa/21443	NCRMP Pacific Reef Assessment and Monitoring Program (RAMP)
Barkley, H.	9/5/2019	Pacific Reef Assessment and Monitoring Program: Ocean and climate change monitoring summary, the Pacific Remote Island Marine National Monument 2018	Pacific Islands Fisheries Science Center, PIFSC Data Report, DR-19-035	https://repository.library.noaa.gov/view/noaa/21444	NCRMP Pacific Reef Assessment and Monitoring Program (RAMP)
Boynton, S.	5/29/2020	Staying calm In the face of trauma: Reflections of a student assistant	NOAA Fisheries Website Science Blog	https://www.fisheries.noaa.gov/science-blog/staying-calm-face-trauma-reflections-student-assistant	Marine Turtle Recovery in the Pacific Islands Region

Brainard, R.E., et al. [T. Acoba, M.A.M. Asher, J.M. Asher, H.C. Barkley, A. DesRochers, A.A. Halperin, B. Huntington, T.L. Kindinger, K.S. McCoy, N. Pomeroy, R. Suka, M. Timmers, B. Vargas-Ángel, M. Winston, C.W. Young]	11/25/2019	Coral reef ecosystem monitoring report for the Pacific Remote Islands Marine National Monument 2000–2017	Pacific Islands Fisheries Science Center, PIFSC Special Publication, SP-19- 006, 820 pp	http://go.usa.gov/xpRRx	Sustaining Healthy Coastal Ecosystems
Carnes, M.J., J.P. Stahl, and K.A. Bigelow	10/1/2019	Evaluation of electronic monitoring pre-implementation in the Hawai'i- based longline fisheries	NOAA Technical Memorandum NMFS- PIFSC-90	https://doi.org/ 10.25923/82gg-jq77	Pacific Fisheries Monitoring Program
Chan, H.	4/24/2020	Potential economic impacts from the 2018 amendment to the Billfish Conservation Act of 2012	Pacific Islands Fisheries Science Center, PIFSC Internal Report, IR-20-004, 9 pp		Socioeconomics of Western Pacific Fisheries
Gaos, A.R.	10/8/2019	Rare olive ridley sea turtle nest discovered on Oahu	NOAA Fisheries Website Feature Story	https://www.fisheries. noaa.gov/feature-story/ rare-olive-ridley-sea- turtle-nest-discovered- oahu	Marine Turtle Recovery in the Pacific Islands Region
Gaos, A.R.	3/19/2020	Studying and conserving Western Pacific leatherback turtles in the Solomon Islands	NOAA Fisheries Website Feature Story	https://www.fisheries. noaa.gov/feature-story/ studying-and-conserv- ing-western-pacific- leatherback-turtles- solomon-islands	Marine Turtle Recovery in the Pacific Islands Region
Gómez, B.P., et al. [M.J. Widlansky]	5/1/2020	Quality control of in situ sea level observations: A review and progress towards automated quality control	Intergovernmental Oceanographic Commission of UNESCO, Paris, France, 2020, IOC Manuals and Guides, 83, vol.1, 71 pp	IOC/2020/MG/83Vol.1	University of Hawaii Sea Level Center
McCoy, K., et al. [J. Asher, A. Gray, T. Kindinger]	11/5/2019	Pacific Reef Assessment and Monitoring Program Data Report Ecological monitoring 2019—Reef fishes and benthic habitats of the main Hawaiian Islands	Pacific Islands Fisheries Science Center, PIFSC Data Report, DR-19-039	https://doi.org/10.25923/ he4m-6n68 .	NCRMP Pacific Reef Assessment and Monitoring Program (RAMP)
McCoy, K., T. Kindinger, and I. Williams	4/5/2020	Fish assemblages and benthic communities in the Manell-Geus watershed, Cocos Lagoon and Achang Reef Flat Marine Preserve	Pacific Islands Fisheries Science Center, PIFSC Data Report DR-20-002	https://doi. org/10.25923/3mqb- x312 .	Sustaining Healthy Coastal Ecosystems
Miller-Greene, D., R. Amin, J. Taylor, and J. Asher	5/1/2020	MOUSS Protocol for the Pacific Islands Fisheries Science Center	NOAA Technical Memorandum, NOAA-TM- NMFS-PIFSC-102	https://doi.org/ 10.25923/7q3t-yk14	Ecosystem Observations and Research Program: Science Operations Project
Misa, W., et al. [J. Taylor, A. Rollo, D. Miller, C. Demarke, K. Koyanagi]	1/1/2020	BotCam to MOUSS: Comparative tests on bottomfish relative abundance, length data, and imagery generated by 2 stereo- camera systems during field surveys in Hawaii	NOAA Technical Memorandum, NOAA-TM- NMFS-PIFSC-94	https://doi.org/10.25923/ ara7-2w20	Ecosystem Observations and Research Program: Science Operations Project
Morioka, J., K. O'Brien, B. Huntington, R. Suka, and T. Acoba	1/1/2020	2018 Marine debris removal and assessment in the Northwestern Hawaiian Islands	Pacific Islands Fisheries Science Center, PIFSC Special Publication, SP-20- 001, 8 pp	https://doi.org/10.25923/ f19b-je14	Marine Debris Mitigation Project
Nadon, M., M. Sculley, and F. Carvalho	5/1/2020	Stock assessment of uku (<i>Aprion virescens</i>) in Hawaii, 2020	NOAA Technical Memorandum, NOAA- TM-NMFS-PIFSC-100	https://doi.org/10. 25923/57nb-8138	Stock Assessment Research Program
Rguez-Baron, J.M., S. Kelez, M. Lilies, A. Zavala-Norzagaray, O.L. Torres-Suárez, D. Amoroch, and A.R. Gaos (eds.)	1/1/2020	Sea turtles in the East Pacific Ocean region: IUCN-SSC Marine Turtle Specialist Group Annual Regional Report 2019 (Draft report of the IUCN-SSC Marine Turtle Specialist Group, 2019)	International Union for the Conservation of Nature; Marine Turtle Specialist Group	https://www.research gate.net/profile/Juan_ M_Rguez-Baron/ publication/338902013 _Sea_Turtles_in_the_ East_Pacific_Ocean_ Region_IUCN-SSC_ Marine_Turtle_ Specialist_Group_ Annual_Regional_ Report_2019/links/5e7 ce05292851caef4a- 1ce4a/Sea-Turtles-in- the-East-Pacific-Ocean- Region-IUCN-SSC- Marine-Turtle-Special- ist-Group-Annual- Regional-Report-2019. pdf	Marine Turtle Recovery in the Pacific Islands Region

Staman, J.W.	5/8/2020	Punahale: A green sea turtle's Journey to "destination unknown"	NOAA Fisheries Website Feature Story	https://www.fisheries.noaa.gov/science-blog/punahale-green-sea-turtles-journey-destination-unknown	Marine Turtle Recovery in the Pacific Islands Region
Staman, J.W.	8/29/2019	There and back again: A turtle biologist's tale	NOAA Fisheries Website Science Blog	https://www.fisheries.noaa.gov/science-blog/there-and-back-again-turtle-biologists-tale	Marine Turtle Recovery in the Pacific Islands Region
Suka, R., et al. [M. Asbury, C. Couch, A. Gray, M. Winston]	12/1/2019	Processing photomosaic Imagery of coral reefs using structure-from-motion standard operating procedures	NOAA Technical Memorandum NOAA-TM-NMFS-PIFSC-93	https://repository.library.noaa.gov/view/noaa/22753	Marine Debris Mitigation Project
Whitall, D., M. Curtis, A. Mason, and B. Vargas-Angel	10/1/2019	Excess nutrients in Vatia Bay, American Samoa: Spatiotemporal variability, source identification and impact on coral reef ecosystems	NOAA Technical Memorandum NOS NCCCS 266, 69 pp	https://doi.org/10.25923/j8cp-x570	Sustaining Healthy Coastal Ecosystems
Winston M., C. Couch, B. Huntington, and B. Vargas-Angel	2/1/2020	Ecosystem Sciences Division standard operating procedures: Data collection for rapid ecological assessment benthic surveys: 2019 update	NOAA Technical Memorandum NOAA-TM-NMFS-PIFSC-96, 56 pp	https://repository.library.noaa.gov/view/noaa/23951	NCRMP Pacific Reef Assessment and Monitoring Program (RAMP)
Winston, M., et al. [C. Couch, B. Huntington, B. Vargas-Angel, R. Suka, A. Halperin, A. Gray, K. McCoy, M. Asbury, H. Barkley, J. Morioka]	3/1/2020	Preliminary results of patterns of 2019 thermal stress and coral bleaching across the Hawaiian Archipelago	NOAA Pacific Islands Fisheries Science Center administrative report H, 20-04	https://repository.library.noaa.gov/view/noaa/23699	Sustaining Healthy Coastal Ecosystems
Wongbusarakum, S., T. Kindinger, and M. Gorstein	6/30/2020	Assessing socio-economic indicators to improve their usefulness for resource management in the US Pacific islands	NOAA Technical Memorandum NOAA-TM-NMFS-PIFSC-98, 67 pp	https://doi.org/10.25923/27jh-pm07	Socioeconomics of Western Pacific Fisheries

Conference and Workshop Proceedings

Author(s) Names	Publication Date	Title	Published In (journal name, vol. and page no.)	Citation No. or Hyperlink	Project Title
Allen, C.D., S.J. Gaylor, L.E. Peavey Reeves, T. Eguchi, T.T. Jones, and J.A. Seminoff	10/15/2019	First sex ratio of immature and adult olive ridley sea turtles foraging in the high-seas of the Pacific: Establishing baselines for climate change research	7th Conference of the International Society of Wildlife Endocrinology, Kruger National Park, South Africa, October 13-16, 2019	NA	Marine Turtle Recovery in the Pacific Islands Region
Allen, C.D., S.J. Gaylor, L.E. Peavey Reeves, T. Eguchi, T.T. Jones, and J.A. Seminoff	11/15/2019	First sex ratio of immature and adult olive ridley sea turtles foraging in the high-seas of the Pacific: Establishing baselines for climate change research (poster)	The Third JIMAR/PIFSC Symposium-New Technologies Driving Ocean Science Breakthroughs, Honolulu, HI, November 15, 2019	NA	Marine Turtle Recovery in the Pacific Islands Region
Francis, M., S. Clarke, M. Hutchinson, et al.	8/10/2019	Report of the Workshop on Joint Analysis of Shark Post-Release Mortality Tagging Results	Western and Central Pacific Fisheries Commission Scientific Committee 15th Regular Session, Pohnpei, Federated States of Micronesia, Aug. 12-20, 2019, Working Paper SC15-EB-WP-01	https://www.wcpfc.int/node/42977	Fishing Impacts on Non-Target Species
Hutchinson, M., and K. Bigelow	8/11/2019	Quantifying post release mortality rates of sharks incidentally captured in Pacific tuna longline fisheries and identifying handling practices to improve survivorship	Western and Central Pacific Fisheries Commission Scientific Committee 15th Regular Session, Pohnpei, Federated States of Micronesia, Aug. 12-20, 2019, Working Paper WCPFC SC15 EB-WP-04	https://www.wcpfc.int/node/43162	Fishing Impacts on Non-Target Species
Justel-Rubio, A., Y. Swimmer, and M. Hutchinson	8/11/2019	Graphics for best handling practices for the safe release of sharks	Western and Central Pacific Fisheries Commission Scientific Committee 15th Regular Session, Pohnpei, Federated States of Micronesia, Aug. 12-20, 2019, Working Paper WCPFC SC15 EB-IP-02	https://www.wcpfc.int/node/43172	Fishing Impacts on Non-Target Species
Ronco, H.	12/7/2019	Photoidentification of Hawaiian monk seals using ACDSsee	Rare Pinniped Conservation Network Workshop, December 7, 2019, World Marine Mammal Conference, Barcelona, Catalonia, Spain, December 9-12, 2019		Hawaiian Monk Seal Research Program

Yingling, N., T.B. Kelly, T. Shropshire, K.E. Selph, M.R. Landry, A.N. Knapp, S.A. Kranz, and M.R. Stukel	2/20/2020	Phytoplankton nutrient uptake, size structure and biomass distribution in the spawning region of Atlantic Bluefin Tuna in the oligotrophic Gulf of Mexico (OB43B-07 Abstract)	Ocean Sciences Meeting 2020, San Diego, CA, Feb. 16-21, 2020		Effects of Nitrogen Sources and Plankton Food-Web Dynamics on Habitat Quality for the Larvae of Atlantic Bluefin Tuna in the Gulf of Mexico
Chowdhury, M.R.	10/5/2019	The use of ENSO-related climate information in disaster preparedness: Experience from the Pacific Islands and Bangladesh	Planning for Sustainable Cities and Communities, Proceedings 1st International Conference on Urban and Regional Planning, Dhaka, Bangladesh, Oct. 5-6, 2019, Bangladesh Institute of Planners, p. 482-502	http://www.bip.org.bd/SharingFiles/journal_book/upload_content/201912270424103.pdf	Transferal of Pacific ENSO Applications Climate (PEAC) Center Products and Services to Weather Forecast Office (WFO) Honolulu
Selph, K.E.	11/14/2019	Phytoplankton: Flow cytometry and a little bit of microscopy	NOAA RESTORE Data meeting, University of Miami, Cooperative Institute for Marine and Atmospheric Studies, Miami, FL, Nov. 14, 2019		Effects of Nitrogen Sources and Plankton Food-Web Dynamics on Habitat Quality for the Larvae of Atlantic Bluefin Tuna in the Gulf of Mexico

Presentations

Author(s) Names	Publication Date	Title	Published In (journal name, vol. and page no.)	Citation No. or Hyperlink	Project Title
Asher, J. I. Williams, D. Miller-Greene, W. Misa, A. Rollo, and E. Harvey	11/15/2019	A deeper examination of mesophotic reefs, community shifts, and fishery-targeted species domains around Guam (poster)	The Third JIMAR/PIFSC Symposium-New Technologies Driving Ocean Science Breakthroughs, Honolulu, HI, November 15, 2019		Sustaining Healthy Coastal Ecosystems
Barlow, J., J. Moore, J.L.K. McCullough, and E. Griffiths	12/12/2019	Abundance estimation of Mesoplodon beaked whale species using drifting acoustics recorders	World Marine Mammal Conference, Barcelona, Catalonia, Spain, December 9-12, 2019		Cetacean Research Program
Bayless, A., J. Morioka, M. Sullivan, and J. Kuwabara	11/15/2019	Communicating science in the Pacific Islands Region (poster)	The Third JIMAR/PIFSC Symposium-New Technologies Driving Ocean Science Breakthroughs, Honolulu, HI, November 15, 2019		Ecosystems Observations and Research Program: Research Support Project
Chowdhury, M.R.	3/11/2020	Disaster planning and preparedness in the face of changing ENSO: Evidence from the US-Affiliated Pacific Islands	2020 Pacific Risk Management Ohana (PRiMO) Conference, Honolulu, HI, March 10-14, 2020		Transferal of Pacific ENSO Applications Climate (PEAC) Center Products and Services to Weather Forecast Office (WFO) Honolulu
Couch, C.		Scaling up coral reef monitoring through imagery and machine learning	Third JIMAR/PIFSC Symposium-New Technologies Driving Ocean Science Breakthroughs, Honolulu, HI, November 15, 2019		NCRMP Pacific Reef Assessment and Monitoring Program (RAMP)
Fukunaga, A.	11/15/2019	Extraction of habitat metrics from 3D reconstruction of coral reefs: 3D vs 2.5D	The Third JIMAR/PIFSC Symposium-New Technologies Driving Ocean Science Breakthroughs, Honolulu, HI, November 15, 2019		Papahānaumokuākea Marine National Monument Monitoring and Research
Gaos, A.R.	2/3/2020	Western Pacific Leatherback Workshop	Solomon Islands Leatherback Workshop, Buala, Santa Isabel Isle, Solomon Islands, Feb. 3, 2020	NA	Marine Turtle Recovery in the Pacific Islands Region
Gaos, A.R., S. Martin, L. Kurpita, I. Kelly, E. LaCasella, H. Bernard, L. Sundquist, C.S. King, J. Browning, T. Eguchi, P. Dutton, and T.T. Jones	4/14/2020	Evaluating current and future conservation scenarios of hawksbill turtles in Hawaii	Annual 2020 Hawaii Hawksbill Network Meeting (via Google Hangout), Honolulu, HI, April 14, 2020	NA	Marine Turtle Recovery in the Pacific Islands Region
Gove, J., J. Whitney, M. McManus, J. Lecky, F. Carvalho, J. Lynch, J. Li, P. Neubauer, S. Smith, J. Phipps, D. Kobayashi, K. Balagso, E. Contreras, M. Manuel, M. Merrifield, J. Polovina, G. Asner, J. Maynard, and G. Williams	2/18/2020	Prey-size plastics are invading larval fish nurseries	Ocean Sciences Meeting 2020, San Diego, CA, Feb. 16-21, 2020		West Hawaii Integrated Ecosystem Assessment

Gruden, P., and P.R. White	11/13/2019	Addressing challenges in automated whistle extraction	178th Meeting of the Acoustical Society of America, San Diego, CA, December 2-6, 2019	https://doi.org/10.1121/1.5137324	Cetacean Research Program
Hill, M.C., A.L. Bradford, D. Steel, C.S. Baker, A.D. Ligon, A.C. U, J.M.V. Acebes, O.A. Filatova, S. Hakala, N. Kobayashi, Y. Morimoto, H. Okabe, R. Okamoto, J. Rivers, T. Sato, O.V. Titova, R.K. Uyeyama, and E.M. Oleson	12/6/2019	Humpback whales in the Mariana Archipelago: Local breeding habitat and links to other Western North Pacific breeding and feeding grounds	World Marine Mammal Conference, Barcelona, Catalonia, Spain, December 9-12, 2019		Cetacean Research Program
Hourigan, T.F., et al. [S. Bingo, V. Moriwake, M. Putts]	2/19/2020	Forests of the deep: High-density deep-sea coral and sponge communities in the Central and Western Pacific	Ocean Sciences Meeting 2020, San Diego, CA, Feb. 16-21, 2020		Pacific Islands Deep Sea Coral and Sponge Initiative
Hutchinson, M.	11/15/2019	Electronic tagging to improve the fate of incidentally captured sharks in commercial fisheries	The Third JIMAR/PIFSC Symposium-New Technologies Driving Ocean Science Breakthroughs, Honolulu, HI, November 15, 2019		Fishing Impacts on Non-Target Species
Kim, K., et al. [M.R. Chowdhury]	1/12/2020	Integration of ENSO hazards risk assessment into transportation systems planning (poster)	Transportation Research Board 99th Annual Meeting, Washington, D.C., January 12-16, 2020		Transfer of Pacific ENSO Applications Climate (PEAC) Center Products and Services to Weather Forecast Office (WFO) Honolulu
Matthews, T.	11/15/2019	Data-limited approaches to coral reef fishery monitoring and management (poster)	The Third JIMAR/PIFSC Symposium-New Technologies Driving Ocean Science Breakthroughs, Honolulu, HI, November 15, 2019		Pacific Islands Territorial Science Initiative (PITSI)
McCullough, J.	11/15/2019	An acoustic survey of beaked whales and Kogia in the Mariana Archipelago using drifting recorders	The Third JIMAR/PIFSC Symposium-New Technologies Driving Ocean Science Breakthroughs, Honolulu, HI, November 15, 2019		Cetacean Research Program
McCullough, J.L.K., E. Oleson, A. Allen, J. Wren, and M. Hill	12/6/2019	An acoustic survey of beaked whales and Kogia in the Mariana Archipelago using drifting recorders	World Marine Mammal Conference, Barcelona, Catalonia, Spain, December 9-12, 2019		Cetacean Research Program
Merkens, K., J.L.K. McCullough, T. Nick, S. Urmy, and E. Oleson	12/6/2019	Kogia conundrum: Variability in the acoustic signals of dwarf and pygmy sperm whales in deep water	World Marine Mammal Conference, Barcelona, Catalonia, Spain, December 9-12, 2019		Cetacean Research Program
Morioka, J., R. Suka, and T. Acoba	11/15/2019	UAV, 3-D, and buoys: Innovative technologies for DFG detection, impact, and movement (poster)	The Third JIMAR/PIFSC Symposium-New Technologies Driving Ocean Science Breakthroughs, Honolulu, HI, November 15, 2019		Marine Debris Mitigation Project
Rankin, S., et al. [J.L.K. McCullough]	12/6/2019	Beaker BANTER: A machine learning approach to acoustic classification of beaked whales	World Marine Mammal Conference, Barcelona, Catalonia, Spain, December 9-12, 2019		Cetacean Research Program
Reed, E.	8/23/2019	Products of the NOAA Commercial Fisheries Biosampling Program	Pacific Insular Fisheries Monitoring, Assessment and Planning Summit (PIFMAPS), Honolulu, HI, August 19-23, 2019		Territorial Biosampling
Reed, E., and J. O'Malley	9/12/2019	Identifying fish life history relationships with climate and the environment	Third Annual Collaborative Climate Science Workshop, Honolulu, HI, September 11-12, 2019		Territorial Biosampling
Ronco, H., T. Johanos, V. Khurana, and S. Robinson	12/9/2019	Mobilizing Hawaiian monk seal data accessibility for the 21st century	Pacific Islands Fisheries Science Center, PIFSC Special Publication, SP-19-006, 820 pp		Hawaiian Monk Seal Research Program

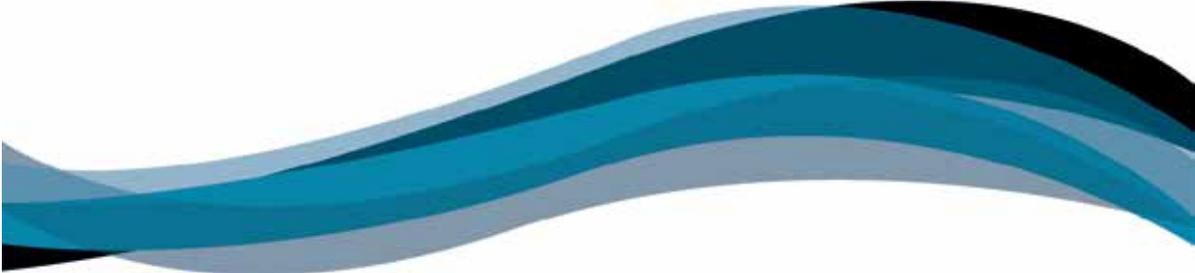
Souza, T., and M. Moews-Asher	11/15/2019	Defining Large Marine Ecosystems (LME) in the Pacific Islands Region: the Marianas LME (poster)	The Third JIMAR/PIFSC Symposium-New Technologies Driving Ocean Science Breakthroughs, Honolulu, HI, November 15, 2019	Ecosystems Observations and Research Program: Research Support Project
Stahl, J., and M. Carnes	11/15/2019	Electronic monitoring in the Hawaii-based Pacific longline fishery (poster)	The Third JIMAR/PIFSC Symposium-New Technologies Driving Ocean Science Breakthroughs, Honolulu, HI, November 15, 2019	Pacific Fisheries Monitoring Program
Timmers, M., R. Toonen, and R. Brainard	11/15/2019	Metabarcoding the hidden diversity on coral reefs (poster)	The Third JIMAR/PIFSC Symposium-New Technologies Driving Ocean Science Breakthroughs, Honolulu, HI, November 15, 2019	Sustaining Healthy Coastal Ecosystems
Vivier, F., et al. [M. Hill, K. Yano]	12/6/2019	Calibrating Unoccupied Aerial System (UAS) photogrammetry to derive delphinid population demographic parameters	World Marine Mammal Conference, Barcelona, Catalonia, Spain, December 9-12, 2019	Cetacean Research Program
Vivier, F., et al. [M. Hill, K. Yano]	11/15/2019	Calibrating Unoccupied Aerial System (UAS) photogrammetry to derive delphinid population demographic parameters (poster)	The Third JIMAR/PIFSC Symposium-New Technologies Driving Ocean Science Breakthroughs, Honolulu, HI, November 15, 2019	Cetacean Research Program
Whitney, J., et al. [J. Gove, K. Smith]	2/16/2020	Biophysical interactions between fish larvae and surface slicks enhance a tropical ecosystem	Ocean Sciences Meeting 2020, San Diego, CA, February 16-21, 2020	West Hawaii Integrated Ecosystem Assessment
Wongbusarakum, S.	11/15/2019	Estimating price elasticity of demand for the Honolulu Fish Auction (poster)	The Third JIMAR/PIFSC Symposium-New Technologies Driving Ocean Science Breakthroughs, Honolulu, HI, November 15, 2019	Socioeconomics of Western Pacific Fisheries
Wongbusarakum, S., T. Kindinger, and M. Gorstein	11/6/2019	Do scientists and managers think and feel the same about data? Insights from the Pacific island region	72nd Annual Conference of the Gulf and Caribbean Fisheries Institute (GCFI 72), Punta Cana, Dominican Republic, November 4-8, 2019	Socioeconomics of Western Pacific Fisheries
Yano, K.M., E.M. Oleson, M.C. Hill, J.L. Keating McCullough, and M.O. Lammers	11/15/2019	A late-season survey reveals large numbers of humpback whales in Northwestern Hawaiian Islands (poster)	The Third JIMAR/PIFSC Symposium-New Technologies Driving Ocean Science Breakthroughs, Honolulu, HI, November 15, 2019	Cetacean Research Program
Yano, K.M., E.M. Oleson, M.C. Hill, J.L. Keating McCullough, and M.O. Lammers	12/6/2019	A late-season survey reveals large numbers of humpback whales in Northwestern Hawaiian Islands	World Marine Mammal Conference, Barcelona, Catalonia, Spain, December 9-12, 2019	Cetacean Research Program
Ziegenhorn, M., K.E. Frasier, E. Oleson, J.L. Keating, and S. Baumann-Pickering	12/6/2019	Developing a click type 'library' for Hawaiian odontocetes using machine learning methods	178th Meeting of the Acoustical Society of America, San Diego, CA, December 2-6, 2019	Cetacean Research Program
Ziegenhorn, M., K.E. Frasier, E. Oleson, J.L. Keating, and S. Baumann-Pickering	2/21/2020	Facilitating the conservation and management of Hawaiian odontocetes using an echolocation click type 'library'	Ocean Sciences Meeting 2020, San Diego, CA, Feb. 16-21, 2020	Cetacean Research Program

Publication Summary

The table below shows the total count of publications for the reporting period categorized by JIMAR Lead Author, NOAA Lead Author, or Other Lead Author and whether it was peer-reviewed or non-peer reviewed.

		FY 17	FY 18	FY 19	FY 20
Peer Reviewed	JIMAR Lead Author	19	18	15	18
	NOAA Lead Author	5	3	5	6
	Other Lead Author	16	15	17	24
Non Peer-Reviewed	JIMAR Lead Author	16	52	41	46
	NOAA Lead Author	1	6	4	9
	Other Lead Author	0	3	6	12

Appendices



Appendix I List of Acronyms

3D	Three Dimension
AAM	Authorized Application Module
ABT	Atlantic bluefin tuna
ACE	Accumulated Cyclone Energy
ACL	Annual Catch Limit
AD	Automatic Differentiation
ADCP	Acoustic Doppler Current Profiler
ADMB	Automatic Differentiation Model Builder
AGEPRO	Age Structured Projection Model
AGU	American Geophysical Union
AIS	Automatic Identification System
ALOHA	A Long-term Oligotrophic Habitat Assessment
APDRC	Asia-Pacific Data Research Center
APEX	Application Express
API	Application Programming Interface
AR5	Fifth Assessment Report (IPCC)
ARL	Air Resources Laboratories
ARMS	Autonomous Reef Monitoring Structure
ARSHSL	Archive of Rapidly-Sampled Hawaiian Sea Level
ARW	Advanced Research WRF
ASBE	Annual Small Boat Evaluation
ASC	Annual Science Conference
ASRAMP	American Samoa Reef Assessment and Monitoring Program
ATDD	Atmospheric Turbulence and Diffusion Division
ATN	Animal Telemetry Network
AUV	Autonomous Underwater Vehicle
AWIPS	Advanced Weather Interactive Processing System
BET	Big Eye Tuna
BFISH	Bottomfish Fishery-Independent Survey in Hawaii
BMP	Best Management Practices
BOEM	Bureau of Ocean Energy Management
BSH	Blue Shark
CAM5	Community Atmosphere Model
CAPAM	Center for the Advancement of Population Assessment Methodology
CAU	Calcification and Accretion Unit
CCD	Centralized Cruise Database
CCI	Climate Change Initiative
CCMP	Cross-Calibrated Multi-Platform

CCR	Closed-Circuit Rebreathers
CFSv2	Coupled Forecast System, version 2
CLI	Command Line Interface
CMIP	Coupled Model Intercomparison Project
CMIP5	Coupled Model Intercomparison Project Phase 5
CMORE	Center for Microbial Oceanography: Research and Education
CNMI	Commonwealth of the Northern Mariana Islands
CNP	Central North Pacific
COBALT	Carbon Ocean And Lower Trophics
CONUS	Continental United States
CoRIS	Coral Reef Information System
COVID-19	Corona Virus Disease 2019
CP	Central Pacific
CPR	Cardiopulmonary Resuscitation
CPU	Central Processing Unit
CPUE	Catch Per Unit Effort
CRCP	Coral Reef Conservation Program
CRIMP-2	Coral reef instrumented platform -2
CRP	Cetacean Research Program
CTD	Conductivity-Temperature-and Depth
CTE	Cold tongue El Niño
DAPPER	Data Access Protocol server
DAR	State of Hawaii Division of Aquatic Resources
DART	Deep-ocean Assessment and Reporting of Tsunamis
DAS	Days at Sea
DASBR	Drifting Acoustic Spar Buoy Recorder
DAWR	Division of Aquatic and Wildlife Resources (Guam)
DCHART	Web-based server for display of in situ and gridded data sets
DCIP	DropCam Instrument Package
DFW	Division of Fish and Wildlife (CNMI)
DGC	Data Governance Council
DIAS	Document Image Archival System
DIC	Dissolved inorganic carbon
DIDSON	Dual-Frequency Identification Sonar
DLNR	Department of Land and Natural Resources
DMWR	Department of Marine and Wildlife Resources (American Samoa)
DMHA	Disaster Management and Humanitarian Assistance
DMT	Tactical Data Management Team
DNA	Deoxyribonucleic Acid
DoD	Department of Defense (U.S.)

DODS	Distributed Ocean Data System
DSCRTP	Deep Sea Coral Research and Technology Program
DVM	Data Validation Module
DVR	Digital Video Recorder
E/V	Exploration Vessel
EAR	Ecological Acoustic Recorder
EBFM	Ecosystem-Based Fisheries Management
Eco-FOCI	Ecosystems Fisheries-Oceanography Coordinated Investigations Program
EDM	Environmental Data Management
eDNA	Environmental Deoxyribonucleic Acid
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EM	Electronic Monitoring
ENP	Eastern North Pacific
ENSO	El Niño Southern Oscillation
EOI	Earth-Oceans Interactions Program
EORP	Ecosystems Observations and Research Program
EP	Eastern Pacific
EPE	Eastern Pacific El Niño
ER	Electronic Reporting
ERDDAP	Environmental Research Division Data Access Platform
ESA	European Space Agency
ESD	Ecosystem Sciences Division
E/V	Exploration Vessel
EVA	Extreme Value Analysis
EX	NOAA R/V Okeanos Explorer
FA	First Aid
FAD	Fish Aggregation Device
FDM	Farallon de Medinilla
FEP	Fishery Ecosystem Plan
FFS	French Frigate Shoals
FMP	Fishery Management Plan
FOCI	Fisheries-Oceanography Coordinated Investigations
FOT	Final Out Turn Receipt
FRDS	Fisher Reporting and Dealer System
FRMD	Fisheries Research and Monitoring Division
FSM	Federated States of Micronesia
FSWP	Fishery Statistics of the Western Pacific
FTIR	Fourier transform infrared spectroscopy
FUS	Fisheries of the United States

FY	Fiscal Year
GCM	Generalized Circulation Model
GCN	Global Sea-level Observing System Core Network
GCOS	Global Climate Observing System
GDS	GrADS DODS Server
GIS	Geographic Information System
GLOSS	Global Sea Level Observing System
GMSL	Global Mean Sea Level
GNSS	Global Navigation Satellite System
GOA-ON	Global Ocean Acidification Observing Network
GoM	Gulf of Mexico
GPS	Global Positioning System
GPT	Geospatial Products Team
GrADS	Grid Analysis and Display System
GTS	Global Telecommunication System
GUI	Graphic User Interface
HARAMP	Hawaiian Islands Reef Assessment and Monitoring Program
HARP	High-frequency Acoustic Recording Package
HCTP	Hawaii Community Tagging Program
HDAR	Hawaii Division of Aquatic Resources
Hg	Mercury
Hg0	Elemental Mercury
HgP	Particulate Mercury
HIMB	Hawaii Institute of Marine Biology
HMAR	Hawaii Marine Animal Response
HMS	Hawaiian Monk Seal
HMSRP	Hawaiian Monk Seal Research Program
HPA	Hawaii Preparatory Academy
HPU	Hawaii Pacific University
HU	Hurricane
HURDAT2	Hurricane Data, 2 nd version
HYCOM	Hybrid Coordinate Ocean Model
IATTC	Inter-American Tropical Tuna Commission
ICES	International Council for the Exploration of the Sea
IEA	Integrated Ecosystem Assessment
IEC	International Electrotechnical Commission
IHLRT	Institute for Hawaiian Language Research and Translation
IOC	Intergovernmental Oceanographic Commission
IPCC	Intergovernmental Panel on Climate Change
IPRC	International Pacific Research Center

IRC	Inouye Regional Center
ISC	International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean
ISO	International Organization for Standardization
ISSF	International Seafood Sustainability Foundation
ISTS	International Sea Turtle Symposium
IT	Information Technology
IWLS	Integrated Water Level Service
JABBA	Just Another Bayesian Biomass Assessment
JIMAR	Joint Institute for Marine and Atmospheric Research
Kd490	Diffuse Attenuation Coefficient at 490 nm
KM	Kaplan-Meier
LAS	Live Access Server
LBSP	Land Based Sources of Pollutions
LED	Light Emitting Diode
LHP	Life History Program
LHRC	Lāhui Hawai'i Research Center
LME	Large Marine Ecosystem
MACS	Marianas Archipelago Cetacean Survey
MAPCO ₂	Moored autonomous partial pressure of CO ₂
MARAMP	Marianas Archipelago Reef Assessment Monitoring Program
MC-ICP-MS	Multi Collector-Inductively Coupled Plasma-Mass Spectrometer
MCMC	Markov Chain Monte Carlo
ME	Mixed El Niño
MES	Micronesian Environmental Services
MHHW	Mean Higher High Water
MHI	Main Hawaiian Islands
MIF	Mass Independent Fractionation
MITgcm	Massachusetts Institute of Technology general circulation model
MLO	Mauna Loa Observatory
MMPA	Marine Mammal Protection Act
MOP	Marine Option Program
MOUSS	Modular Underwater Stereoscopic System
MPA	Marine Protected Area
MTBAP	Marine Turtle Biology and Assessment Program
MTT	Multi-target tracking
MUS	Management Unit Species
N2N	NOAA to NOAA
NABC	Naval Amphibious Base—Coronado
NCCOS	National Centers for Coastal Ocean Science

NCEAS	National Center for Ecological Analysis and Synthesis
NCEI	National Centers for Environmental Information
NCEP	National Centers for Environmental Prediction
NCRMP	National Coral Reef Monitoring Program
NCTR	NOAA Center for Tsunami Research
NCWCP	NOAA Center for Weather and Climate Prediction
NDBC	National Data Buoy Center
NESDIS	National Environmental Satellite, Data, and Information Service
NGO	Non-Governmental Organization
NGS	National Geodetic Survey
NHPoL	Native Hawaiian Place of Learning
NIES	National Institute for Environmental Studies (Japan)
NMFS	National Marine Fisheries Service
NMSAS	National Marine Sanctuary of American Samoa
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NSF	National Science Foundation
NTHMP	National Tsunami Hazard Mitigation Program
NUTS	No U-Turn Sampler
NWFSC	Northwest Fisheries Science Center
NWHI	Northwestern Hawaiian Islands
NWS	National Weather Service
OA	Ocean acidification
OAP	Ocean Acidification Program (NOAA office)
OAR	Office of Oceanic and Atmospheric Research
OC	Ocean Color
OCC	Ocean and Climate Change
OCS	Oceanic whitetip shark (FAO 3 alpha code)
ODRS	Online Commercial Marine Dealer Reporting System
OFES	Ocean model For the Earth Simulator
OFES/AFES/CFES	Ocean/Atmosphere/Coupled model For the Earth Simulator
OFR	Online Fishers Reporting System
OMI	Operations, Management and Information Division
ONMS	Office of National Marine Sanctuaries
OPeNDAP	Open-source Project for a Network Data Access Protocol
OWCP	OceanWatch - Central Pacific
PacIOOS	Pacific Islands Ocean Observing System
PacMAPPS	Pacific Marine Assessment Program for Protected Species
PACOM	Pacific Command
PAR	Photosynthetically Available Radiation

PARR	Public Access to Research Results
PATs	Pop-off archival tags
PDC	Pacific Disaster Center
PDO	Pacific Decadal Oscillation
PEAC	Pacific ENSO Applications Climate Center
PHR	Pearl and Hermes Reef
PI	Principal Investigator
PIFG	Pacific Island Fisheries Group
PIFMAPS	Pacific Insular Fisheries Monitoring Assessment and Planning Summit
PIFSC	Pacific Islands Fisheries Science Center
PIMPAC	Pacific Island Managed and Protected Area Community
PIR	Pacific Islands Region
PIRO	Pacific Islands Regional Office
PIROP	Pacific Islands Regional Office Observer Program
PIT	Passive Integrated Transponder
PLOS	Public Library of Science
PMEL	Pacific Marine Environmental Laboratory
PMNM	Papahānaumokuākea Marine National Monument
PRA	Paperwork Reduction Act
PRIA	Pacific Remote Island Area
PRIMNM	Pacific Remote Islands Marine National Monument
PRM	Post release mortality
PRSN	Puerto Rico Seismic Network
PSD	Protected Species Division
PTWC	Pacific Tsunami Warning Center
PYSO	PIFSC Young Scientist Opportunity
QC	Quality Control
QUEST	Quantitative Underwater Ecological Surveying Techniques
R/V	Research Vessel
RAID	Redundant Array of Inexpensive Disks
RAMNM	Rose Atoll Marine National Monument
RAMP	Reef Assessment and Monitoring Program
RA-V	Regional Alliance Five (Pacific Islands)
RCC	Regional Climate Center
RCUH	Research Corporation of the University of Hawaii
RESTORE	Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies
RFA	Regional Frequency Analysis
RFMO	Regional Fishery Management Organization
RGM	Reactive Gaseous Mercury
RMI	Republic of the Marshall Islands

ROMS	Regional Ocean Modeling System
ROV	Remotely Operated underwater Vehicle
RPL	Regional Purse-Seine Logsheet
R/V	Research Vessel
RSMAS	Rosenstiel School of Marine and Atmospheric Science
SAFE	Stock Assessment and Fisheries Evaluation
SAMI-alk	Submersible Autonomous Moored Instrument for alkalinity
SAP	Stock Assessment Program
SCADA	Supervisory Control and Data Acquisition
SCR	System Change Request
SCUBA	Self-Contained Underwater Breathing Apparatus
SDT	Software Development Team
SfM	Structure from Motion
SHCE	Sustaining Healthy Coastal Ecosystems
SIFT	Short-term Inundation Forecasting for Tsunamis
SIO	Scripps Institution of Oceanography
SL	Sea level
SMAP	Soil Moisture Active Passive
SMOS	Soil Moisture and Ocean Salinity
SOD	Science Operations Division
SOEST	School of Ocean and Earth Science and Technology
SONEL	Système d’Observation du Niveau des Eaux Littorales, dedicated center for (GNSS) data at or near tide gauge stations
SOP	Standard Operating Procedure
SPA	Seal Population Assessment
SPC	Secretariat of the Pacific Community
SPTT	South Pacific Tuna Treaty
SQL	Structured Query Language
SSC	Scientific and Statistical Committee
SSH	Sea Surface Height
SST	Sea Surface Temperature
SSTP	Survey and Sampling Technologies Program
STEM	Science Technology Engineering Math
SWFSC	Southwest Fisheries Science Center
SWS	SeaWater System
TA	Total alkalinity
TB	Terabyte
TC	Tropical cyclone
TDOA	Time difference of arrival
TG	Trailing gear

TG	Tide gauge
THREDDS	Thematic Real-time Environmental Distributed Data Services
TIGA	Tide Gauge Benchmark Monitoring Project
TMB	Template Model Builder
TNC	The Nature Conservancy
TS	Tropical Storm
TSI	Territorial Science Initiative
TWC	Tsunami Warning Centers
U.S.	United States
UAS	Unmanned Aerial System
UC	University of California
UH	University of Hawaii
UHDAS	University of Hawaii Data Acquisition System
UHM	University of Hawaii at Manoa
UHSLC	University of Hawaii Sea Level Center
UL	Unloading and Transshipment Logsheet
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNR	University of Nevada at Reno
UoG	University of Guam
USA	United States of America
USAPI	United States Affiliated Pacific Islands(Guam, Palau, Yap, Pohnpei, Majuro, Kwajalein, and Pago Pago)
USCG	United States Coast Guard
USFWS	United States Fish and Wildlife Service
VARs	Video Annotation and Reference System
VFP	Visual Fox Pro
VIAME	Video and Image Analytics for Marine Environment
VOC	Vessel Operation Coordination
WAMI	Wide Area Motion Imagery
WAP	West Antarctic Peninsula
WCPFC	Western and Central Pacific Fisheries Commission
WCPO	Western and Central Pacific Ocean
WestPac	Western Pacific Regional Fishery Management Council
WFO	Weather Forecast Office
WMO	World Meteorological Office
WPacFIN	Western Pacific Fisheries Information Network
WPE	Warm pool El Niño
WPRFMC	Western Pacific Regional Fishery Management Council
WRF	Weather Research and Forecasting model

Appendix II List of Awards and Related Amendment Numbers

JOINT INSTITUTE FOR MARINE AND ATMOSPHERIC RESEARCH (JIMAR) COOPERATIVE AGREEMENT NO. NA16NMF4320058

List of Projects described in the Annual Report for the period: July 1, 2019-June 30, 2020

Title	NOAA Technical Lead/Sponsor	Amendment Number(s)
Analysis of the Vulnerability of Military Installations in the Pacific Basin to Coastal Flooding	John Marra	31, 64, 109, 160
Atmospheric Gases in the Remote Pacific Marine Free Troposphere Measured in Hawaii	Brian Vasel	19, 39, 42, 94, 161
Cetacean Research Program	Michael Seki	8, 80, 117, 141
Characterization and Dynamics of Mesoscale and Submesoscale Oceanic Variability in the Solomon Sea Simulated by a Nested ROMS Model	Gary Matlock	3, 50, 84, 92, 98, 129, 134
Ecosystem Structure and Function	Michael Seki	10, 77, 124, 139
Ecosystems Observations and Research Program: Research Support Project	Michael Seki	37, 81, 113, 155
Ecosystems Observations and Research Program: Science Operations Project	Michael Seki	34, 71, 112, 128, 130, 154
Effects of Nitrogen Sources and Plankton Food-Web Dynamics on Habitat Quality for the Larvae of Atlantic Bluefin Tuna in the Gulf of Mexico	John Lamkin	47, 86, 136
Enhancement of Data and Research Activities for Climate Studies at the International Pacific Research Center (IPRC)	Howard Diamond	1, 43, 73, 96, 135
Fishing Impacts on Non-Target Species	Michael Seki	24, 40, 41, 56, 114, 146
Hawaiian Monk Seal Northwestern Hawaiian Islands Research Seasonal Support	Michael Seki	38, 60, 118, 147, 169
Hawaiian Monk Seal Research Program	Michael Seki	7, 65, 121, 142
Main Hawaiian Islands Commercial Fisheries Fast Track Data Project	Michael Seki	27, 52, 125
Marine Debris Mitigation Project	Michael Seki	100, 165
Marine Turtle Recovery in the Pacific Islands Region	Michael Seki	12, 68, 115, 144, 168
National Ocean Acidification Observing Network — Oahu NCRMP Class III	Dwight Gledhill	137
National Weather Service Pacific Region Fellowship	Raymond Tanabe	26, 57, 95
NCRMP Pacific Reef Assessment and Monitoring Program (RAMP)	Michael Seki	123, 157
Observation and Dynamics of Oceanic Variability in the Solomon Sea	Gary Matlock	163
Ocean Remote Sensing	Michael Seki	25, 63, 107, 151
On-site Support for OA Mooring Test-beds: Evaluating and Expanding New Carbon Technologies to Subsurface Habitats	Dwight Gledhill	138
Open Source ADMB Project	Michael Seki	33, 74, 106, 159

Optimizing Routine Ocean Current Measurements by the NOAA Fleet: Renewal for FY 2017–2021	Solomon Tadele	36, 53, 126, 164
Pacific ENSO Applications Climate (PEAC) Center	Raymond Tanabe	23, 61, 127
Pacific Fisheries Monitoring Program	Michael Seki	15, 66, 101, 150
Pacific Islands Deep Sea Coral and Sponge Initiative	Michael Seki	17, 76, 97, 162
Pacific Islands Territorial Science Initiative (PITSI)	Michael Seki	4, 54, 102, 158
Pacific Tuna Fishery Data Management	Michael Seki	13, 79, 120
Papahānaumokuākea Marine National Monument Monitoring and Research	Randall Kosaki	9, 70, 122, 145
Profiling CTD Float Array Implementation and Ocean Climate Research	Gary Matlock	32, 55, 89, 131
Socioeconomics of Western Pacific Fisheries	Michael Seki	20, 67, 116, 149
Stock Assessment Research Program	Michael Seki	21, 69, 119, 143
Sustaining Healthy Coastal Ecosystems	Michael Seki	35, 78, 108, 111, 156
Territorial Biosampling	Michael Seki	14, 72, 105, 148
Transferal of Pacific ENSO Applications Climate (PEAC) Center Products and Services to Weather Forecast Office (WFO) Honolulu	Raymond Tanabe	75, 103
Tsunami Research and Modeling	Gary Matlock	46, 133
University of Hawaii Sea Level Center	David Legler	22, 59, 82, 85, 91, 132
West Hawaii Integrated Ecosystem Assessment	Michael Seki	11, 62, 110, 140
Western Pacific Fisheries Information Network (WPacFIN)	Michael Seki	30, 48, 104, 153

Appendix III Visiting Scientists

DATE	NAME/AFFILIATION	PURPOSE OF VISIT
05/07/19- 09/10/19	Kate Anderson Volunteer Seattle, WA	To participate in the 2019 Hawaiian Monk Seal Field Camp aboard the NOAA R/V Oscar Elton Sette and at the field camps on Midway and Kure Atoll to conduct monk seal surveys.
05/15/19- 09/03/19	Eli Michael Volunteer Kailua Kona, HI	To participate in the 2019 Hawaiian Monk Seal Field Camp aboard the NOAA R/V Oscar Elton Sette and on Lisianski Island to conduct monk seal surveys.
05/15/19- 09/03/19	Kristina Kaleel Volunteer Boca Raton, FL	To participate in the 2019 Hawaiian Monk Seal Field Camp aboard the NOAA R/V Oscar Elton Sette and on Laysan Island to conduct monk seal surveys.
05/23/19- 09/03/19	Alexa Gonzalez Volunteer Honolulu, HI	To participate in the 2019 Hawaiian Monk Seal Field Camp aboard the NOAA R/V Oscar Elton Sette and at the Pearl and Hermes Reef to conduct monk seal surveys.
07/16/19- 07/17/19	Stephanie Vlachos Volunteer Honolulu, HI	To tag Hawaiian monk seal pups and monitor nursing mom and pup pairs in Kalaupapa, HI.
08/13/19- 09/03/19	Jan Willem Staman Volunteer Kailua, HI	To recover 2019 turtle field campers aboard NOAA R/V Oscar Elton Sette.
09/16/19- 09/20/19	Elan Portner Student Stanford University Pacific Grove, CA	To collaborate with the NOAA Pacific Island Fisheries Science Center (PIFSC) and assist in the ongoing lancet fish diet monitoring project and to train the new lab technician in the stomach content analysis techniques.
10/28/19- 10/30/19	Karen Shapiro Assistant Professor University of California, Davis, Davis, CA	To participate as a technical scientific expert in a collaborative JIMAR/NOAA sponsored workshop intended to inform the HMSRP's toxoplasmosis research to help identify targets for further study and ultimately mitigation of this threat to the recovery of the Hawaiian monk seal endangered species.
10/28/19- 10/30/19	Christopher Lepczyk Professor Auburn University Auburn, AL	To participate as a technical scientific expert in a collaborative JIMAR/NOAA sponsored workshop intended to inform the HMSRP's toxoplasmosis research to help identify targets for further study and ultimately mitigation of this threat to the recovery of the Hawaiian monk seal endangered species.
10/28/19- 10/30/19	Kathleen Colegrove-Calvey Clinical Professor University of Illinois Naperville, IL	To participate as a technical scientific expert in a collaborative JIMAR/NOAA sponsored workshop intended to inform the HMSRP's toxoplasmosis research to help identify targets for further study and ultimately mitigation of this threat to the recovery of the Hawaiian monk seal endangered species.

10/28/19- 10/29/19	Patricia Conrad Professor / Associate Dean University of California, Davis, Davis, CA	To participate as a technical scientific expert in a collaborative JIMAR/NOAA sponsored workshop intended to inform the HMSRP's toxoplasmosis research to help identify targets for further study and ultimately mitigation of this threat to the recovery of the Hawaiian monk seal endangered species.
10/28/19- 10/30/19	Katherine Haman Wildlife Veterinarian Washington Dept. of Fish and Wildlife, Kalama, WA	To participate as a technical scientific expert in a collaborative JIMAR/NOAA sponsored workshop intended to inform the HMSRP's toxoplasmosis research to help identify targets for further study and ultimately mitigation of this threat to the recovery of the Hawaiian monk seal endangered species.
10/28/19- 10/30/19	Tristan Burgess Principal Scientist Arcadia Wildlife Services North Yarmouth, ME	To participate as a technical scientific expert in a collaborative JIMAR/NOAA sponsored workshop intended to inform the HMSRP's toxoplasmosis research to help identify targets for further study and ultimately mitigation of this threat to the recovery of the Hawaiian monk seal endangered species.
10/28/19- 10/30/19	Tracey Goldstein Professor University of California, Davis, Davis, CA	To participate as a technical scientific expert in a collaborative JIMAR/NOAA sponsored workshop intended to inform the HMSRP's toxoplasmosis research to help identify targets for further study and ultimately mitigation of this threat to the recovery of the Hawaiian monk seal endangered species.
10/28/19- 10/30/19	James Oliver Roberts Contractor, Quantifish Wellington, New Zealand	To participate as a technical scientific expert in a collaborative JIMAR/NOAA sponsored workshop intended to inform the HMSRP's toxoplasmosis research to help identify targets for further study and ultimately mitigation of this threat to the recovery of the Hawaiian monk seal endangered species.
10/28/19- 10/30/19	Elizabeth VanWormer Assistant Professor University of Nebraska, Lincoln, Lincoln, NE	To participate as a technical scientific expert in a collaborative JIMAR/NOAA sponsored workshop intended to inform the HMSRP's toxoplasmosis research to help identify targets for further study and ultimately mitigation of this threat to the recovery of the Hawaiian monk seal endangered species.
11/13/19- 11/15/19	Charles Baker Professor Oregon State University Newport, OR	To participate at the 2019 JIMAR Symposium as a guest speaker and to collaborate with scientists at NOAA PIFSC and UH HIMB.
12/09/19- 12/12/19	Jayantha Obeysekera Research Professor Florida International University West Palm Beach, FL	To participate in the SERDP Mid-Project Review meeting in San Francisco, CA
01/09/20- 01/26/20	Volker Roeber Assistant Professor University of Pau Anglet, France	To collaborate on improving the implementation of the Boussinesq Ocean Surf Zone model for forecasting gravity wave runup on the coast of West Maui and other coasts.

02/10/20- 02/21/20	Javier Porobic Garate Research Scientist CSIRO Tasmania, Australia	To collaborate with PIFSC JIMAR staff to serve as the consultant for the Atlantis ecosystem model.
02/16/20- 02/21/20	Natalia Yingling Graduate Research Assistant Florida State University Tallahassee, FL	To present data from the NOAA Restore Act Project at the 2020 AGU Ocean Sciences meeting in San Diego, CA .

Appendix IV Workshops, Meetings and Seminars

Sea Turtles in the Pacific Islands Region

January 15, 2020, Waikiki Aquarium Seminar, University of Hawaii, Honolulu, HI

Camryn Allen, JIMAR Pacific Islands Fisheries Science Center

Improving the Utility of Shipboard ADCP Data

February 6, 2020, Dept. of Oceanography Seminar University of Hawaii at Manoa, Honolulu, HI

Jules Hummon, Oceanographic Researcher, UHM Joint Inst. for Marine and Atmospheric Research, and Research Associate, Dept. of Oceanography

Acoustic Signal Processing for Tracking Marine Mammals

February 19, 2020, Dept. of Ocean and Resources Engineering Seminar, University of Hawaii at Manoa

Pina Gruden, Postdoctoral Researcher, UHM Joint Inst. for Marine and Atmospheric Research

The Third JIMAR/PIFSC Symposium, New Technologies Driving Ocean Science Breakthroughs

November 15, 2019, Keoni Auditorium, Hawaii Imin Conference Center, East-West Center, Honolulu, HI

Ann Allen	Jeff Hare	Eva-Marie Nosal	Charley Westbrook
Camryn Allen	Brian Hauk	Brooke Olenski	Angelique White
Ruhul Amin	Fernanda Henderikx	Erin Oleson	Jonathan Whitney
Shannon Amiot	Hannah Herman	Joseph O'Malley	Kevin Wong
Jacob Asher	Elia Herman	Michael Parke	Sarah Wong
Scott Baker	Marie Hill	Frank Parrish	Shaun Wriston
Anna Baker Mikkelsen	Nan Himmelsbach	Kirsten Poff	Kym Yano
Benedetto Barone	Mark Hixon	Jim Potemra	Chip Young
Ali Bayless	Mykle Hoban	Meagan Putts	
Lars Bejder	Kim Holland	Oscar Ramfelt	
Brian Bowen	Evan Howell	Erin Reed	
Tia Brown	Melanie Hutchinson	Benjamin Richards	
John Burns	Melissa Iwamoto	Audrey Rollo	
Seth Bushinsky	Andrea Jani	Mark Royer	
Petra Byl	T. Todd Jones	Ryan Rykaczewski	
Matthew Cairns	Sam Kahng	Jennifer Samson	
Glenn Carter	Dave Karl	Jessica Schem	
Felipe Carvalho	Vikram Khurana	Eva Schemmel	
Fabio Casagrande Hirono	Randy Kosaki	Michelle Sculley	
Johnathan Casey	Fiona Langerberger	Mike Seki	
Lauren Chamberlain	Matt Lauretta	Uri Sheyn	
Richard Coleman	Anne Lee	Noriko Shoji	
Emily Contreras	Keo Lopes	Taylor Souza	
Courtney Couch	Beth Lumsden	Jennifer Stahl	
Chris Demarke	Doug Luther	Gabrielle Stedman	
Margal Dherd	Cassie Lyons	Rhonda Suka	
Jeff Drazen	Elizabeth Madin	Molly Timmers	
Akalani Dudoit	Peter Marko	Frances Tong	
Mathilde Dugenne	Paolo Marra-Biggs	Robert Toonen	
Elena Duke	Stephen Matadobra	Sarah Tucker	
Sara Ferron	Toby Matthews	Jennifer Urmston	
Tobias Friedrich	Kaylyn McCoy	Robert Uyeyama	
Atsuko Fukunaga	Jennifer McCullough	Martin van Aswegen	
Andrew Garcia	Drew McWhirter	Jesse van der Grient	
Erica Goetz	Dianna Miller-Greene	Fabien Vivier	
Alexa Gonzalez	Paula Moehlenkamp	Hannah von Hammerstein	
Andrew Gray	Virginia Moriwake	Rebecca Walker	
Pina Gruden	Josefa Munoz	Gordon Walker	
Ariel Halperin	Ilana Nimz	Maya Walton	

Appendix V JIMAR Personnel

Information as of June 30, 2020

Category	Number	High School	Associates	Bachelors	Masters	Ph.D.
Research Scientist	23	0	0	0	0	23
Visiting Scientist	0	0	0	0	0	0
Postdoctoral Fellow	0	0	0	0	0	0
Research Support Staff	76	3	3	44	24	2
Administrative	10	0	0	7	2	1
Total (≥ 50% support)	109	3	3	51	26	26
Undergraduate Students	7	7	0	0	0	0
Graduate Students	11	0	0	8	3	0
Employees that receive < 50% NOAA Funding (not including students)	6	0	0	0	1	5
Located at Lab (include name of lab)	5 - PMEL 90 - PIFSC 1 - ESRL 4 - PMNM					
Obtained NOAA employment within the last year	4					

Appendix VI Awards

Hannah Barkley

- PIFSC Team Member of the Year, Professional/Scientific/Technical

Sarah Bingo, Virginia Moriwake, and Meagan Putts

- 2019 RCUH Outstanding Employees of the Year, Honorable Mention, Team Category

Lindsey Bull

- 2020 UH Student Employee of the Year Award
- 2020 Hawaii State Winner, Western Association of Student Employment Administrators

Kevin Higaki

- PIFSC Team Member of the Year, Administrative/Support

JIMAR Marine Debris Removal Team (James Morioka, Kevin O'Brien, Joao Garriques, Tate Wester, Tomoko Acoba, Kaylyn McCoy, Rhonda Suka, Andrew Gray, Ariel Halperin, Rebecca Weible, Kristen Kelly, Tessa Code, Jessica Schem, Kelly Williams, Matthew Chauvin, Andrew McWhirter, Michael Pamatat, Steven Gnam)

- Ocean Heroes Award 2019-National Ocean Service Award; awarded for the 2018-2019 Debris Removal Mission

Dianna Miller-Greene

- PIFSC Team Member of the Year, Professional/Scientific/Technical

Ashley Uyehara

- PIFSC Team Member of the Year, Administrative/Support

Appendix VII Graduates

Nothing to report for this period.

Appendix VIII List of Progress Reports for Associated Awards

The following associated awards progress reports can be found under their respective award numbers in Grants Online.

Award#: NA17NMF4320294

Title: 2017 Marine Turtle Nearshore Assessment in the Mariana Islands

Principal Investigator: Dr. Douglas Luther

Award#: NA18NMF4320334

Title: 2018 Cetacean Density and Acoustic Analyses in the Hawaiian Islands

Principal Investigator: Dr. Douglas Luther

Award#: NA17OAR4310110

Title: Multi-model Seasonal Sea Level Forecasts for the U.S. Coast

Principal Investigator: Dr. Mark Merrifield

Award#: NA16NWS4680019

Title: Towards Advancing the MJO and 1-30-day Weather Forecasting in the Fully Coupled NGGPS

Principal Investigator: Dr. Joshua Xiouhua Fu

